turbo range extender

by Robert Hughes

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HYBRID MOTORCYCLE RANGE EXTENDER

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This thesis is the result of the author's original research. It has been composed by the author and has not been previously submitted for examination which has led to the award of a degree.

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Abstract

In 2018 two members of the Batchelor of Engineering motorcycle course at the University of Wales Trinity Saint David, designed an electric motorcycle as part of a group project, as can be seen in appendix 1, the motorcycle, designed from mainly off the shelf parts, had a power output to rival its petrol burning counterpart, being lighter was calculated to be more efficient, the biggest drawback was that the range available from the battery was limited, to stay within the weight limit set down at the start of the project of 100Kg, the team could only fit a 10amp/hour battery, utilising power limiting software within the controller (to keep the power level the same as the standard bike) an estimated 40 miles could be achieved; This range fell far short of the gasoline burning counterpart.

The idea of a range extender to fit on a motorcycle began with inspiration from analysing hybrid cars. How small could a range extender be made and still be capable of propelling the motorcycle at highway speeds but still be light enough to be fun to ride.

The initial ethos of keeping the motorcycle under 100kg would certainly not be achievable with an extender fitted as the extender would have to comprise of the motive system, be it engine or turbine, the alternator, fuel tank and the associated control gear to safely run the entire system. Although the weight would always have to be a governing factor as with more weight comes less efficiency.

The reasoning behind the selection of a turbo turbine forms a major part of this research and the reasons behind it, the environmental argument for a more efficient utilisation of available fuels and alternative fuels.

The energy created and used within the turbocharger system (under its current configuration as affixed to the engine) are investigated to realise the most optimum operating condition and output.

The finished system design should be efficient, practical and aesthetically pleasing. It must not impede the use of the motorcycle in any way and not have protruding parts that could be deemed dangerous, and the weight increase should be kept to a minimum so as to maintain the fun factor when riding.

Introduction

One of the major contributors to local atmospheric pollution is the automobile and all of it derivatives, although manufacturers strive to reduce emissions there are fundamental problems that at this point are insurmountable; figures from 2017 show that the transport sector produced 34% of the carbon dioxide output of the UK, this amounts to 124.4 million metric tonnes of CO_2 (Vanlint, 2019).

The problem being faced currently is the carbon dioxide output contributing to global warming, the overwhelming public understanding is that the automobile industry is the greatest culprit. In 2008 the UK the government mandated restrictions on the green-house gas outputs of coal and gas power stations primarily and allowed the European parliament to regulate the automotive sector (energy-uk, 2018) (José Manuel BARROSO, 2012).

There are strategies that are being investigated that show promise but as they are emergent and niche; research and development costs are prohibitive (Service, 2019).

Carbon capture technology is now starting to be seriously researched and there are some developments being made, this research is generally university lead, getting funding for large scale testing is difficult especially for something that is seen to have no end product, Drax power have recently started using carbon capture on the output of a demonstration plant at a power station in the UK, this is capturing CO_2 from a biomass generator but the cost is prohibitive (drax, 2019).

The more efficient a vehicle becomes the less CO_2 it will emit, there are only two ways of making a vehicle produce less CO_2, firstly weight, if a vehicle is lighter it will use less fuel hence less emissions, secondly making the power plant use the fuel more efficiently results in more motive force from less fuel, therefore less emissions.

A motor cycle would be the ideal candidate as it is lighter than a car, but a more efficient power plant to package onto a motorcycle is not easy.

Propulsion options

Hydrogen and hydrogen fuel cells

Hydrogen fuel cells are a method of producing electricity without a combustion process, there is theoretically only one by-product of this reaction; water.

There are many companies and universities around the world doing research on how to optimise the construction of the fuel cell, at the moment the predominant limiting factor in the optimisation is the use of platinum and other rare metals. The metals are used to thinly coat the sub-straight making the catalyst used in the reaction; it is prohibitively expensive to source and the production of the molecular sub-straight is difficult.

Research by University of California – Riverside have had some interesting results using carbon nanofibers as a reaction sub-straight, this is a very young advancement and will need much more research (UoC R, 2019).

The problems behind using hydrogen for propulsion whether in a fuel cell or for combustion is the supply network required would be vast and at this point in time massively expensive, combined with the logistics of turning hydrogen into a liquid is difficult, it requires the gaseous hydrogen after it is produced to be liquified to make it viable to contain in a vehicle, this requires either cryogenic cooling or very powerful compressors (Field, 2019).

The act of producing and liquefying hydrogen is expensive and requires a lot of energy, this energy cost must be subsequently subtracted from the overall efficiency of the vehicle system to fairly compare with other systems.

Gasoline V Diesel

On initial analysis gasoline looks to be the better of the two fuels, environmentally though diesel wins through, gasoline is less dense than diesel and has a lower specific energy output than diesel, gasoline has a energy output of 5100 Mj/Kmol and diesel has 7512 Mj/Kmol, a mol or mole is a way of scientifically measuring a quantity of a substance at a molecular level, one mole is approximately the number of atoms in a gram of hydrogen. (what if, 2018)

Alternative fuels

Ideally alternative fuels should be from renewable sources and not derived from fossil reserves, this limits the selection to methanol, ethanol and some biofuels, the major drawback is that they are less energy dense, they have a lower calorific value therefore more is required to travel the same distance; This on the face of it looks as though it is less efficient, but it would be an environmentally sound decision.

Grown Fuels

Biofuels fall into two categories, bio-diesels and bio-alcohols, alcohol by its very nature is flammable, alcohol for human consumption is made a lot stronger than when sold, it is diluted generally to 40% ABV and is mildly flammable but to be used as fuel the alcohol by volume needs to be much higher.

Alcohol fuel is made in much the same way as alcohol for human consumption, but the initial crop are of much lower quality, the fermentation with yeast is the same but to speed it along there is bacteria added, crops used, such as sugar cane and corn; Care must be taken to not take food grade crops from people that rely on them.

Crops such as oil seed rape, canola and soybeans are processed into bio-diesel, after pressing to extract the oil it still has to be refined to be useable.

The poisonous Jatropha weed grows quickly on ground that tends to be unsuitable for other crops, on drought prone land it is known to live in excess of fifty years, its seeds yield 40% oil by volume. In India they use the whole Jatropha plant, after oil extraction the waste is used as a biomass fuel (McFadden, 2018).

Grown fuels have the advantage of absorbing most of the carbon dioxide that is emitted in its use, the only CO_2 that is left over is that that is created in the refining process (McFadden, 2018).

Bio-diesel as with its oil derived counterpart is more energy rich than the bio-alcohols available, bio-alcohols are also less energy dense than gasoline requiring the engine management system to sense when a bio fuel is in the system to adjust the air fuel ratio accordingly, there are some multi-fuel cars on the market such as the 1996 Ford Taurus (USA) and the 2003 Volkswagen Gol total flex (Brazil) (Vasconcellos, 2011).

Electrical vehicle categories

Plug in electric vehicles (PEV) rely on being plugged into an electrical outlet on a regular basis and are limited on range, battery technology at the moment, although advancing slowly is limited by weight and the price and availability of the base materials.

There are other logistical problems with the availability of charging points both at home and away from home, home charging can be limited because a large number of the populous do not have off street or designated parking where charge points could be situated, the availability of charging points for public use, although getting better is still severely limited.

Plugin hybrid electric vehicles (PHEV) come in two distinct types, one where the engine is only used to charge the battery and cannot directly drive the wheels, this is called a series hybrid. The second type is the parallel hybrid where the engine both charges the battery and can take over driving the wheels through a gearbox like a conventional car.

The control of the parallel hybrid is through a management computer, the computer decides by analysing the current driving conditions such as battery charge, speed, load and to an extent the current driving style decides the most efficient motive force for the vehicle.

The series hybrid cars currently produced have limitations, the batteries, even at full charge have a limited distance and to limit weight the manufacturers fit small engine/alternator (generator) combinations that does not allow the vehicle to be used at highway speeds with a flat battery, to give a longer charging interval a larger battery or generator is required but this adds weight and hence reduces efficiency.

The parallel hybrid looks to be the best of all options but the fact there are more parts in the car means more weight and less efficiency their only saving grace, as with all electric vehicle options is the fact that they can be charged from an external source.

In an ideal world everyone would charge their vehicles from renewable sources, but this unfortunately would be, in the shorter term the exception rather than the norm.

The electricity supply in the United Kingdom is primarily from burnt fossil fuels, although figures from the Office of Gas and Electricity Markets (OFGEM), the government body set up to protect the interests of electricity and gas customers, show the amount of solid fuel used to generate electricity is falling the use of gas is rising (ofgem, 2019).

Nuclear power generation has remained fairly constant over the last ten years; the amount from renewable sources is growing strongly.

This brings the question could current power infrastructure keep up with demand as the overnight load on the national grid increases due to more car charging.

Pumped water Power plant are an essential part of the countries strategy for ensuring there is always enough electricity to supply the changing demands of the general populous, to balance peak loads, they rely on night time demand dropping, freeing up electricity generated at other stations to pump water to refill their upper reservoirs to be ready for the next day's excess demand (Anderson, 2014).

In general, most power stations can only react slowly to changing demand, nuclear power stations can take days to raise and lower their output levels because of their heated

mass, fossil fuel plants such as coal fired stations take hours, gas fired can take tens of minutes. The pumped water system can react in seconds, For example, Dinorwig power station in north Wales, UK, can go from zero to its full capacity of 1800Mw in as little as sixteen seconds, but, as the water is limited and if the night time energy surplus becomes unavailable this quick reaction time would be lost (Scottish_Renewables, 2019).

Range extender options

To circumvent the problem of the limitations of current battery technology it appears the only option is to equip vehicles with a fuel burning generator, as in the above hybrid vehicles.

Conventional internal combustion engines in regular vehicles run at variable speeds, in general their thermal efficiency is around 25%, Toyota have produced an engine that can achieve 40% thermal efficiency, one of the methods of achieving this is to raise the compression ratio and change how the fuel is introduced into the cylinder, the fuel is injected directly into the cylinder when the temperature and pressure are sufficient for the fuel to instantaneously combust when it reaches a suitable air fuel ratio (Carney, 2018).

Even at 40% efficiency, an internal combustion engine has the disadvantage of mass, their complexity and therefore weight is such that they reduce the overall efficiency of the vehicle, this then requires a bigger battery and so a bigger engine, a self-perpetuating problem.

A two cycle or two stroke engine has the advantage of being one of the lightest piston/crank engines available, unfortunately a two-stroke engine requires the addition of oil to the fuel to lubricate the internal bearings, this lubricant ultimately gets burnt and increases exhaust emissions, as this oil is burnt it produces an odour that some people find offensive (or love).

Duke engine

The Duke engine does away with the crank, it uses a reciprocating and rotating arrangement to move the pistons in and out in a circular array running in a counter rotating cylinder block, this engine has no conventional valves but instead moves its cylinders around a fixed valve head which houses open ports, spark plugs and injectors.

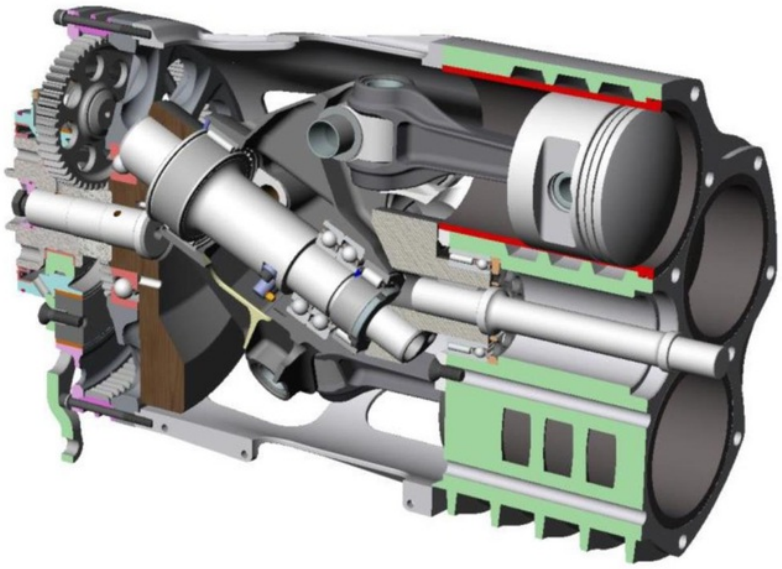


Figure 1,duke engine cutaway (ultimatemotorcycling 2019)

The Duke does save mass as compared to its conventional counterpart, there are less losses due to the absence of the valve train, but on the whole the weight savings and efficiency gains still preclude it from being light enough for the application in hand (Dukeengines, 2019).

Achates engine

The Opposed-piston architecture of the Achates engine is a method of increasing the efficiency of the engine, this option is efficient due to it running at a high compression ratio, diesel engines are inherently more efficient than their spark ignition counterparts because they run an open air intake and throttle by limiting the fuel input; this on top of diesel being more energy rich by volume makes it a win-win fuel (Naik, et al., 2015).

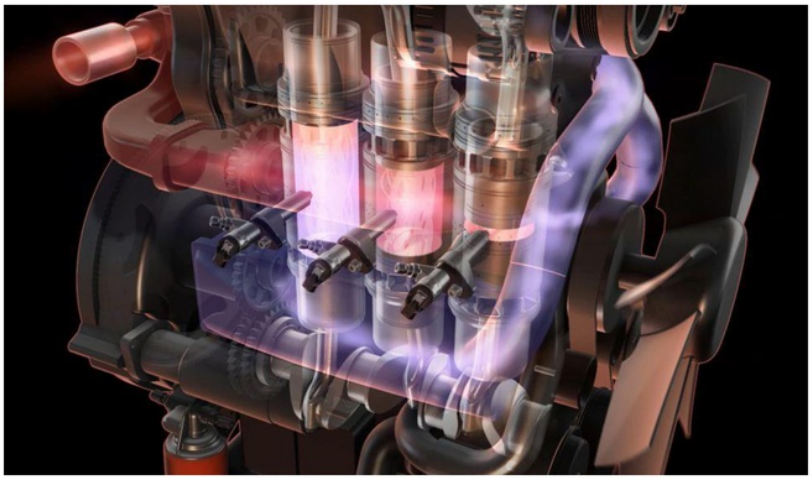


Figure 2, achates engine visualisation (Csere, 2018)

The problem arises from the fact it has two crank shafts with gears to connect them, there is a huge increase in weight, unfortunately the increase in efficiency does not make up for the increase in weight.

Free piston

Free piston linear generation is being pursued from multiple agencies around the world, they act as a conventional piston on one end and have a spring of some kind on the other, the spring ideas range from a conventional spring which reduces in stiffness as it contracts, to a cylinder which just compresses air to bounce the piston back. The generator part is coupled to, and reciprocates with, the piston.

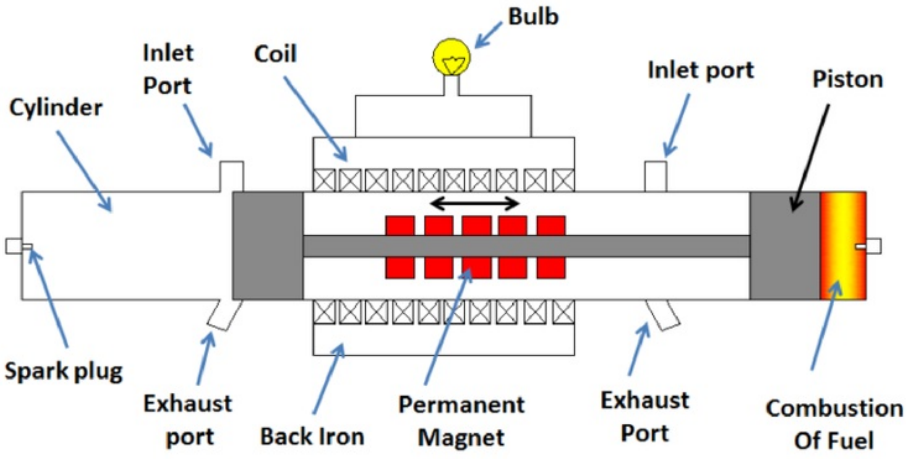


Figure 3, free piston engine detail (Mishra, 2017).

The drawback is the vibration that is generated, the amount of power produced is limited, if this were built into a vehicle which itself has a small mass the vibration would be intolerable.

turbine

The smallest of all the options is a turbine, of which there are two main designs. The first and simplest is the axial turbine where the air flow is in line with the axis of rotation, most commercial airliners use this technology.

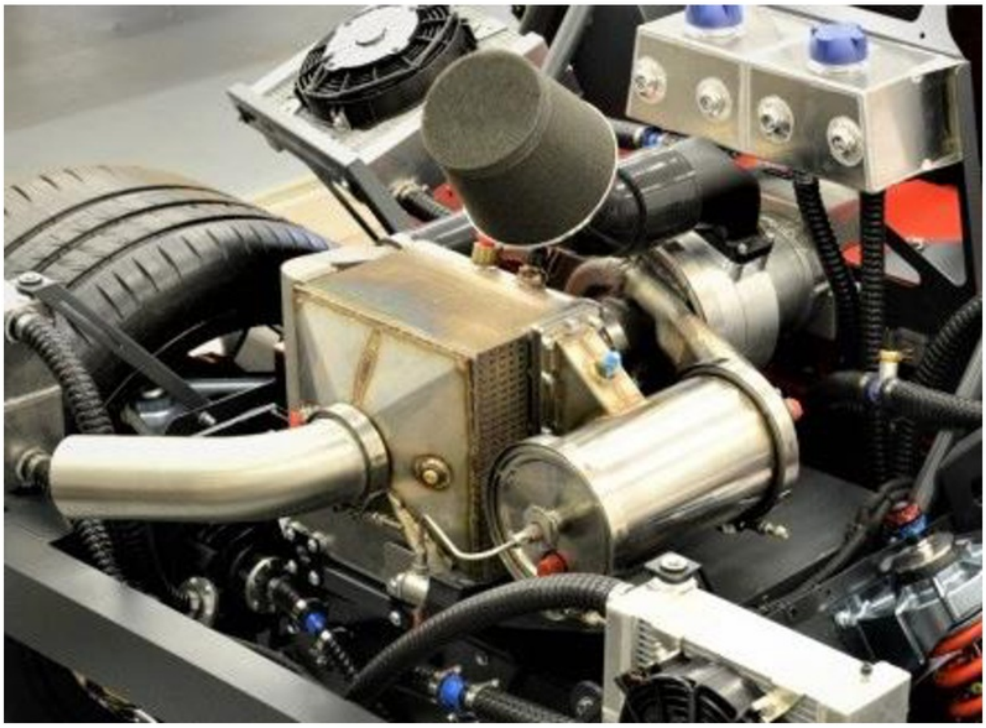


Figure 4, the Ariel Hipercar powerplant by Delta motorsport

The other is a radial flow that utilises a compressor wheel that intakes air from the end and expires it at the side, subsequently, the turbine rotor, being the powered part, receives from the side and releases axially.

Micro axial turbines excel at producing thrust whereas the Micro radial turbine gives good thrust but can also better withstand a load being mechanically taken from the rotating shaft.

Because of their simplicity, having only one moving part, they can be made small enough to be included into even the smallest of vehicles, the only opposing argument to their use is the complexity of the control gear required to run them safely.

Sizing

The development of an axial turbine for a portable gas turbine generator is not a new idea, there are already power stations that produce electricity by this means, the key is to shrink it down to a microturbine scale and maintain the utmost efficiency, complicating it still further is to package everything to safely fit on a motorcycle.

The micro turbine unit fitted to Ariel's Hipercar, manufactured by Delta motorsport, see figure 4, is not small enough to be incorporated onto a motorcycle, the technology will be very much the same but has to be on a sub micro scale.

The scale needs to be so small as to fit within the would be engine dimensions of the bike, the heat exchanger that is fitted to Ariel's car is made by a company called HiETA technologies is state of the art and works extremely well but on the scale proposed here would be far too big, the only way to package a heat exchanger for the motorcycle would be to have a tube in tube exchanger that would mimic the bikes exhaust.

Turbo selection

The turbo chosen for this study has been chosen primarily for its size but also for the extensive test information available.

The size of the turbo would neatly fit below the battery in the previously developed motorcycle, with the addition of an alternator connected for its output.

The turbocharger itself is from a Ford motor company car, utilising the Fox engine. The fox engine is a 1.6ltr engine developing, with the aid of its turbo, 133Kw power output.

Thanks to links between the University of Wales Trinity Saint David and Ford's Bridgend engine plant the data from the engine testing is available, this is invaluable as the testing procedure is long and arduous, the data will allow quantification of the power's used and created within the turbo system.

The utilisation of the turbo on the other hand is more akin to a jet engine, this means that instead of using the compressor to induce higher pressures it is used to flow a greater volume of air, the efficiency of the compressor will be determined from the Ford data and used as a benchmark from where to begin when testing eventually begins.

The power generated by the turbine to run the compressor will be calculated exactly as it would be for the engine setup, there is no change in its application.

The Compressor

The calculations to pinpoint the maximum efficiency of the compressor are from basic thermodynamic principals, it is a calculation including input pressure and temperature versus output pressure and temperature, but to achieve a power used figure the enthalpy contained in the constituent gasses have to be calculated for the temperatures pre and post compressor.

Initial supplied measurements were in the wrong units and had to be corrected before any calculations could commence, temperatures, supplied in Celsius were changed to Kelvin and pressures transposed into Pascals.

The speed the engine rotates determines the amount of air required, for calculation purposes this needs to be in kilograms per second.

Compressor input data

The air mass entering the system is detailed in figure 5. This data has been extrapolated directly from the Ford data by dividing by 3600 to reduce the Kg per hour to Kg per second, as the fuel mass has not yet entered the system it can be disregarded until the calculations for the turbine section. The cell marked in yellow in the following tables is of particular importance and will be explained later.

		air mass Kg/sec															
	rpm	800	1000	1250	1500	1750	2000	2250	2500	3000	3500	4000	4500	5000	5500	6000	6500
load	2	0.0013	0.0016	0.0019	0.0023	0.0027	0.0032	0.0035	0.0041	0.0050	0.0059	0.0075	0.0086				
	5	0.0015	0.0017	0.0022	0.0026	0.0032	0.0036	0.0041	0.0045	0.0054	0.0066	0.0082	0.0096	0.0111	0.0128	0.0145	0.0166
	10	0.0018	0.0021	0.0027	0.0032	0.0038	0.0043	0.0048	0.0053	0.0067	0.0079	0.0098	0.0112	0.0130	0.0149	0.0171	0.0196
	20	0.0025	0.0030	0.0038	0.0045	0.0054	0.0061	0.0068	0.0076	0.0091	0.0110	0.0129	0.0150	0.0172	0.0196	0.0221	0.0250
	30	0.0037	0.0039	0.0049	0.0059	0.0069	0.0078	0.0088	0.0097	0.0117	0.0141	0.0162	0.0187	0.0214	0.0244	0.0273	0.0309
	40	0.0043	0.0048	0.0060	0.0073	0.0083	0.0094	0.0106	0.0118	0.0143	0.0169	0.0196	0.0226	0.0258	0.0292	0.0328	0.0367
	50		0.0057	0.0071	0.0086	0.0098	0.0111	0.0125	0.0140	0.0168	0.0198	0.0230	0.0263	0.0300	0.0339	0.0383	0.0427
	60		0.0067	0.0083	0.0100	0.0114	0.0128	0.0146	0.0165	0.0196	0.0228	0.0267	0.0303	0.0350	0.0394	0.0441	0.0492
	70		0.0078	0.0096	0.0114	0.0132	0.0148	0.0167	0.0187	0.0222	0.0260	0.0306	0.0347	0.0399	0.0448	0.0499	0.0559
	80		0.0091	0.0109	0.0130	0.0148	0.0166	0.0186	0.0210	0.0251	0.0293	0.0344	0.0394	0.0449	0.0504	0.0558	0.0623
	90		0.0106	0.0129	0.0149	0.0170	0.0187	0.0210	0.0236	0.0283	0.0329	0.0384	0.0439	0.0496	0.0556	0.0618	0.0689
	100		0.0124	0.0151	0.0171	0.0193	0.0214	0.0236	0.0265	0.0315	0.0369	0.0429	0.0485	0.0546	0.0611	0.0675	0.0742
	110		0.0144	0.0174	0.0195	0.0217	0.0238	0.0263	0.0291	0.0344	0.0404	0.0472	0.0531	0.0593	0.0663	0.0728	0.0806
	120			0.0193	0.0215	0.0237	0.0263	0.0289	0.0318	0.0374	0.0442	0.0520	0.0578	0.0645	0.0719	0.0788	0.0879
	130			0.0211	0.0245	0.0269	0.0284	0.0315	0.0348	0.0409	0.0480	0.0559	0.0623	0.0702	0.0774	0.0870	
	140			0.0234	0.0272	0.0302	0.0311	0.0344	0.0382	0.0446	0.0523	0.0601	0.0673	0.0760	0.0843	0.0949	
	150				0.0296	0.0328	0.0333	0.0370	0.0411	0.0485	0.0566	0.0654	0.0721	0.0819	0.0933		
	160				0.0320	0.0353	0.0355	0.0396	0.0439	0.0528	0.0609	0.0705	0.0774	0.0896			
	170				0.0338	0.0380	0.0379	0.0426	0.0472	0.0568	0.0655	0.0754	0.0833				
	180					0.0379	0.0405	0.0454	0.0504	0.0598	0.0685	0.0810					
	190						0.0434	0.0483	0.0540	0.0642	0.0720						
	200						0.0458	0.0517	0.0574	0.0679	0.0784						
	201		0.0146	0.0237	0.0338	0.0392	0.0458	0.0518	0.0577	0.0676	0.0725	0.0847	0.0868	0.0955	0.0993	0.1008	0.0922

Table 1, air mass calculated from Ford data

To analyse the system from a thermodynamic stance the units of pressure supplied (in bar) needs to be in base units of pascals, also the readings supplied are gauge pressure and need to be an absolute pressure, henceforth called P1. see figure 6.

		compressor entry pressure (Pascals) (Absolute)															
	rpm	800	1000	1250	1500	1750	2000	2250	2500	3000	3500	4000	4500	5000	5500	6000	6500
load	2	99900	100000	100000	100000	100000	100000	99900	99900	99900	99900	99900	99900				
	5	100000	100000	100000	100000	100000	100000	99900	99900	99900	99900	99900	99900	99900	99800	99800	99700
	10	100000	100000	100000	100000	100000	100000	99900	99900	99900	99900	99900	99900	99800	99800	99700	99700
	20	100000	100000	100000	100000	100000	99900	99900	99900	99900	99900	99800	99800	99800	99700	99600	99500
	30	100000	100000	100000	100000	99900	99900	99900	99900	99900	99800	99800	99700	99700	99500	99400	99300
	40	100000	100000	100000	99900	99900	99900	99900	99900	99800	99800	99700	99600	99500	99400	99200	99000
	50		100000	100000	99900	99900	99900	99900	99800	99800	99700	99600	99500	99400	99200	99000	98700
	60		100000	99900	99900	99900	99900	99800	99800	99700	99600	99500	99400	99200	98900	98600	98300
	70		100000	99900	99900	99900	99800	99800	99700	99600	99500	99300	99200	98900	98600	98300	97900
	80		99900	99900	99900	99800	99800	99700	99700	99500	99400	99200	99000	98600	98200	97800	97300
	90		99900	99900	99800	99800	99700	99700	99600	99400	99200	99000	98700	98300	97900	97400	96700
	100		99900	99800	99800	99700	99600	99600	99500	99300	99000	98700	98400	98000	97400	96800	96200
	110		99900	99800	99700	99600	99600	99500	99400	99200	98900	98500	98100	97600	97000	96300	95500
	120			99700	99600	99500	99500	99400	99300	99000	98600	98200	97700	97200	96400	95700	94600
	130			99600	99500	99400	99400	99200	99100	98800	98400	97900	97400	96600	95900	94700	
	140			99500	99400	99300	99200	99100	98900	98600	98100	97500	96900	96000	95100	93700	
	150				99300	99100	99100	99000	98700	98300	97800	97100	96500	95400	93900		
	160				99100	99000	99000	98800	98500	98000	97400	96600	95900	94400			
	170				99000	98800	98900	98600	98300	97700	97100	96100	95200				
	180					98900	98700	98400	98100	97400	96700	95500					
	190						98500	98200	97800	97100	96200						
	200						98400	97900	97500	96700	95700						
	201		99900	99500	99000	98800	98400	97900	97400	96600	96200	95000	94800	93600	93000	92800	94000

Table 2, compressor entry pressure. P1.

The other requirement for thermodynamics is, as its name implies is a table of temperature, the Ford data is in Celsius and the base unit is Kelvin, the adjusted table is table 3, this will be referred to as T1.

		compressor entry temperature (Kelvin)															
	rpm	800	1000	1250	1500	1750	2000	2250	2500	3000	3500	4000	4500	5000	5500	6000	6500
load	2	308.1	297.5	299.9	302.2	303.9	303.3	305	303.6	304.3	303	300.1	298.4				
	5	305.8	297.5	299.5	301	302.4	302	303.3	302	302.2	300.7	298.2	297.2	296.9	303.2	299.3	304.6
	10	304.1	297.3	298.9	299.8	300.9	301	301.8	300.7	300.4	299	296.9	296.3	296.6	300.5	299	302.4
	20	302.1	296.8	297.9	298.5	299.6	299.7	300.2	299.5	299.1	297.6	296	295.6	296.2	299.1	298.7	301
	30	301.1	296.3	297.4	297.7	299	298.8	299.2	299	298.3	296.9	295.5	295.4	296.1	298.7	298.9	300.5
	40	300.5	296	297	297.5	298.8	298.5	298.8	298.9	298.1	296.6	295.4	295.5	296.2	298.6	299.1	300.2
	50		296	296.9	297.4	298.8	298.7	298.6	299	298.1	296.5	295.4	295.6	296.3	298.7	299.5	300.2
	60		295.9	296.9	297.6	298.9	298.7	298.7	299.1	298.2	296.4	295.4	295.8	296.6	298.9	300	300.4
	70		296	297	297.8	299	298.8	298.7	299.4	298.2	296.5	297.1	296	296.9	299.1	300.6	300.8
	80		296	297.3	297.9	299.1	299.1	298.7	299.7	298.3	296.5	296.7	296.4	297.4	299.8	301.1	301.2
	90		296.2	297.7	298.1	299.5	299	298.7	299.8	298.3	296.7	296.5	296.8	297.7	300	301.4	301.5
	100		296.6	298.1	298.4	299.8	299.1	298.7	300	298.4	297	298.2	297.3	298.2	300.1	301.6	301.5
	110		296.9	298.5	298.9	300.2	299.4	298.9	300.3	298.5	297.3	297.7	297.6	298.3	300.3	301.1	301.8
	120			299	299.4	301	299.6	299.2	300.6	298.7	297.5	297.6	297.8	298.7	300.7	300.9	301.9
	130			299.4	300	301.6	300	299.7	300.9	298.9	297.8	297.7	298.2	299.4	300.9	300.6	
	140			299.7	300.8	299.1	300.2	300.1	301.4	299.2	298.1	297.9	298.6	299.6	301.2	300.7	
	150				301.4	298.7	300.5	300.3	301.7	299.6	298.5	298.2	299.1	299.9	301.6		
	160				301.6	298.9	300.5	300.6	301.9	299.9	298.9	298.5	299.2	300.3			
	170				301.8	299.3	300.8	300.9	302.1	300.2	299.2	299	299.8				
	180					299.8	301	301.1	302.4	300.3	299.2	299.2					
	190						301.1	301.4	302.5	300.5	299.4						
	200						301.6	301.5	302.9	300.7	299.9						
	201		297.2	300.2	302.2	300.3	302	299.8	303.4	300.9	300.7	299.5	300.1	300.6	301.8	301	301.9

Table 3, temperature in Kelvin. T1.

A brief explanation of the data in the applied tables, across the top is the indicated speed the engine is rotating in revolutions per minute (RPM and the load scale on the left-hand side is the amount of power called for by the throttle. The tables have blank areas, these are RPM/load sites where it would be unreasonable to expect the engine to operate so therefore omitted; A load of 201 is a fully open throttle position.

To start the calculation the pressure and temperature of the gasses exiting the compressor also have to be converted the tables 4 and 5 show these in pascals and Kelvin; P2 and T2 respectively.

	compressor exit pressure Pa Absolute																
	RPM	800	1000	1250	1500	1750	2000	2250	2500	3000	3500	4000	4500	5000	5500	6000	6500
load	2	99600	99900	99900	100000	100300	100000	100500	100900	100400	101000	104800	105300				
	5	99600	99900	99900	99600	99500	99500	99500	99600	99600	100300	102100	101600	101600	101300	101000	100400
	10	99600	99900	99900	99600	99500	99500	99500	99500	99500	99900	100700	100100	99900	99800	99900	100100
	20	99700	100000	100400	99700	99700	99600	99700	99800	99800	100000	100600	100200	100600	100600	100800	101300
	30	100500	100700	101500	99900	100000	99900	100100	100300	100600	100900	101500	101100	101900	101900	102200	102700
	40	100700	101500	102800	100100	100500	100500	100500	100800	101400	101600	102400	102300	103200	103100	103500	104000
	50		99900	100200	100500	101300	101000	100900	101300	102000	102300	103300	103400	104400	104300	104700	105100
	60		100300	100800	101500	102400	102900	101500	101800	102600	103100	104300	104600	105600	105600	107000	113700
	70		100700	101200	102000	103500	103900	104000	103800	105900	107600	110700	111700	113700	114000	114700	115500
	80		103800	106400	103800	105500	105100	104800	105000	107000	109200	112700	113500	115000	115600	115600	116400
	90		108700	113100	107400	108600	109000	107800	105900	108100	110300	113600	115200	116500	117400	125500	129000
	100		115200	119900	117000	117100	116000	115400	114400	109800	113900	116500	124100	127200	131000	135300	136700
	110		127200	125600	123700	124300	124900	125000	121100	123900	128000	132200	133400	135600	140200	145200	149600
	120			136100	130600	128100	132900	133000	128700	132100	136600	140800	140900	147200	154600	157900	167400
	130			146000	141600	138400	137600	136500	136500	141700	145900	151700	153900	163100	167600	179000	
	140			158900	154800	150500	150900	148600	148100	155400	160500	164700	168900	177700	184800	197100	
	150				166000	162200	163200	161000	161000	168900	174100	180600	181900	195200	210600		
	160				178500	173300	176100	174100	175100	184600	188000	196600	197100	217000			
	170				187600	185500	188000	187300	189500	198800	198400	210600	213300				
	180					197600	200700	200100	203700	212500	214300	226400					
	190						214200	212500	217500	224300	229600						
	200						226200	227100	232200	238200	243700						
	201		127500	159700	187800	204200	226300	227200	233700	242000	242900	237400	222700	232800	225600	210500	176500

Table 4, compressor exit pressure.

To establish the ratio between the input and the output of the compressor the pressure out is divided by the pressure in, see table 6, this needs to be an absolute figure, hereon called P2-P1; to proceed to finding the efficiency of the compressor the input temperature multiplied by the P2-P1 figure to the power gamma, as air is predominantly a diatomic gas gamma is taken to be $\frac{1.4-1}{1.4}$ or 0.2857, this gives a figure which indicates what the reading should be if the thermodynamic system were adiabatic, this T2 perfect figure will be termed as T2perf, shown in figure 7.

Gamma (γ) is the ratio between the specific heat at a constant pressure and the specific heat at a constant volume, written in its scientific form it is $\gamma = \frac{C_p}{C_v}$.

	compressor exit temperature Kelvin															
	rpm	800	1000	1250	1500	1750	2000	2250	2500	3000	3500	4000	4500	5000	5500	6000	6500
load	2	321.9	312.1	313.2	315.3	317.2	315.6	318.4	317.3	315.9	315.5	319.9	318.3				
	5	316.6	311.5	312.1	311.6	311.6	312.3	313.1	312.1	311.7	311.6	311.9	309.9	308.7	314.5	309.1	314.3
	10	314.6	310.1	310.9	309	309.7	310	310.6	309.5	308.5	308.4	307.4	305.2	304.4	308.4	306.7	311.1
	20	312.8	308.9	310.3	307.7	308.8	308.7	308.9	308.4	307.3	306	305.2	304.1	304.9	308	308	311.7
	30	313.2	309.4	311.4	307.5	308.7	308	308.3	308.1	307.5	306.2	305.6	305.1	306.7	309.7	310.8	314.1
	40	312.9	310.5	313.2	307	308.9	308.3	308	308.5	308.2	306.9	306.8	306.8	309	312.1	313.9	317.1
	50		306	306.9	307.1	308.5	308.9	308.2	308.9	308.9	307.6	308	308.9	311.5	314.8	317.5	320.6
	60		304.6	305.4	306.3	308.2	308.6	308.8	309.5	309.8	308.8	309.9	311.4	314.6	318.4	321.6	325.2
	70		304.4	305.5	306.6	309.1	309.2	309	309.9	310.2	310.2	313.8	314.6	318.2	322.1	326	329.4
	80		307.9	311.1	308.3	310.8	310.5	309.7	310.8	311.4	311.9	315.7	317.5	321.1	326.1	329.7	333.4
	90		312.4	317.6	311.6	313.9	313.9	312.4	311.9	312.6	313.8	317.3	320.4	324.1	329.7	339.7	345.7
	100		319	324.6	321.2	322.3	320.5	319.4	319.6	314.7	317.6	322.4	328.9	334.2	341.8	349.4	353.6
	110		331.2	330	327.9	329.4	329.2	328.4	325.9	326.7	329.4	334.6	337.1	341.7	350.4	357.8	365.7
	120			340.7	334.7	333.6	336.7	336	333.2	334.1	337	342	343.9	351.5	361.7	367.6	380
	130			350.2	345.3	343.4	341.2	339.4	340.4	342.4	345	350.8	354.6	364.5	372.2	383.4	
	140			362.2	357.7	351.8	353.4	350.4	350.9	354.1	357	361	366.6	376.2	386	398.5	
	150				368.2	361.4	364.7	361.3	362.2	365.4	368	373.3	377	389.4	406.1		
	160				379.2	371	375.9	372.7	374.2	377.9	378.7	385.3	388.3	406			
	170				387.4	381.5	386.1	383.7	385.8	389.1	387	396	400.8				
	180					393.5	396.8	394.2	397.2	399.2	397.9	407.5					
	190						407.7	404.2	408	408	408.6						
	200						417.8	415.5	419.2	418.1	419.2						
	201		332.5	363.7	388.2	399.6	418.5	412.5	420.8	420.8	420.1	415.6	408	418.9	419	410.9	387.5

Table 5, compressor exit temperature.

	compressor pressure ratio															
	rpm	800	1000	1250	1500	1750	2000	2250	2500	3000	3500	4000	4500	5000	5500	6000	6500
load	2	0.9970	0.9990	0.9990	1.0000	1.0030	1.0000	1.0060	1.0100	1.0050	1.0110	1.0490	1.0541				
	5	0.9960	0.9990	0.9990	0.9960	0.9950	0.9950	0.9960	0.9970	0.9970	1.0040	1.0220	1.0170	1.0170	1.0150	1.0120	1.0070
	10	0.9960	0.9990	0.9990	0.9960	0.9950	0.9950	0.9960	0.9960	0.9960	1.0000	1.0080	1.0020	1.0010	1.0000	1.0020	1.0040
	20	0.9970	1.0000	1.0040	0.9970	0.9970	0.9970	0.9980	0.9990	0.9990	1.0010	1.0080	1.0040	1.0080	1.0090	1.0120	1.0181
	30	1.0050	1.0070	1.0150	0.9990	1.0010	1.0000	1.0020	1.0040	1.0070	1.0110	1.0170	1.0140	1.0221	1.0241	1.0282	1.0342
	40	1.0070	1.0150	1.0280	1.0020	1.0060	1.0060	1.0060	1.0090	1.0160	1.0180	1.0271	1.0271	1.0372	1.0372	1.0433	1.0505
	50		0.9990	1.0020	1.0060	1.0140	1.0110	1.0100	1.0150	1.0220	1.0261	1.0371	1.0392	1.0503	1.0514	1.0576	1.0648
	60		1.0030	1.0090	1.0160	1.0250	1.0300	1.0170	1.0200	1.0291	1.0351	1.0482	1.0523	1.0645	1.0677	1.0852	1.1567
	70		1.0070	1.0130	1.0210	1.0360	1.0411	1.0421	1.0411	1.0633	1.0814	1.1148	1.1260	1.1496	1.1562	1.1668	1.1798
	80		1.0390	1.0651	1.0390	1.0571	1.0531	1.0512	1.0532	1.0754	1.0986	1.1361	1.1465	1.1663	1.1772	1.1820	1.1963
	90		1.0881	1.1321	1.0762	1.0882	1.0933	1.0812	1.0633	1.0875	1.1119	1.1475	1.1672	1.1851	1.1992	1.2885	1.3340
	100		1.1532	1.2014	1.1723	1.1745	1.1647	1.1586	1.1497	1.1057	1.1505	1.1803	1.2612	1.2980	1.3450	1.3977	1.4210
	110		1.2733	1.2585	1.2407	1.2480	1.2540	1.2563	1.2183	1.2490	1.2942	1.3421	1.3598	1.3893	1.4454	1.5078	1.5665
	120			1.3651	1.3112	1.2874	1.3357	1.3380	1.2961	1.3343	1.3854	1.4338	1.4422	1.5144	1.6037	1.6499	1.7696
	130			1.4659	1.4231	1.3924	1.3843	1.3760	1.3774	1.4342	1.4827	1.5495	1.5801	1.6884	1.7477	1.8902	
	140			1.5970	1.5573	1.5156	1.5212	1.4995	1.4975	1.5761	1.6361	1.6892	1.7430	1.8510	1.9432	2.1035	
	150				1.6717	1.6367	1.6468	1.6263	1.6312	1.7182	1.7802	1.8599	1.8850	2.0461	2.2428		
	160				1.8012	1.7505	1.7788	1.7621	1.7777	1.8837	1.9302	2.0352	2.0553	2.2987			
	170				1.8949	1.8775	1.9009	1.8996	1.9278	2.0348	2.0433	2.1915	2.2405				
	180					1.9980	2.0334	2.0335	2.0765	2.1817	2.2161	2.3707					
	190						2.1746	2.1640	2.2239	2.3100	2.3867						
	200						2.2988	2.3197	2.3815	2.4633	2.5465						
	201		275.0000	119.4000	87.8000	86.8333	78.9375	60.5714	51.4231	41.7647	37.6053	27.4800	23.5962	20.7500	17.9429	15.3472	12.7500

Table 6, compressor pressure ratios.

	rpm	800	1000	1250	1500	1750	2000	2250	2500	3000	3500	4000	4500	5000	5500	6000	6500
load	2	307.835	297.415	299.814	302.200	304.160	303.300	305.522	304.465	304.734	303.950	304.234	302.922				
	5	305.450	297.415	299.414	300.656	301.967	301.568	302.953	301.741	301.940	301.044	300.062	298.636	298.335	304.495	300.324	305.210
	10	303.752	297.215	298.815	299.457	300.469	300.569	301.454	300.356	300.056	299.000	297.577	296.469	296.685	300.500	299.171	302.746
	20	301.841	296.800	298.240	298.244	299.343	299.443	300.028	299.414	299.014	297.685	296.676	295.938	296.876	299.869	299.724	302.546
	30	301.529	296.891	298.668	297.615	299.085	298.800	299.371	299.342	298.896	297.831	296.929	296.579	297.952	300.741	301.282	303.404
	40	301.100	297.262	299.353	297.670	299.312	299.011	299.312	299.667	299.458	298.119	297.664	297.767	299.306	301.734	302.748	304.456
	50		295.915	297.070	297.909	299.990	299.636	299.451	300.277	299.963	298.689	298.495	298.865	300.484	303.009	304.329	305.637
	60		296.153	297.662	298.954	301.018	301.236	300.145	300.800	300.653	299.339	299.403	300.141	301.946	304.551	307.090	313.155
	70		296.591	298.099	299.575	302.040	302.257	302.239	302.867	303.472	303.205	306.470	306.209	308.969	311.763	314.148	315.349
	80		299.257	302.703	301.177	303.884	303.555	302.988	304.168	304.558	304.574	307.716	308.204	310.765	314.104	315.834	317.026
	90		303.431	308.445	304.417	306.819	306.717	305.441	305.100	305.537	305.829	308.386	310.203	312.505	315.980	324.038	327.377
	100		308.925	314.145	312.269	313.901	312.414	311.534	312.203	307.094	309.139	312.667	317.679	321.268	326.619	331.880	333.338
	110		318.118	318.769	317.900	319.816	319.403	319.034	317.730	318.077	320.036	323.811	324.917	327.685	333.628	338.583	343.094
	120			326.805	323.501	323.532	325.429	325.158	323.719	324.359	326.540	329.871	330.642	336.305	344.146	347.181	355.371
	130			333.970	331.821	331.515	329.210	328.317	329.726	331.339	333.272	337.382	339.839	347.732	352.935	360.570	
	140			342.588	341.385	336.832	338.424	336.927	338.256	340.731	343.123	346.039	349.973	357.229	364.158	371.881	
	150				349.062	343.852	346.532	345.061	346.970	349.709	351.969	356.047	358.488	367.971	379.890		
	160				356.820	350.753	354.249	353.416	355.835	359.376	360.683	365.694	367.580	380.923			
	170				362.270	358.323	361.394	361.443	364.414	367.756	366.965	374.131	377.514				
	180					365.355	368.665	368.793	372.602	375.280	375.581	382.885					
	190						375.929	375.775	380.104	381.710	383.878						
	200						382.575	383.440	388.126	389.041	391.706						
	201		1479.112	1177.174	1085.372	1075.142	1052.175	968.392	935.229	873.998	847.626	771.871	740.468	714.957	688.611	656.798	624.774

Table 7, output temperature if adiabatic T2perf.

The efficiency calculation utilises the temperature input, output and the perfect output figure, $\frac{T2_{perf}-T1}{T2-T1} * 100$

The 100 figure is to give the output of this equation as a percentage, see table 8.

		%															
	rpm	800	1000	1250	1500	1750	2000	2250	2500	3000	3500	4000	4500	5000	5500	6000	6500
load	2	-1.9176	-0.5824	-0.6445	0.0000	1.9564	0.0000	3.8975	6.3154	3.7446	7.5961	20.8784	22.7245				
	5	-3.2406	-0.6074	-0.6794	-3.2499	-4.7041	-4.1961	-3.5456	-2.5683	-2.7323	3.1515	13.5891	11.3094	12.1597	11.4611	10.4474	6.2836
	10	-3.3147	-0.6639	-0.7119	-3.7296	-4.8935	-4.7863	-3.9290	-3.9147	-4.2488	0.0000	6.4512	1.9030	1.0882	0.0000	2.2240	3.9787
	20	-2.4226	0.0000	2.7417	-2.7840	-2.7943	-2.8602	-1.9751	-0.9628	-1.0436	1.0129	7.3478	3.9767	7.7753	8.6399	11.0090	14.4470
	30	3.5486	4.5124	9.0557	-0.8682	0.8813	0.0000	1.8793	3.7535	6.4751	10.0143	14.1534	12.1573	17.4743	18.5548	20.0152	21.3563
	40	4.8347	8.7023	14.5223	1.7900	5.0658	5.2156	5.5614	7.9886	13.4428	14.7445	19.8587	20.0611	24.2661	23.2173	24.6508	25.1830
	50		-0.8460	1.6954	5.2500	12.2727	9.1769	8.8642	12.9006	17.2493	19.7200	24.5604	24.5493	27.5265	26.7659	26.8263	26.6542
	60		2.9122	8.9621	15.5644	22.7775	25.6144	14.3067	16.3505	21.1458	23.7039	27.6088	27.8272	29.6987	28.9777	32.8254	51.4306
	70		7.0301	12.9312	20.1741	30.0959	33.2400	34.3579	33.0222	43.9303	48.9392	56.1075	54.8867	56.6598	55.0560	53.3396	50.8718
	80		27.3660	39.1519	31.5140	40.8922	39.0768	38.9826	40.2530	47.7741	52.4257	57.9772	55.9435	56.3941	54.3878	51.5179	49.1494
	90		44.6382	53.9960	46.7919	50.8268	51.7893	49.2062	43.8010	50.6117	53.3859	57.1426	56.7906	56.0787	53.8056	59.1072	58.5454
	100		55.0226	60.5472	60.8291	62.6693	62.2144	62.0007	62.2577	53.3366	58.9250	59.7796	64.4899	64.0787	63.5938	63.3465	61.1103
	110		61.8591	64.3447	65.5161	67.1770	67.1227	68.2496	68.0840	69.4234	70.8286	70.7618	69.1562	67.7065	66.5235	66.1076	64.6227
	120			66.6795	68.2750	69.1155	69.6207	70.5382	70.9185	72.4831	73.5194	72.6834	71.2407	71.2208	71.2229	69.3875	68.4643
	130			68.0506	70.2455	71.5661	70.8985	72.0819	72.9775	74.5722	75.1529	74.7316	73.8281	74.2433	72.9809	72.4278	
	140			68.6215	71.3275	71.5969	71.8500	73.2151	74.4569	75.6480	76.4392	76.2893	75.5483	75.2334	74.2427	72.7822	
	150				71.3507	72.0128	71.7011	73.3782	74.8267	76.1530	76.9337	77.0265	76.2367	76.0574	74.9186		
	160				71.1604	71.9179	71.2850	73.2543	74.5991	76.2517	77.4222	77.4122	76.7458	76.2756			
	170				70.6430	71.8039	71.0365	73.1193	74.4494	75.9910	77.1816	77.4549	76.9443				
	180					69.9623	70.6318	72.7101	74.0528	75.8139	77.3867	77.2713					
	190						70.1962	72.3495	73.5585	75.5438	77.3612						
	200						69.6857	71.8770	73.2813	75.2475	76.9540						
	201		3348.1921	1381.0607	910.6651	780.3039	643.9269	593.2490	538.1847	477.9802	458.0623	406.8652	408.1261	350.2594	330.0435	323.7475	377.1896

Table 8, efficiency for all loads and rev ranges.

The cell highlighted in yellow id the most efficient site, the rev range of 4000rpm and a demanded load of 170kw, figure 5 shows a graphical representation of the efficiency of the compressor showing the sweet spot in light blue at the top of the graph.

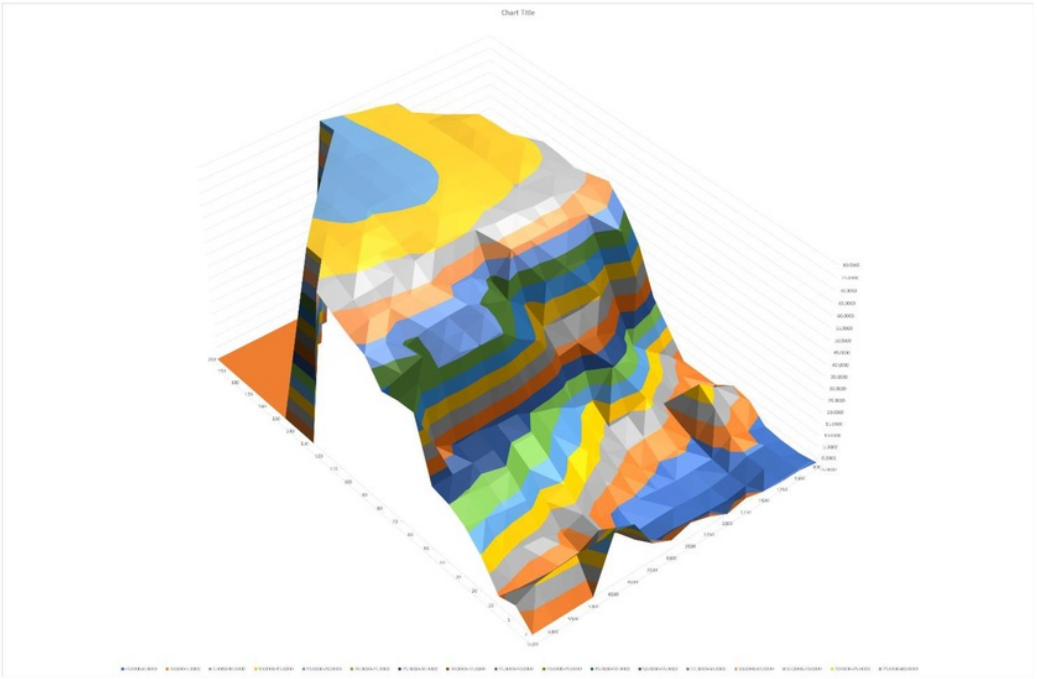


Figure 5, 3D graphical representation of efficiency.

The power usage of the compressor is calculated by analysing the energy contained in the air both going into and out of the system, the enthalpy contained in the constituent gasses in the air are temperature dependant, the colder the air the lower the enthalpy.

Enthalpy is the measure of the energy that is available within the thermodynamic system, the enthalpy has to be calculated for all temperatures that are encountered.

The temperature varies on all load site and all rpm's, the only way to calculate the enthalpy of the constituent gasses is to input the enthalpy tables for oxygen and nitrogen into a program such as excel and create a graph of temperature against enthalpy; the temperature has to be on the 'x' axis and the 'y' axis the enthalpy; the produced graph is a line where the enthalpy can be read for any temperature site.

To read from the graph with any degree of accuracy a trend line has to be generated, this has to be a polynomial expression, the polynomial is the only option of trend line that will closely mimic the original line, the polynomial has to be a fourth order polynomial and to gain accuracy it has to be calculated to fifteen decimal places.

Although Excel does a reasonable job matching the data line it loses coherence where it is needed the most, around the temperature range that is required for this study the trend line is reading lower than the data line it is supposed to follow, because the trend line

in this area is consistently below the data line, any ratio calculations will be correct but the power will read low, this lower output reading will be allowed as this will be a good base line from which to improve.

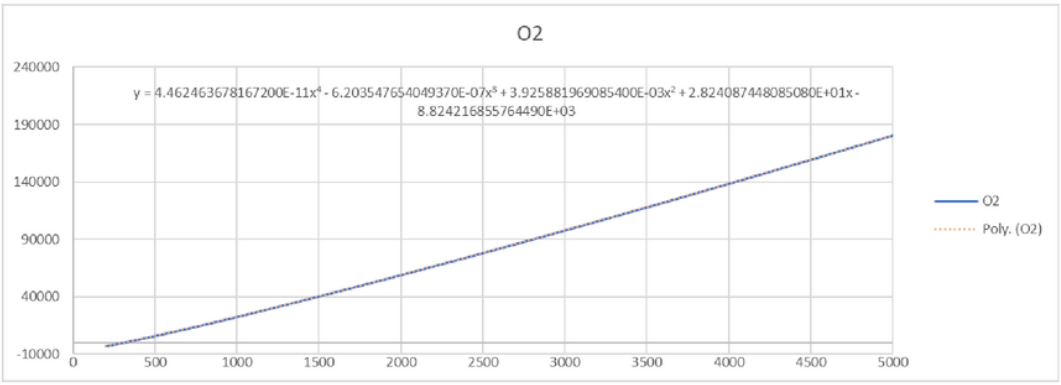


Figure 6, enthalpy graph for O2 with polynomial equation.

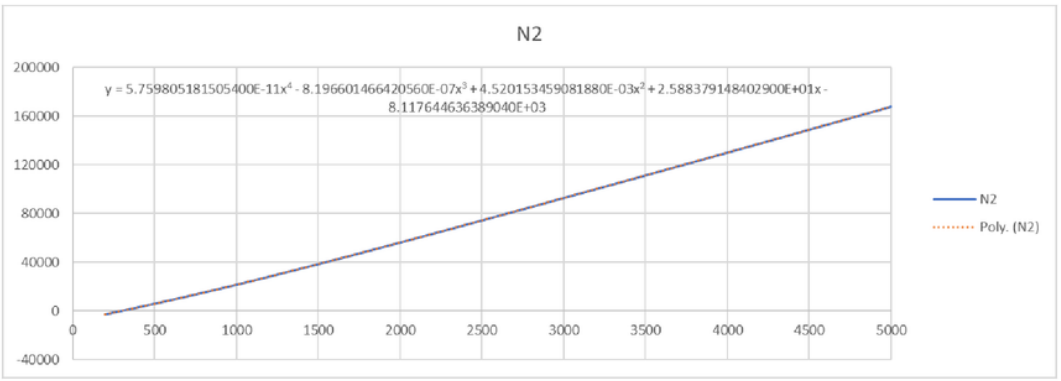


Figure 7, enthalpy graph for N2 with polynomial equation.

The graphs, figure 6 and 7 show the enthalpy tables for oxygen and nitrogen with the respective polynomial equations, these were used to attain tables of enthalpy for both the incoming and the outgoing air.

Dry air is a mixture of 78.09% nitrogen, 20.95% oxygen, the remainder being a mix of argon, CO2 and other trace inert gasses, so for this study the minor gasses will be disregarded.

The enthalpy for the air input at all load/rpm sites are detailed in table 9 and table 10 for oxygen and nitrogen respectively, table 11 is the total enthalpy for the incoming air.

y = 4.4624636781672 00E-11x4 - 6.203547654049370E-07x3 + 3.925881969085400E-03x2 + 2.824087448085080E+01x - 8.824216855764490E+03																	
compressor incoming air enthalpy O2 Kj/Kmol (T1)																	
	rpm	800	1000	1250	1500	1750	2000	2250	2500	3000	3500	4000	4500	5000	5500	6000	6500
load	2	231.7222	-91.0764	-18.0566	51.9574	103.7298	85.4550	137.2401	94.5921	115.9144	76.3184	-11.9698	-63.6985				
	5	161.6164	-91.0764	-30.2293	15.4239	58.0472	45.8678	85.4550	45.8678	51.9574	6.2920	-69.7830	-100.2011	-109.3252	82.4094	-36.3152	125.0536
	10	109.8220	-97.1596	-48.4862	-21.0999	12.3798	15.4239	39.7784	6.2920	-2.8392	-45.4436	-109.3252	-127.5716	-118.4487	0.2045	-45.4436	58.0472
	20	48.9125	-112.3664	-78.9091	-60.6562	-27.1862	-24.1431	-8.9264	-30.2293	-42.4009	-88.0347	-136.6939	-148.8559	-130.6124	-42.4009	-54.5714	15.4239
	30	18.4679	-127.5716	-94.1180	-84.9929	-45.4436	-51.5288	-39.3581	-45.4436	-66.7408	-109.3252	-151.8963	-154.9366	-133.6532	-54.5714	-48.4862	0.2045
	40	0.2045	-136.6939	-106.2839	-91.0764	-51.5288	-60.6562	-51.5288	-48.4862	-72.8251	-118.4487	-154.9366	-151.8963	-130.6124	-57.6138	-42.4009	-8.9264
	50		-136.6939	-109.3252	-94.1180	-51.5288	-54.5714	-57.6138	-45.4436	-72.8251	-121.4897	-154.9366	-148.8559	-127.5716	-54.5714	-30.2293	-8.9264
	60		-139.7345	-109.3252	-88.0347	-48.4862	-54.5714	-54.5714	-42.4009	-69.7830	-124.5307	-154.9366	-142.7750	-118.4487	-48.4862	-15.0133	-2.8392
	70		-136.6939	-106.2839	-81.9510	-45.4436	-51.5288	-54.5714	-33.2723	-69.7830	-121.4897	-103.2425	-136.6939	-109.3252	-42.4009	3.2482	9.3359
	80		-136.6939	-97.1596	-78.9091	-42.4009	-42.4009	-54.5714	-24.1431	-66.7408	-121.4897	-115.4076	-124.5307	-94.1180	-21.0999	18.4679	21.5121
	90		-130.6124	-84.9929	-72.8251	-30.2293	-45.4436	-54.5714	-21.0999	-66.7408	-115.4076	-121.4897	-112.3664	-84.9929	-15.0133	27.6006	30.6450
	100		-118.4487	-72.8251	-63.6985	-21.0999	-42.4009	-54.5714	-15.0133	-63.6985	-106.2839	-69.7830	-97.1596	-69.7830	-11.9698	33.6894	30.6450
	110		-109.3252	-60.6562	-48.4862	-8.9264	-33.2723	-48.4862	-5.8828	-60.6562	-97.1596	-84.9929	-88.0347	-66.7408	-5.8828	18.4679	39.7784
	120			-45.4436	-33.2723	15.4239	-27.1862	-39.3581	3.2482	-54.5714	-91.0764	-88.0347	-81.9510	-54.5714	6.2920	12.3798	42.8231
	130			-33.2723	-15.0133	33.6894	-15.0133	-24.1431	12.3798	-48.4862	-81.9510	-84.9929	-69.7830	-33.2723	12.3798	3.2482	
	140			-24.1431	9.3359	-42.4009	-8.9264	-11.9698	27.6006	-39.3581	-72.8251	-78.9091	-57.6138	-27.1862	21.5121	6.2920	
	150				27.6006	-54.5714	0.2045	-5.8828	36.7339	-27.1862	-60.6562	-69.7830	-42.4009	-18.0566	33.6894		
	160				33.6894	-48.4862	0.2045	3.2482	42.8231	-18.0566	-48.4862	-60.6562	-39.3581	-5.8828			
	170				39.7784	-36.3152	9.3359	12.3798	48.9125	-8.9264	-39.3581	-45.4436	-21.0999				
	180					-21.0999	15.4239	18.4679	58.0472	-5.8828	-39.3581	-39.3581					
	190						18.4679	27.6006	61.0923	0.2045	-33.2723						
	200						33.6894	30.6450	73.2731	6.2920	-18.0566						
	201		-100.2011	-8.9264	51.9574	-5.8828	45.8678	-21.0999	88.5006	12.3798	6.2920	-30.2293	-11.9698	3.2482	39.7784	15.4239	42.8231

Table 9, oxygen enthalpy at inlet temperature.

y = 5.7598051815054 00E-11x4 - 8.196601466420560E-07x3 + 4.520153459081880E-03x2 + 2.588379148402900E+01x - 8.117644636389040E+03																	
compressor incoming air enthalpy N2 Kj/Kmol (T1)																	
	rpm	800	1000	1250	1500	1750	2000	2250	2500	3000	3500	4000	4500	5000	5500	6000	6500
load	2	262.7766	-38.2858	29.8043	95.0985	143.3854	126.3405	174.6416	134.8626	154.7502	117.8190	35.4805	-12.7572				
	5	197.3791	-38.2858	18.4529	61.0269	100.7782	89.4192	126.3405	89.4192	95.0985	52.5108	-18.4307	-46.7940	-55.3015	123.4999	12.7777	163.2746
	10	149.0677	-43.9580	1.4281	26.9663	58.1881	61.0269	83.7401	52.5108	43.9953	4.2654	-55.3015	-72.3144	-63.8083	46.8337	4.2654	100.7782
	20	92.2588	-58.1371	-26.9405	-9.9203	21.2906	24.1284	38.3187	18.4529	7.1027	-35.4496	-80.8198	-92.1593	-75.1496	7.1027	-4.2462	61.0269
	30	63.8658	-72.3144	-41.1219	-32.6133	4.2654	-1.4091	9.9401	4.2654	-15.5940	-55.3015	-94.9939	-97.8286	-77.9847	-4.2462	1.4281	46.8337
	40	46.8337	-80.8198	-52.4657	-38.2858	-1.4091	-9.9203	-1.4091	1.4281	-21.2674	-63.8083	-97.8286	-94.9939	-75.1496	-7.0833	7.1027	38.3187
	50		-80.8198	-55.3015	-41.1219	-1.4091	-4.2462	-7.0833	4.2654	-21.2674	-66.6437	-97.8286	-92.1593	-72.3144	-4.2462	18.4529	38.3187
	60		-83.6548	-55.3015	-35.4496	1.4281	-4.2462	-4.2462	7.1027	-18.4307	-69.4791	-97.8286	-86.4897	-63.8083	1.4281	32.6423	43.9953
	70		-80.8198	-52.4657	-29.7769	4.2654	-1.4091	-4.2462	15.6152	-18.4307	-66.6437	-49.6299	-80.8198	-55.3015	7.1027	49.6722	55.3494
	80		-80.8198	-43.9580	-26.9405	7.1027	7.1027	-4.2462	24.1284	-15.5940	-66.6437	-60.9727	-69.4791	-41.1219	26.9663	63.8658	66.7048
	90		-75.1496	-32.6133	-21.2674	18.4529	4.2654	-4.2462	26.9663	-15.5940	-60.9727	-66.6437	-58.1371	-32.6133	32.6423	72.3829	75.2221
	100		-63.8083	-21.2674	-12.7572	26.9663	7.1027	-4.2462	32.6423	-12.7572	-52.4657	-18.4307	-43.9580	-18.4307	35.4805	78.0614	75.2221
	110		-55.3015	-9.9203	1.4281	38.3187	15.6152	1.4281	41.1569	-9.9203	-43.9580	-32.6133	-35.4496	-15.5940	41.1569	63.8658	83.7401
	120			4.2654	15.6152	61.0269	21.2906	9.9401	49.6722	-4.2462	-38.2858	-35.4496	-29.7769	-4.2462	52.5108	58.1881	86.5796
	130			15.6152	32.6423	78.0614	32.6423	24.1284	58.1881	1.4281	-29.7769	-32.6133	-18.4307	15.6152	58.1881	49.6722	
	140			24.1284	55.3494	7.1027	38.3187	35.4805	72.3829	9.9401	-21.2674	-26.9405	-7.0833	21.2906	66.7048	52.5108	
	150				72.3829	-4.2462	46.8337	41.1569	80.9007	21.2906	-9.9203	-18.4307	7.1027	29.8043	78.0614		
	160				78.0614	1.4281	46.8337	49.6722	86.5796	29.8043	1.4281	-9.9203	9.9401	41.1569			
	170				83.7401	12.7777	55.3494	58.1881	92.2588	38.3187	9.9401	4.2654	26.9663				
	180					26.9663	61.0269	63.8658	100.7782	41.1569	9.9401	9.9401					
	190						63.8658	72.3829	103.6182	46.8337	15.6152						
	200						78.0614	75.2221	114.9787	52.5108	29.8043						
	201		-46.7940	38.3187	95.0985	41.1569	89.4192	26.9663	129.1811	58.1881	52.5108	18.4529	35.4805	49.6722	83.7401	61.0269	86.5796

Table 10, nitrogen enthalpy at inlet temperature.

compressor incoming air, total enthalpy Kj/Kmol (from T1)																	
	rpm	800	1000	1250	1500	1750	2000	2250	2500	3000	3500	4000	4500	5000	5500	6000	6500
load	2	1219.7622	-235.0310	94.0076	409.5279	642.8590	560.4951	793.8924	601.6754	697.7753	519.3180	121.4367	-111.6655				
	5	903.7618	-235.0310	39.1536	244.8852	436.9733	382.0839	560.4951	382.0839	409.5279	203.7325	-139.0825	-276.1464	-317.2587	546.7691	11.7288	738.9662
	10	670.3164	-262.4416	-43.1167	80.2936	231.1673	244.8852	354.6413	203.7325	162.5830	-29.4058	-317.2587	-399.4736	-358.3677	176.2991	-29.4058	436.9733
	20	395.8057	-330.9620	-180.2054	-97.9564	52.8666	66.5799	135.1518	39.1536	-15.6947	-221.3251	-440.5762	-495.3748	-413.1748	-15.6947	-70.5373	244.8852
	30	258.6035	-399.4736	-248.7365	-207.6189	-29.4058	-56.8271	-1.9831	-29.4058	-125.3742	-317.2587	-509.0735	-522.7719	-426.8757	-70.5373	-43.1167	176.2991
	40	176.2991	-440.5762	-303.5549	-235.0310	-56.8271	-97.9564	-56.8271	-43.1167	-152.7905	-358.3677	-522.7719	-509.0735	-413.1748	-84.2470	-15.6947	135.1518
	50		-440.5762	-317.2587	-248.7365	-56.8271	-70.5373	-84.2470	-29.4058	-152.7905	-372.0700	-522.7719	-495.3748	-399.4736	-70.5373	39.1536	135.1518
	60		-454.2764	-317.2587	-221.3251	-43.1167	-70.5373	-70.5373	-15.6947	-139.0825	-385.7720	-522.7719	-467.9762	-358.3677	-43.1167	107.7219	162.5830
	70		-440.5762	-303.5549	-193.9123	-29.4058	-56.8271	-70.5373	25.4410	-139.0825	-372.0700	-289.8509	-440.5762	-317.2587	-15.6947	190.0156	217.4497
	80		-440.5762	-262.4416	-180.2054	-15.6947	-15.6947	-70.5373	66.5799	-125.3742	-372.0700	-344.6651	-385.7720	-248.7365	80.2936	258.6035	272.3221
	90		-413.1748	-207.6189	-152.7905	39.1536	-29.4058	-70.5373	80.2936	-125.3742	-344.6651	-372.0700	-330.9620	-207.6189	107.7219	299.7604	313.4801
	100		-358.3677	-152.7905	-111.6655	80.2936	-15.6947	-70.5373	107.7219	-111.6655	-303.5549	-139.0825	-262.4416	-139.0825	121.4367	327.2002	313.4801
	110		-317.2587	-97.9564	-43.1167	135.1518	25.4410	-43.1167	148.8672	-97.9564	-262.4416	-207.6189	-221.3251	-125.3742	148.8672	258.6035	354.6413
	120			-29.4058	25.4410	244.8852	52.8666	-1.9831	190.0156	-70.5373	-235.0310	-221.3251	-193.9123	-70.5373	203.7325	231.1673	368.3624
	130			25.4410	107.7219	327.2002	107.7219	66.5799	231.1673	-43.1167	-193.9123	-207.6189	-139.0825	25.4410	231.1673	190.0156	
	140			66.5799	217.4497	-15.6947	135.1518	121.4367	299.7604	-1.9831	-152.7905	-180.2054	-84.2470	52.8666	272.3221	203.7325	
	150				299.7604	-70.5373	176.2991	148.8672	340.9206	52.8666	-97.9564	-139.0825	-15.6947	94.0076	327.2002		
	160				327.2002	-43.1167	176.2991	190.0156	368.3624	94.0076	-43.1167	-97.9564	-1.9831	148.8672			
	170				354.6413	11.7288	217.4497	231.1673	395.8057	135.1518	-1.9831	-29.4058	80.2936				
	180					80.2936	244.8852	258.6035	436.9733	148.8672	-1.9831	-1.9831					
	190						258.6035	299.7604	450.6965	176.2991	25.4410						
	200						327.2002	313.4801	505.5930	203.7325	94.0076						
	201		-276.1464	135.1518	409.5279	148.8672	382.0839	80.2936	574.2215	231.1673	203.7325	39.1536	121.4367	190.0156	354.6413	244.8852	368.3624

Table 11, enthalpy or air at inlet temperature.

Now the input enthalpy is known the same procedure has to be repeated for the compressor exit gasses, tables 12 through 15 show the same as 9 through 11 but for the exit temperatures.

compressor air exit enthalpy O2 Kj/Kmol (T2)																		
	rpm	800	1000	1250	1500	1750	2000	2250	2500	3000	3500	4000	4500	5000	5500	6000	6500	
load	2	653.1061	353.7304	387.3016	451.4147	509.4474	460.5761	546.1121	512.5024	469.7382	457.5223	591.9566	543.0563					
	5	491.1186	335.4223	353.7304	338.4735	338.4735	359.8337	384.2493	353.7304	341.5247	338.4735	347.6274	286.6125	250.0165	426.9872	262.2141	420.8810	
	10	430.0404	292.7128	317.1166	259.1646	280.5125	289.6626	307.9647	274.4128	243.9181	240.8690	210.3818	143.3338	118.9608	240.8690	189.0448	323.2182	
	20	375.0930	256.1152	298.8133	219.5273	253.0658	250.0165	256.1152	240.8690	207.3335	167.7111	143.3338	109.8220	134.1934	228.6733	228.6733	341.5247	
	30	387.3016	271.3630	332.3712	213.4302	250.0165	228.6733	237.8200	231.7222	213.4302	173.8061	155.5219	140.2869	189.0448	280.5125	314.0659	414.7750	
	40	378.1450	304.9142	387.3016	198.1888	256.1152	237.8200	228.6733	243.9181	234.7711	195.1408	192.0927	192.0927	259.1646	353.7304	408.6693	506.3924	
	50		167.7111	195.1408	201.2370	243.9181	256.1152	234.7711	256.1152	256.1152	216.4787	228.6733	256.1152	335.4223	436.1470	518.6126	613.3559	
	60		125.0536	149.4277	176.8537	234.7711	246.9673	253.0658	274.4128	283.5625	253.0658	286.6125	332.3712	430.0404	546.1121	643.9320	754.0615	
	70		118.9608	152.4748	185.9969	262.2141	265.2637	259.1646	286.6125	295.7630	295.7630	405.6166	430.0404	540.0006	659.2225	778.5465	882.6556	
	80		225.6246	323.2182	237.8200	314.0659	304.9142	280.5125	314.0659	332.3712	347.6274	463.6301	518.6126	628.6431	781.6074	891.8454	1005.2358	
	90		362.8854	521.6679	338.4735	408.6693	408.6693	362.8854	347.6274	368.9890	405.6166	512.5024	607.2415	720.4016	891.8454	1198.5159	1382.8376	
	100		564.4481	735.7005	631.7007	665.3392	610.2986	576.6734	582.7865	433.0936	521.6679	668.3977	867.3406	1029.7646	1263.0013	1496.6217	1625.8917	
	110		937.8034	901.0358	836.7156	882.6556	876.5294	852.0272	775.4856	799.9744	882.6556	1042.0307	1118.7175	1259.9299	1527.3897	1755.2782	1998.9628	
	120			1229.2196	1045.0973	1011.3676	1106.4448	1084.9702	999.1042	1026.6983	1115.6492	1269.1443	1327.5160	1561.2421	1875.5269	2057.6316	2441.1032	
	130			1521.2356	1370.5421	1312.1527	1244.5739	1189.3061	1220.0078	1281.4311	1361.3211	1539.6987	1656.6875	1961.9210	2199.7699	2546.4239		
	140			1890.9506	1752.1962	1570.4760	1619.7334	1527.3897	1542.7762	1641.2888	1730.6242	1853.9364	2026.7503	2323.4810	2627.0139	3015.0781		
	150				2076.1635	1866.2735	1968.0940	1863.1891	1890.9506	1989.7015	2069.9860	2233.7800	2348.2357	2732.4672	3251.5145			
	160				2416.3328	2162.6770	2314.1990	2215.2281	2261.6124	2376.0898	2400.8534	2605.3123	2698.3418	3248.4011				
	170				2670.4268	2487.5589	2630.1144	2555.7205	2620.8131	2723.1595	2658.0218	2937.3844	3086.5920					
	180					2859.7311	2962.2420	2881.4700	2974.6724	3036.8396	2996.4280	3295.1091						
	190						3301.3380	3192.3706	3310.6817	3310.6817	3329.3709							
	200						3616.2274	3544.4625	3659.9269	3625.5905	3659.9269							
	201		977.6459	1937.2317	2695.2398	3049.2762	3638.0756	3450.9069	3709.8846	3709.8846	3688.0261	3547.5820	3310.6817	3650.5617	3653.6834	3401.0342	2673.5282	

Table 12, oxygen enthalpy at outlet temperatures.

compressor air exit enthalpy N2 Kj/Kmol (T2)																		
	rpm	800	1000	1250	1500	1750	2000	2250	2500	3000	3500	4000	4500	5000	5500	6000	6500	
load	2	656.0029	376.6070	407.9316	467.7585	521.9164	476.3080	556.1354	524.7676	484.8581	473.4581	598.9245	553.2834					
	5	504.8110	359.5247	376.6070	362.3716	362.3716	382.3017	405.0835	376.6070	365.2185	362.3716	370.9126	313.9853	279.8434	444.9634	291.2228	439.2654	
	10	447.8125	319.6766	342.4451	288.3779	308.2942	316.8309	333.9064	302.6034	274.1542	271.3097	242.8688	180.3255	157.5916	271.3097	222.9646	348.1380	
	20	396.5398	285.5330	325.3683	251.4002	282.6882	279.8434	285.5330	271.3097	240.0251	203.0642	180.3255	149.0677	171.7997	259.9324	259.9324	365.2185	
	30	407.9316	299.7582	356.6779	245.7125	279.8434	259.9324	268.4652	262.7766	245.7125	208.7497	191.6943	177.4835	222.9646	308.2942	339.5988	433.5676	
	40	399.3876	331.0603	407.9316	231.4945	285.5330	268.4652	259.9324	274.1542	265.6209	228.6511	225.8079	225.8079	288.3779	376.6070	427.8702	519.0653	
	50		203.0642	228.6511	234.3380	274.1542	285.5330	265.6209	285.5330	285.5330	248.5563	259.9324	285.5330	359.5247	453.5110	530.4702	618.8985	
	60		163.2746	186.0097	211.5925	265.6209	276.9988	282.6882	302.6034	311.1397	282.6882	313.9853	356.6779	447.8125	556.1354	647.4392	750.2482	
	70		157.5916	188.8520	220.1215	291.2228	294.0679	288.3779	313.9853	322.5224	322.5224	425.0216	447.8125	550.4315	661.7124	773.1078	870.3150	
	80		257.0883	348.1380	268.4652	339.5988	331.0603	308.2942	339.5988	356.6779	370.9126	479.1579	530.4702	633.1679	775.9656	878.8963	984.7873	
	90		385.1492	533.3216	362.3716	427.8702	427.8702	385.1492	370.9126	390.8443	425.0216	524.7676	613.1913	718.8240	878.8963	1165.3236	1337.5379	
	100		573.2490	733.1066	636.0220	667.4222	616.0449	584.6596	590.3653	450.6617	533.3216	670.2772	856.0144	1007.6961	1225.5682	1443.8700	1564.6941	
	110		921.8127	887.4782	827.4188	870.3150	864.5945	841.7157	770.2501	793.1140	870.3150	1019.1523	1090.7807	1222.6986	1472.6258	1685.6486	1913.5101	
	120			1194.0074	1022.0166	990.5140	1079.3170	1059.2584	979.0608	1004.8322	1087.9146	1231.3075	1285.8455	1504.2657	1798.0798	1968.3806	2327.1309	
	130			1466.8740	1326.0486	1271.4908	1208.3521	1156.7200	1185.4015	1242.7869	1317.4325	1484.1302	1593.4810	1878.8686	2101.3344	2425.6936		
	140			1812.5022	1682.7672	1512.8964	1558.9376	1472.6258	1487.0065	1579.0866	1662.5996	1777.8916	1939.4980	2217.0721	2501.1217	2864.4390		
	150				1985.7136	1789.4273	1884.6415	1786.5432	1812.5022	1904.8487	1979.9356	2133.1506	2240.2336	2599.8323	3085.8857			
	160				2303.9519	2066.6359	2208.3877	2115.7952	2159.1886	2266.2959	2289.4674	2480.8093	2567.8873	3082.9693				
	170				2541.7571	2370.6041	2504.0237	2434.3943	2495.3178	2591.1191	2530.1455	2791.6854	2931.4120					
	180					2718.9768	2814.9617	2739.3307	2826.6015	2884.8181	2846.9741	3126.7237						
	190						3132.5588	3030.4852	3141.3121	3141.3121	3158.8205							
	200						3427.6045	3360.3520	3468.5592	3436.3793	3468.5592							
	201		959.0206	1855.7802	2564.9837	2896.4649	3448.0801	3272.6879	3515.3816	3515.3816	3494.8946	3363.2752	3141.3121	3459.7820	3462.7077	3225.9599	2544.6601	

Table 13, nitrogen enthalpy at outlet temperatures.

compressor air exit, total enthalpy Kj/Kmol (from T2)																		
	rpm	800	1000	1250	1500	1750	2000	2250	2500	3000	3500	4000	4500	5000	5500	6000	6500	
load	2	3119.6771	1769.7727	1921.1244	2210.1868	2471.8531	2251.4941	2637.1813	2485.6285	2292.8046	2237.7247	2843.9126	2623.4020					
	5	2389.2080	1687.2352	1769.7727	1700.9905	1700.9905	1797.2880	1907.3634	1769.7727	1714.7463	1700.9905	1742.2588	1467.1971	1302.2278	2100.0495	1357.2119	2072.5187	
	10	2113.8155	1494.6969	1604.7103	1343.4653	1439.6987	1480.9468	1563.4526	1412.2017	1274.7378	1260.9934	1123.5684	821.3576	711.5052	1260.9934	1027.3918	1632.2172	
	20	1866.0825	1329.7191	1522.1981	1164.7922	1315.9733	1302.2278	1329.7191	1260.9934	1109.8278	931.2326	821.3576	670.3164	780.1603	1206.0191	1206.0191	1714.7463	
	30	1921.1244	1398.4537	1673.4801	1137.3093	1302.2278	1206.0191	1247.2493	1219.7622	1137.3093	958.7049	876.2923	807.6248	1027.3918	1439.6987	1590.9574	2044.9893	
	40	1879.8424	1549.7008	1921.1244	1068.6082	1329.7191	1247.2493	1206.0191	1274.7378	1233.5056	1054.8691	1041.1303	1041.1303	1343.4653	1769.7727	2017.4613	2458.0780	
	50		931.2326	1054.8691	1082.3477	1274.7378	1329.7191	1233.5056	1329.7191	1329.7191	1151.0505	1206.0191	1329.7191	1687.2352	2141.3484	2513.1804	2940.4143	
	60		738.9662	848.8242	972.4416	1233.5056	1288.4826	1315.9733	1412.2017	1453.4477	1315.9733	1467.1971	1673.4801	2113.8155	2637.1813	3078.3035	3574.9946	
	70		711.5052	862.5581	1013.6538	1357.2119	1370.9588	1343.4653	1467.1971	1508.4474	1508.4474	2003.6979	2113.8155	2609.6231	3147.2612	3685.4319	4155.0400	
	80		1192.2765	1632.2172	1247.2493	1590.9574	1549.7008	1439.6987	1590.9574	1673.4801	1742.2588	2265.2639	2513.1804	3009.3545	3699.2382	4196.4953	4708.0360	
	90		1811.0462	2526.9569	1700.9905	2017.4613	2017.4613	1811.0462	1742.2588	1838.5636	2003.6979	2485.6285	2912.8406	3423.1798	4196.4953	5580.1328	6411.9802	
	100		2719.8644	3492.1813	3023.1436	3174.8468	2926.6273	2774.9934	2802.5601	2127.5818	2526.9569	3188.6401	4085.9547	4818.7020	5871.1377	6925.5728	7509.1416	
	110		4403.8192	4237.9538	3947.8102	4155.0400	4127.4048	4016.8781	3671.6261	3782.0830	4155.0400	4874.0434	5220.0528	5857.2768	7064.4627	8093.3168	9193.7606	
	120			5718.6875	4887.8796	4735.7004	5164.6767	5067.7819	4680.3729	4804.8675	5206.2083	5898.8604	6162.2952	7217.2813	8636.3070	9458.7425	11191.1153	
	130			7036.6820	6356.4850	6092.9582	5787.9778	5538.5731	5677.1175	5954.3100	6314.8672	7120.0283	7648.1760	9026.4671	10100.7872	11667.0317		
	140			8705.9588	8079.4008	7258.9663	7481.3388	7064.4627	7133.9205	7578.6545	7981.9986	8538.8088	9319.2630	10659.6720	12031.2314	13785.3689		
	150				9542.4466	8594.5200	9054.3459	8580.5917	8705.9588	9151.9326	9514.5439	10254.4263	10771.5141	12507.8365	14854.4448			
	160				11079.1919	9933.2278	10617.7368	10170.6181	10380.1616	10897.3624	11009.2507	11933.1552	12353.5981	14840.3655				
	170				12227.4334	11401.0303	12045.2436	11709.0431	12003.2079	12465.7674	12171.3689	13434.1215	14108.7013					
	180					13083.0838	13546.4979	13181.3532	13602.6941	13883.7556	13701.0504	15051.5901						
	190						15079.7591	14586.9950	15122.0150	15122.0150	15206.5359							
	200						16504.0202	16179.3858	16701.7096	16546.3768	16701.7096							
	201		4583.5633	8914.9654	12339.5784	13939.9840	16602.8568	15756.2132	16927.7196	16927.7196	16828.8298	16193.4967	15122.0150	16659.3421	16673.4643	15530.6434	12241.4503	

Table 14, enthalpy or air at outlet temperature.

To calculate the energy used by the compressor to compress the air to its final pressure the total enthalpy of the incoming gasses must be taken away from the outgoing gasses, again this is done in a table for all sites recorded, table 15.

	compressor air, total enthalpy induced (T2-T1) Kj/Kmol																
	rpm	800	1000	1250	1500	1750	2000	2250	2500	3000	3500	4000	4500	5000	5500	6000	6500
load	2	1899.9149	2004.8037	1827.1168	1800.6590	1828.9941	1690.9990	1843.2889	1883.9531	1595.0293	1718.4067	2722.4760	2735.0675				
	5	1485.4462	1922.2661	1730.6191	1456.1053	1264.0173	1415.2041	1346.8683	1387.6888	1305.2184	1497.2580	1881.3413	1743.3435	1619.4864	1553.2805	1345.4831	1333.5525
	10	1443.4991	1757.1385	1647.8270	1263.1718	1208.5314	1236.0616	1208.8113	1208.4692	1112.1548	1290.3992	1440.8270	1220.8312	1069.8729	1084.6942	1056.7977	1195.2439
	20	1470.2768	1660.6812	1702.4036	1262.7486	1263.1067	1235.6479	1194.5674	1221.8398	1125.5224	1152.5578	1261.9338	1165.6912	1193.3351	1221.7138	1276.5564	1469.8611
	30	1662.5209	1797.9273	1922.2166	1344.9282	1331.6336	1262.8463	1249.2324	1249.1680	1262.6834	1275.9636	1385.3658	1330.3968	1454.2675	1510.2359	1634.0741	1868.6902
	40	1703.5433	1990.2770	2224.6794	1303.6392	1386.5463	1345.2057	1262.8463	1317.8545	1386.2961	1413.2368	1563.9022	1550.2038	1756.6402	1854.0197	2033.1560	2322.9263
	50		1371.8089	1372.1278	1331.0842	1331.5650	1400.2564	1317.7526	1359.1250	1482.5096	1523.1206	1728.7911	1825.0939	2086.7087	2211.8856	2474.0268	2805.2625
	60		1193.2426	1166.0829	1193.7667	1276.6222	1359.0199	1386.5105	1427.8963	1592.5302	1701.7453	1989.9690	2141.4564	2472.1832	2680.2980	2970.5816	3412.4116
	70		1152.0814	1166.1130	1207.5661	1386.6177	1427.7860	1414.0026	1441.7561	1647.5299	1880.5174	2293.5487	2554.3917	2926.8818	3162.9559	3495.4163	3937.5903
	80		1632.8527	1894.6588	1427.4547	1606.6521	1565.3954	1510.2359	1524.3775	1798.8543	2114.3288	2609.9290	2898.9524	3258.0910	3618.9446	3937.8919	4435.7139
	90		2224.2210	2734.5758	1853.7810	1978.3077	2046.8672	1881.5835	1661.9652	1963.9378	2348.3629	2857.6986	3243.8027	3630.7987	4088.7734	5280.3724	6098.5001
	100		3078.2321	3644.9718	3134.8091	3094.5533	2942.3219	2845.5307	2694.8381	2239.2472	2830.5118	3327.7226	4348.3963	4957.7845	5749.7010	6598.3727	7195.6615
	110		4721.0779	4335.9103	3990.9269	4019.8882	4101.9638	4059.9948	3522.7589	3880.0394	4417.4816	5081.6623	5441.3780	5982.6510	6915.5955	7834.7133	8839.1193
	120			5748.0933	4862.4386	4490.8152	5111.8102	5069.7650	4490.3573	4875.4048	5441.2393	6120.1855	6356.2076	7287.8186	8432.5745	9227.5752	10822.7529
	130			7011.2409	6248.7630	5765.7580	5680.2559	5471.9933	5445.9502	5997.4266	6508.7795	7327.6472	7787.2585	9001.0261	9869.6199	11477.0161	
	140			8639.3789	7861.9511	7274.6610	7346.1871	6943.0260	6834.1601	7580.6376	8134.7892	8719.0143	9403.5100	10606.8054	11758.9093	13581.6364	
	150				9242.6862	8665.0573	8878.0468	8431.7245	8365.0382	9099.0661	9612.5003	10393.5088	10787.2088	12413.8289	14527.2447		
	160				10751.9917	9976.3445	10441.4376	9980.6024	10011.7992	10803.3549	11052.3674	12031.1116	12355.5812	14691.4983			
	170				11872.7920	11389.3015	11827.7939	11477.8758	11607.4022	12330.6157	12173.3520	13463.5274	14028.4077				
	180					13002.7902	13301.6127	12922.7497	13165.7208	13734.8884	13703.0335	15053.5733					
	190						14821.1556	14287.2345	14671.3185	14945.7159	15181.0948						
	200						16176.8201	15865.9057	16196.1166	16342.6443	16607.7020						
	201		4859.7097	8779.8137	11930.0506	13791.1168	16220.7729	15675.9197	16353.4981	16696.5523	16625.0973	16154.3431	15000.5783	16469.3265	16318.8229	15285.7582	11873.0879

Table 15, enthalpy created through compressor.

The next step in assessing the energy used compressing the air is to give mass to the air throughput, as the oxygen has a mass of 31.999 kg/Kmol and nitrogen has a mass of 28.013 Kg/Kmol the total mass is oxygen plus nitrogen, there is 3.76 times more nitrogen to oxygen the calculation must be 31.999 + (28.013 * 3.76), this results in a weight of 137.328 Kg/Kmol.

The following table, table 16 is a reading of how many Kilojoules of energy per kilogramme of weight of air.

	enthalpy by weight (Kj/Kg)																
	rpm	800	1000	1250	1500	1750	2000	2250	2500	3000	3500	4000	4500	5000	5500	6000	6500
load	2	13.8349	14.5987	13.3048	13.1121	13.3184	12.3136	13.4225	13.7186	11.6148	12.5132	19.8246	19.9163				
	5	10.8168	13.9976	12.6021	10.6031	9.2044	10.3053	9.8077	10.1049	9.5044	10.9028	13.6996	12.6948	11.7928	11.3107	9.7976	9.7107
	10	10.5113	12.7952	11.9992	9.1982	8.8003	9.0008	8.8024	8.7999	8.0985	9.3965	10.4919	8.8899	7.7906	7.8986	7.6954	8.7036
	20	10.7063	12.0928	12.3966	9.1951	9.1977	8.9978	8.6987	8.8972	8.1959	8.3927	9.1892	8.4884	8.6897	8.8963	9.2957	10.7033
	30	12.1062	13.0922	13.9973	9.7936	9.6967	9.1958	9.0967	9.0962	9.1947	9.2914	10.0880	9.6877	10.5897	10.9973	11.8991	13.6075
	40	12.4049	14.4929	16.1998	9.4929	10.0966	9.7956	9.1958	9.5964	10.0948	10.2910	11.3881	11.2883	12.7916	13.5007	14.8051	16.9152
	50		9.9893	9.9916	9.6927	9.6962	10.1964	9.5957	9.8969	10.7954	11.0911	12.5888	13.2900	15.1951	16.1066	18.0155	20.4275
	60		8.6890	8.4912	8.6928	9.2962	9.8962	10.0964	10.3977	11.5966	12.3918	14.4906	15.5937	18.0020	19.5175	21.6313	24.8486
	70		8.3893	8.4915	8.7933	10.0971	10.3969	10.2965	10.4986	11.9971	13.6936	16.7013	18.6007	21.3131	23.0321	25.4531	28.6729
	80		11.8902	13.7966	10.3945	11.6994	11.3990	10.9973	11.1003	13.0990	15.3962	19.0051	21.1097	23.7249	26.3526	28.6751	32.3002
	90		16.1964	19.9128	13.4989	14.4057	14.9050	13.7014	12.1022	14.3011	17.1004	20.8093	23.6209	26.4389	29.7738	38.4508	44.4083
	100		22.4152	26.5421	22.8272	22.5340	21.4255	20.7207	19.6234	16.3058	20.6113	24.2320	31.6643	36.1018	41.8684	48.0483	52.3977
	110		34.3781	31.5734	29.0613	29.2722	29.8699	29.5642	25.6522	28.2538	32.1674	37.0039	39.6233	43.5647	50.3583	57.0511	64.3651
	120			41.8567	35.4075	32.7014	37.2234	36.9172	32.6981	35.5019	39.6222	44.5662	46.2849	53.0687	61.4047	67.1938	78.8096
	130			51.0548	45.5025	41.9853	41.3627	39.8462	39.6566	43.6723	47.3959	53.3588	56.7056	65.5441	71.8690	83.5738	
	140			62.9106	57.2495	52.9729	53.4938	50.5580	49.7653	55.2010	59.2363	63.4905	68.4749	77.2371	85.6265	98.8993	
	150				67.3038	63.0976	64.6485	61.3985	60.9129	66.2580	69.9967	75.6839	78.5508	90.3955	105.7851		
	160				78.2943	72.6462	76.0329	72.6772	72.9043	78.6683	80.4816	87.6087	89.9714	106.9812			
	170				86.4558	82.9351	86.1281	83.5801	84.5233	89.7896	88.6444	98.0393	102.1527				
	180					94.6843	96.8602	94.1014	95.8707	100.0153	99.7833	109.6178					
	190						107.9253	104.0374	106.8342	108.8323	110.5463						
	200						117.7971	115.5330	117.9376	119.0046	120.9347						
	201		35.3876	63.9332	86.8727	100.4247	118.1171	114.1496	119.0836	121.5817	121.0613	117.6334	109.2318	119.9270	118.8311	111.3085	86.4580

Table 16, Kj / Kg of air.

To deduce the power used in the compression of the air, it now only leaves the multiplication of the energy by the mass of air going through the system, see table 17.

		power used by compressor (Kw)															
	rpm	800	1000	1250	1500	1750	2000	2250	2500	3000	3500	4000	4500	5000	5500	6000	6500
load	2	0.0177	0.0231	0.0251	0.0302	0.0359	0.0397	0.0474	0.0556	0.0584	0.0744	0.1487	0.1715				
	5	0.0159	0.0241	0.0273	0.0277	0.0297	0.0372	0.0398	0.0455	0.0517	0.0718	0.1123	0.1217	0.1314	0.1448	0.1421	0.1616
	10	0.0190	0.0267	0.0320	0.0294	0.0337	0.0390	0.0423	0.0469	0.0544	0.0744	0.1026	0.0995	0.1013	0.1176	0.1319	0.1704
	20	0.0268	0.0359	0.0475	0.0416	0.0493	0.0550	0.0592	0.0677	0.0749	0.0923	0.1184	0.1273	0.1492	0.1740	0.2053	0.2673
	30	0.0444	0.0516	0.0692	0.0577	0.0668	0.0713	0.0798	0.0884	0.1078	0.1306	0.1637	0.1814	0.2268	0.2682	0.3252	0.4207
	40	0.0527	0.0696	0.0976	0.0688	0.0836	0.0917	0.0973	0.1133	0.1439	0.1741	0.2236	0.2546	0.3297	0.3941	0.4853	0.6207
	50		0.0572	0.0713	0.0835	0.0953	0.1130	0.1197	0.1388	0.1817	0.2190	0.2899	0.3500	0.4563	0.5463	0.6906	0.8721
	60		0.0584	0.0705	0.0867	0.1061	0.1267	0.1470	0.1719	0.2268	0.2823	0.3868	0.4730	0.6296	0.7699	0.9542	1.2224
	70		0.0652	0.0814	0.1004	0.1335	0.1539	0.1719	0.1966	0.2666	0.3557	0.5108	0.6459	0.8496	1.0320	1.2698	1.6033
	80		0.1080	0.1510	0.1348	0.1729	0.1893	0.2050	0.2334	0.3286	0.4508	0.6546	0.8309	1.0656	1.3293	1.6010	2.0107
	90		0.1723	0.2567	0.2010	0.2445	0.2782	0.2877	0.2861	0.4044	0.5634	0.7983	1.0367	1.3109	1.6558	2.3754	3.0617
	100		0.2783	0.3996	0.3893	0.4344	0.4595	0.4898	0.5195	0.5141	0.7603	1.0400	1.5357	1.9696	2.5598	3.2446	3.8876
	110		0.4937	0.5490	0.5667	0.6342	0.7111	0.7785	0.7468	0.9724	1.2983	1.7464	2.1044	2.5812	3.3362	4.1521	5.1903
	120			0.8092	0.7613	0.7758	0.9771	1.0665	1.0391	1.3274	1.7511	2.3174	2.6742	3.4215	4.4143	5.2915	6.9309
	130			1.0792	1.1135	1.1278	1.1765	1.2552	1.3803	1.7869	2.2750	2.9836	3.5315	4.6026	5.5599	7.2709	
	140			1.4714	1.5569	1.5980	1.6643	1.7372	1.9008	2.4626	3.0951	3.8165	4.6106	5.8679	7.2164	9.3899	
	150				1.9892	2.0717	2.1532	2.2734	2.5025	3.2117	3.9606	4.9489	5.6600	7.4049	9.8703		
	160				2.5054	2.5648	2.6992	2.8748	3.1977	4.1541	4.8982	6.1764	6.9653	9.5837			
	170				2.9179	3.1515	3.2657	3.5568	3.9914	5.1030	5.8062	7.3911	8.5070				
	180					3.5927	3.9255	4.2764	4.8335	5.9787	6.8324	8.8760					
	190						4.6828	5.0285	5.7661	6.9864	7.9563						
	200						5.3958	5.9756	6.7683	8.0791	9.4867						
	201		0.5171	1.5149	2.9344	3.9361	5.4137	5.9104	6.8738	8.2169	8.7803	9.9629	9.4819	11.4497	11.7973	11.2143	7.9709

Table 17, power used by the compressor to compress the air.

As can be seen the power required to compress the air from 96100 Pa to 210600 Pa is 7.39 Kw.

The Turbine

The power used by the compressor is solely supplied by the turbine or hot end of the turbo. The turbine will also be supplying the power to run the alternator to ultimately charge the battery of the vehicle.

This power is created, not by the flow of gasses into the turbine but the heat used in its transit through the thermodynamic system. The heat difference is used to calculate the power created through the loss of enthalpy from the entry of the gasses to the exit of said gasses, this has to be calculated for the gaseous constituents of the exhaust, as this is post combustion the combustion has to be modelled to give an accurate gas mixture.

The gasses are carbon monoxide, carbon dioxide, water, oxygen and nitrogen, all of which have differing enthalpies at different temperatures, this should be done for different fuels as a turbine can run on anything that is liquid and will combust to a greater or lesser power output.

The nitrogen output under certain circumstances can combine with other constituent gasses to form nitrogen oxides and sulphides, the output of these gasses can be modelled using the Zeldovich model method but as there are so many rpm/load sites it would need to be automated in Excel, this is proving very time consuming and will not be pursued further at this juncture.

The power produced by the turbine is not straight forward to calculate, there are many things which need to be accounted for, the enthalpies of all the constituent gasses at all the differing temperatures for the input and the output, there are five constituent gasses which when tabulated through the polynomial results in very large figures, therefore the tables will be detailed in appendix 2a and 2c, the inlet and output gas enthalpies have to be totalled to derive the power available at the turbine.

Turbine inlet enthalpy tables are detailed in appendix 2a and exit enthalpies in appendix 2c.

The tables and calculations within this study assume that the combustion process is running at a lambda reading of one, the excel document the author has produced has an option to change lambda and indeed the type of fuel, it accurately mimics the combustion process and outputs the exhaust gasses and ratios, to document every table for every fuel ratio would run into hundreds of tables, these will not be included within this document.

The constituent gas mixture varies with the varying fuel air mixture, when fuel ratio is lean, a lambda figure of greater than one, the combustion process gives carbon dioxide, water vapour, oxygen and nitrogen but when the mixture is rich IE lambda less than one, there is no oxygen in the exhaust gasses but instead it is replaced by carbon monoxide, the enthalpy difference between carbon monoxide and oxygen is significant, as this study is run at lambda 1 there is no carbon monoxide or excess oxygen.

The enthalpy calculation gives an output that is in Kilojoules per Kmol, this has to be converted into a form that can be calculated with later on, through the combustion modelling the amount of constituent gasses is also modelled in Kmol, fortuitously this can be directly multiplied to the enthalpy calculation to give the amount of energy contained in the gas, this has to be repeated for all the gasses, see appendix 2b.

Again, the enthalpy is dependent on the temperature of the gasses entering the turbine, the temperatures are detailed in table 18.

	turbine entry temperature Kelvin																
	rpm	800	1000	1250	1500	1750	2000	2250	2500	3000	3500	4000	4500	5000	5500	6000	6500
load	2	512.4	576.6	662.7	671.8	726	806.9	802.2	835.3	912.8	944.1	954.2	970.7				
	5	523.8	585.8	676.7	719.3	764.2	813	826.2	836.9	891.3	918.3	953.9	973.3	1002.1	1004.5	1007	1037.1
	10	589.8	632.1	701.3	725.8	755	770.9	792.2	809.1	867.2	909.7	956.4	986.2	1015	1022.2	1032.4	1055.8
	20	606.6	652.5	698.6	746.1	773.8	798	821.1	846.2	888.8	929.2	964.7	1001.8	1029.4	1047.5	1056.2	1079.4
	30	657.4	688.8	731.8	763.8	785.9	802.6	836.4	861.3	907.9	946.2	978.8	1008	1038	1063	1076.9	1097.4
	40	678.2	715.6	755.5	785.6	803.7	822.3	855.2	878.6	929.9	965.9	996.2	1021.6	1050.1	1068.2	1087.2	1107
	50		732.7	778.5	811.9	832.2	853.7	877.9	903.6	947.6	981.4	1014.9	1036	1060.2	1073.4	1097.4	1117.2
	60		751.4	803.5	835.4	857.7	880.1	906.9	933.1	968.4	996.2	1030.6	1050.3	1072.5	1090.1	1110.3	1130.9
	70		772.7	828.6	861.2	886.4	902.6	929.9	948.9	980.5	1011.7	1044.1	1063.7	1083.7	1099.7	1120.7	1144.6
	80		790.8	847.8	872.8	900.6	918.4	944.5	963.9	1001.8	1027.5	1058	1076.3	1091.1	1116.1	1130.1	1157.6
	90		811.7	868.5	883.1	909.2	938.1	959.1	973.5	1009.4	1040.9	1064.9	1089.3	1099.9	1120.1	1145.9	1178.5
	100		818.2	882.2	896.5	918	945.2	967.4	983.1	1019.5	1057.9	1079.5	1102.3	1113.5	1137.6	1160.5	1180
	110		846.9	896.2	921.2	926.4	957	979.4	993.8	1034.5	1073.9	1105.3	1119.8	1123.9	1148.4	1169.7	1195.5
	120			908	925.3	941.1	977.6	993.9	1008.6	1048.4	1093	1123.8	1136.3	1145	1171.3	1183.7	1216.9
	130			910.2	933.6	961.4	994.4	1013.9	1035	1076.1	1111	1137.9	1152.1	1174.9	1188.1	1222.6	
	140			920.1	946	972.3	1021.6	1044.5	1067.2	1105.2	1134.6	1157.9	1174.8	1199.6	1215.2	1242	
	150				951.9	982.9	1044.7	1068.2	1092.8	1128.8	1155.8	1180.4	1189.1	1221.1	1255.2		
	160				964.1	991.1	1066.1	1090.7	1117.3	1154.8	1176	1201.4	1206	1247			
	170				973.1	1002.1	1081.3	1109.8	1138.7	1174.4	1152.5	1217.7	1226.6				
	180					1044.9	1096.3	1123.5	1156.2	1182.1	1194.7	1236.1					
	190						1112.3	1136	1171.9	1182.2	1226.1						
	200						1126.9	1153.4	1189	1197.1	1247.1						
	201		847	916.5	973.8	1053	1126.6	1152.2	1190.4	1201.8	1222.6	1248.3	1240.7	1268.1	1268.5	1253.7	1219

Table 18, gas temperature at turbine inlet in Kelvin.

All the enthalpies once multiplied by the combustion model outputs and added together give a figure in kilojoules, this is not the true energy output as yet as it only gives a potential figure, the figure has to be associated to another to give it either a time or a mass, in this case the amount of gasses passing through the system per second is the governing factor with which the power can be attributed, the output of this amalgamation is a table of powers in kilojoules per kilogramme, see table 19.

	total enthalpy contained in gasses entering turbine Kj/Kg																
	rpm	800	1000	1250	1500	1750	2000	2250	2500	3000	3500	4000	4500	5000	5500	6000	6500
load	2	318.7954	517.4340	816.5658	1022.5507	1378.1070	1976.5902	2143.8514	2634.7019	3770.0153	4699.2285	6030.6897	7107.9192				
	5	386.8898	581.7604	974.5771	1312.2706	1803.3451	2244.1894	2587.4524	2933.1049	3930.4415	4983.9926	6583.8953	7943.9853	9660.3320	11146.6586	12670.4651	15200.9915
	10	618.6896	822.1343	1280.9697	1632.7067	2099.3643	2460.1223	2857.4059	3286.3926	4643.6748	5904.1432	7889.1742	9468.8310	11494.4164	13305.8143	15545.6570	18374.4077
	20	908.0596	1248.0280	1827.9223	2429.0647	3063.4486	3679.5344	4298.4796	5051.1254	6566.8921	8483.0728	10537.9338	12994.8046	15501.0490	18127.0518	20724.1338	24208.5813
	30	1560.6986	1831.8541	2562.0889	3289.3277	4042.1180	4712.2009	5716.3878	6642.6176	8716.2465	11150.8721	13563.4578	16374.0565	19581.5629	23110.6642	26397.5892	30710.1075
	40	1919.6439	2392.9306	3304.6383	4251.6165	5045.0176	5928.6786	7148.0487	8330.2152	11002.6597	13855.9109	16869.6257	20131.4400	23982.6505	27863.8819	32106.3890	36922.3882
	50		2971.9637	4121.6757	5336.4575	6349.8460	7465.8737	8788.9709	10352.1928	13386.6530	16581.1999	20350.2162	24008.0628	28341.3234	32606.2339	38081.9809	43554.2736
	60		3650.8289	5060.3465	6481.4949	7748.9579	9061.9178	10804.3413	12831.7023	16083.6572	19567.6034	24146.8078	28231.9123	33579.8714	38800.7901	44589.8656	51099.2171
	70		4434.1341	6145.9914	7798.6273	9462.3319	10907.1485	12893.3651	14922.8890	18630.3022	22843.4365	28212.6241	32930.6475	38872.1605	44653.4298	51128.9971	59113.8020
	80		5385.9723	7288.2365	9055.6395	10847.7349	12580.3396	14751.4101	17175.2286	21735.4113	26363.6552	32410.3282	37988.8844	44248.3873	51388.1843	57928.4192	66902.8013
	90		6588.8112	8902.5952	10588.8269	12645.4316	14616.0038	17021.9058	19606.2590	24789.7140	30256.7776	36451.8169	43130.4847	49434.8838	56952.1312	65425.1038	76061.8439
	100		7789.9118	10650.9827	12426.5880	14581.9869	16984.2422	19419.1962	22294.1440	28063.4673	34716.4227	41630.4639	48519.5878	55400.7625	64067.0474	72905.8490	82283.0259
	110		9500.1197	12605.7003	14792.8698	16626.2521	19223.1012	22045.6052	24927.3908	31319.2414	38866.7380	47426.5712	54392.0149	61007.9964	70402.0161	79642.4398	91135.7946
	120			14310.2990	16413.8037	18660.7942	21909.4954	24739.6696	27832.6234	34714.2486	43694.3796	53553.0426	60461.4721	68219.5038	78702.7838	87748.5583	102109.8354
	130			15701.7540	18915.9662	21768.6295	24377.5194	27811.7199	31704.4561	39507.4679	48613.7352	58650.3401	66510.4031	77139.7100	86553.6688	101655.1944	
	140			17663.9094	21452.3225	24860.2202	27784.0813	31734.9528	36440.3430	44823.9520	54571.6237	64668.6383	73974.7528	86059.0063	97447.3041	113631.9044	
	150				23532.3259	27516.2830	30764.0120	35368.7528	40610.2599	50243.6744	60713.7241	72337.3455	80655.0333	95366.3469	113152.9741		
	160				25995.3556	29980.2695	33809.1666	38978.4165	44796.8374	56584.6482	66965.9676	80003.9635	88522.8112	107689.0404			
	170				27817.7855	32833.4002	36890.8355	43025.5601	49590.4360	62410.1526	70248.9244	87294.5835	97597.8586				
	180					35011.4228	40250.3955	46789.0602	54136.9061	66396.8287	77314.7216	95883.5435					
	190						44025.1995	50593.5579	59096.4910	71468.0165	84285.9051						
	200						47367.6625	55375.4883	64170.4339	76928.1236	93915.8848						
	201		9661.1287	17776.9250	27872.3696	36581.1416	47378.7401	55336.0944	64654.8658	77126.9157	84685.9475	101699.0445	103412.7277	117635.5419	122392.4600	122348.9370	107515.0839

Table 19,enthalpy entering turbine per kilogramme of gas.

The total figure of power contained in the gas is now extrapolated by multiplying the entries in table 19 with the volume of gas entering the turbine, gas volume detailed in table 20 and the results in table 21.

	exhaust total mass per sec Kg/sec															
	rpm	800	1000	1250	1500	1750	2000	2250	2500	3000	3500	4000	4500	5000	5500	6000	6500
load	2	0.0014	0.0017	0.0020	0.0025	0.0029	0.0034	0.0038	0.0043	0.0054	0.0063	0.0080	0.0092				
	5	0.0016	0.0018	0.0023	0.0028	0.0034	0.0039	0.0043	0.0048	0.0058	0.0070	0.0087	0.0102	0.0119	0.0137	0.0155	0.0178
	10	0.0019	0.0022	0.0028	0.0034	0.0041	0.0046	0.0051	0.0057	0.0072	0.0085	0.0104	0.0120	0.0139	0.0159	0.0183	0.0209
	20	0.0027	0.0032	0.0041	0.0048	0.0057	0.0065	0.0073	0.0081	0.0098	0.0117	0.0138	0.0160	0.0183	0.0209	0.0236	0.0267
	30	0.0039	0.0042	0.0053	0.0063	0.0074	0.0083	0.0094	0.0104	0.0125	0.0150	0.0173	0.0200	0.0229	0.0260	0.0292	0.0330
	40	0.0045	0.0051	0.0064	0.0077	0.0088	0.0100	0.0113	0.0126	0.0152	0.0181	0.0210	0.0241	0.0275	0.0312	0.0350	0.0392
	50		0.0061	0.0076	0.0092	0.0105	0.0118	0.0133	0.0150	0.0180	0.0211	0.0246	0.0281	0.0321	0.0362	0.0409	0.0456
	60		0.0072	0.0089	0.0106	0.0122	0.0137	0.0155	0.0176	0.0209	0.0243	0.0285	0.0324	0.0373	0.0421	0.0471	0.0525
	70		0.0083	0.0102	0.0122	0.0141	0.0158	0.0178	0.0200	0.0237	0.0277	0.0327	0.0371	0.0426	0.0478	0.0533	0.0597
	80		0.0097	0.0117	0.0138	0.0158	0.0177	0.0199	0.0225	0.0268	0.0313	0.0368	0.0420	0.0480	0.0539	0.0596	0.0665
	90		0.0114	0.0137	0.0159	0.0181	0.0199	0.0224	0.0252	0.0302	0.0352	0.0410	0.0469	0.0529	0.0594	0.0660	0.0737
	100		0.0132	0.0160	0.0182	0.0206	0.0229	0.0252	0.0283	0.0337	0.0394	0.0458	0.0518	0.0583	0.0653	0.0722	0.0795
	110		0.0153	0.0185	0.0208	0.0231	0.0254	0.0281	0.0311	0.0368	0.0431	0.0504	0.0567	0.0633	0.0708	0.0780	0.0864
	120			0.0205	0.0229	0.0253	0.0280	0.0309	0.0339	0.0399	0.0472	0.0556	0.0617	0.0689	0.0769	0.0844	0.0944
	130			0.0225	0.0260	0.0286	0.0304	0.0336	0.0372	0.0437	0.0513	0.0598	0.0666	0.0750	0.0828	0.0934	
	140			0.0248	0.0289	0.0321	0.0332	0.0367	0.0408	0.0477	0.0558	0.0642	0.0720	0.0812	0.0903	0.1021	
	150				0.0314	0.0349	0.0356	0.0396	0.0439	0.0518	0.0605	0.0699	0.0771	0.0877	0.1001		
	160				0.0340	0.0376	0.0379	0.0423	0.0469	0.0564	0.0650	0.0754	0.0829	0.0962			
	170				0.0358	0.0404	0.0405	0.0455	0.0505	0.0607	0.0703	0.0806	0.0892				
	180					0.0405	0.0433	0.0486	0.0539	0.0640	0.0734	0.0867					
	190						0.0464	0.0517	0.0577	0.0689	0.0771						
	200						0.0490	0.0553	0.0613	0.0728	0.0839						
	201		0.0155	0.0251	0.0359	0.0418	0.0490	0.0554	0.0617	0.0726	0.0778	0.0907	0.0930	0.1026	0.1067	0.1084	0.0992

Table 20, volume of gasses entering turbine.

	total enthalpy contained in all gasses entering turbine Kw																
	rpm	800	1000	1250	1500	1750	2000	2250	2500	3000	3500	4000	4500	5000	5500	6000	6500
load	2	0.4357	0.8753	1.6467	2.5166	3.9659	6.7973	8.0752	11.4024	20.2324	29.8140	48.2958	65.3336				
	5	0.6083	1.0698	2.2551	3.6561	6.2065	8.6526	11.1979	14.0871	22.8402	35.0264	57.5908	81.2714	114.9311	152.4615	196.2514	270.1554
	10	1.1927	1.8292	3.6472	5.5693	8.5899	11.3781	14.6521	18.7051	33.3184	49.8900	82.3542	113.1525	159.5808	211.5624	284.4855	384.2803
	20	2.4240	3.9625	7.4792	11.7405	17.5297	23.9987	31.2237	41.0264	64.0454	99.6054	144.9844	208.0613	284.0998	378.4526	488.5715	645.4277
	30	6.1084	7.7091	13.5150	20.6679	29.7208	38.9804	53.5594	68.9356	109.0741	167.2941	234.8739	327.2537	447.7107	601.7760	770.0763	1013.5189
	40	8.7131	12.2704	21.2598	32.9028	44.5783	59.2538	80.7531	104.9839	167.3627	250.1762	353.6530	484.7203	659.9892	868.4243	1123.1885	1446.3320
	50		18.1455	31.4049	49.0361	66.6381	88.3462	117.0154	155.0241	240.5507	349.5870	500.2761	674.9600	908.5756	1180.6174	1558.5051	1985.5909
	60		26.1947	44.8684	68.9919	94.4512	123.8966	167.8875	226.4083	335.7463	475.8189	688.1840	914.3218	1253.7418	1633.9444	2100.1827	2684.6961
	70		36.8156	62.8769	95.0349	133.5503	172.3935	229.8242	298.2920	441.9522	633.3977	921.2205	1220.6293	1654.3344	2136.1705	2723.7553	3530.2434
	80		52.2140	85.1509	125.3955	171.1230	223.1263	293.5940	385.6316	582.0864	824.0839	1191.8898	1596.1663	2122.0789	2768.1102	3453.8211	4448.1071
	90		74.7830	122.1634	168.2447	229.0579	291.3051	381.7162	494.8947	748.5116	1064.4502	1493.1069	2021.1424	2617.4398	3382.1656	4317.1482	5602.1661
	100		103.1514	170.5045	226.1984	299.9839	388.7504	490.2268	630.3050	944.8814	1367.7306	1908.4098	2513.3146	3228.3255	4183.9341	5262.9922	6544.0148
	110		144.9296	232.8903	307.0342	384.4359	488.4804	619.9102	775.0341	1151.1561	1676.3440	2391.7483	3086.1425	3861.8062	4983.0938	6209.0131	7878.1831
	120			293.9574	375.3746	472.4809	614.0136	763.2875	944.6856	1386.1592	2063.9526	2976.0616	3732.4882	4699.1868	6051.3696	7408.6595	9640.8703
	130			352.5480	491.6049	621.9781	740.5349	935.7871	1178.7893	1726.8056	2494.0197	3505.0095	4426.6368	5787.6210	7169.7693	9491.4890	
	140			438.6047	619.3762	797.1844	923.2805	1164.9372	1487.3733	2136.7329	3047.3704	4154.4211	5323.0999	6990.3818	8798.1381	11596.1358	
	150				738.1306	960.4711	1094.4297	1399.2272	1783.3544	2602.6223	3671.4938	5055.1748	6218.2790	8368.1320	11326.9270		
	160				883.1200	1125.7591	1282.3066	1647.5960	2100.2251	3193.1031	4355.7642	6028.2986	7340.0164	10355.4978			
	170				996.8813	1327.6550	1494.8986	1956.7069	2503.2150	3790.7233	4935.7675	7039.5807	8708.1689				
	180					1417.0873	1743.6248	2272.6486	2917.6785	4250.1348	5675.3301	8312.8369					
	190						2041.9132	2614.5626	3409.3751	4923.5508	6498.4433						
	200						2318.9102	3063.4951	3936.6779	5602.5043	7875.1078						
	201		149.8548	446.9909	999.6890	1529.1933	2320.9002	3063.7751	3989.5644	5599.8426	6587.1553	9221.8434	9618.5327	12065.8122	13055.5357	13265.3436	10662.2111

Table 21, total enthalpy entering turbine.

At the sweet spot for the compressor it can be noted that the enthalpy is 7039Kw, this may seem very high at this stage, but this figure has the output enthalpy deducted to reveal the power extracted by the turbo.

The exit of the turbine emits gasses at a lower temperature and therefore a lower enthalpy, the polynomial equations are the same but the temperature sites for the output are used to reveal the lower figure, the turbine output temperature is detailed in table 22.

	turbine output temperature Kelvin																
	rpm	800	1000	1250	1500	1750	2000	2250	2500	3000	3500	4000	4500	5000	5500	6000	6500
load	2	474.6	475.8	551.2	567.7	608.6	639.1	659.3	682.6	754.3	793.1	820.7	845				
	5	436.7	474.6	530.7	564.6	619.9	641.5	664.1	684.4	746.8	783.8	827.4	855.9	875.3	915.5	920	969.5
	10	452.9	491.1	538.8	586.1	627.6	648	670.5	691.5	747.9	787.7	839.5	876.8	908.4	929.5	947.7	976.3
	20	480.8	525.3	570.3	620.9	657.9	678.7	705.5	736.5	778.4	832.4	871.1	910.1	938.4	965	981.2	1007.2
	30	536.5	569.6	624.9	677.7	714.4	726.7	756.2	785.7	832.5	877.3	908.8	939.9	969.1	998.5	1015.6	1036.5
	40	571.4	611.5	667.6	729	755.2	770.5	797.6	826.8	874.9	911.9	942.1	966.8	995	1016.4	1036.5	1055.2
	50		666.2	721.1	769.5	796.2	813.3	832.6	863	904.6	935.5	969.3	990.1	1013.9	1029.3	1054.3	1073
	60		701.5	757.4	803.7	831.5	846.8	867.3	897.7	932	956.7	991.4	1010.3	1032.8	1052.9	1075.5	1095
	70		737.6	792.3	833.6	862.2	875.5	893.2	916	948.1	975.9	1008.6	1027.5	1049.3	1069.2	1091.7	1115.2
	80		751	794.4	842.1	869.7	889.1	908.4	930.1	970.5	994.7	1024.8	1043.8	1061.8	1091.4	1103.3	1129
	90		760.5	801.3	843.9	868.7	897.5	920.2	940.1	980.6	1010.6	1035.9	1061.1	1072.2	1095.6	1113	1138.8
	100		761	815.3	843.6	873.3	900.3	920.1	942.2	991.2	1028.9	1055.3	1071.2	1079.8	1102.6	1117.7	1119
	110		783.8	842.3	872.3	884	911.9	931.5	949.9	992.7	1034.5	1066.8	1083.6	1085.5	1105.7	1106.2	1122.7
	120			856	877.2	904.7	933.8	948	964.2	1004.5	1049.8	1081.3	1094.2	1099	1116.1	1110.1	1127.1
	130			856.9	888.2	922.8	952	970.6	991.6	1028.9	1063.1	1088.4	1100.3	1117.3	1115.9	1128.6	
	140			861	899.1	930	966.4	994.2	1016.6	1050.1	1075.2	1099.5	1112.4	1127.3	1128.2	1134.3	
	150				901.8	936.9	976.2	1005.3	1031.7	1064.9	1088	1111.2	1112.9	1129.9	1146		
	160				908.4	942.9	986.4	1016.5	1042.8	1077.4	1098.5	1121.3	1118	1138.3			
	170				913.9	950.6	995.5	1028.5	1055.1	1088.5	1067.8	1126.3	1127.7				
	180					970.7	1002.4	1034.3	1062.6	1085.4	1095	1132.7					
	190						1010.8	1040.3	1072.3	1075.7	1116.2						
	200						1019	1049.5	1080.8	1088.8	1134						
	201		787.3	856.9	914.7	975	1018.8	1045.1	1081.4	1091.6	1105.9	1139.7	1135.7	1149.1	1148.4	1135.6	1118.5

Table 22, turbine exit in Kelvin.

The calculation tables for turbine exit are detailed in appendix 2b, the important tables are table 23 and 24 as the are the final calculations for the exiting gasses.

	total enthalpy contained in gasses exiting turbine Kj/Kg																
	rpm	800	1000	1250	1500	1750	2000	2250	2500	3000	3500	4000	4500	5000	5500	6000	6500
load	2	316.4391	509.5570	805.8670	1010.3061	1361.7002	1948.0710	2117.1838	2601.6821	3726.6021	4649.8716	5975.3354	7047.7851				
	5	380.6770	572.3003	958.5232	1291.5176	1779.0355	2211.4674	2552.5452	2896.4905	3887.7543	4935.5181	6526.5559	7881.3668	9581.2145	11082.4831	12599.3658	15137.0138
	10	606.5223	807.4498	1258.8586	1609.6531	2073.8532	2432.1441	2826.4802	3253.0317	4600.2972	5851.3074	7825.8193	9400.3856	11416.3656	13227.8206	15463.3661	18285.6142
	20	892.4447	1228.9355	1802.7078	2399.5236	3030.7387	3640.8922	4256.4651	5006.1787	6511.9324	8424.3212	10470.7363	12917.4771	15412.6295	18035.2692	20629.6513	24105.1618
	30	1538.2640	1807.8024	2534.6054	3262.6032	4015.9140	4680.7712	5678.4264	6602.6789	8667.6067	11097.0140	13499.8003	16302.0652	19497.6684	23020.6764	26301.4503	30601.5759
	40	1896.4360	2367.0391	3276.7836	4229.7370	5023.4714	5902.5227	7114.8960	8296.7169	10959.1719	13804.7682	16809.7030	20061.3198	23901.5524	27777.1614	32010.7153	36812.4911
	50		2952.0393	4099.8782	5316.8055	6330.6625	7441.4694	8758.0018	10320.7429	13346.2490	16530.1991	20290.6711	23939.1917	28261.6837	32520.2930	37986.5536	43444.8238
	60		3633.1105	5039.7896	6464.3358	7732.6065	9038.4886	10772.4797	12799.1275	16043.6905	19516.7675	24087.2091	28162.5080	33500.0730	38716.1157	44500.8756	50996.3965
	70		4419.5860	6127.1543	7781.3931	9444.7050	10884.9588	12859.2814	14888.4472	18589.7390	22790.6880	28150.5745	32858.5186	38793.1110	44574.3498	51044.8933	59017.7668
	80		5366.6216	7256.4971	9033.7978	10822.5079	12553.3171	14713.8366	17135.3423	21690.9468	26308.9591	32344.7569	37915.2522	44172.3554	51315.7875	57841.2475	66798.5217
	90		6559.5382	8855.5056	10556.7747	12607.4280	14573.7784	16976.1395	19561.8447	24743.4916	30199.7244	36387.8968	43059.0000	49355.3680	56872.8969	65306.3695	75901.0170
	100		7751.7196	10596.0878	12376.9498	14534.2679	16930.5474	19356.4887	22233.1421	28012.7007	34655.0358	41570.5515	48432.2338	55294.0622	63942.2680	72736.5482	82016.6615
	110		9451.2263	12554.3782	14740.1873	16575.2543	19163.0514	21974.6710	24855.2286	31237.2333	38775.2213	47321.3066	54280.3005	60875.7091	70236.7963	79371.2382	90789.6380
	120			14255.0639	16356.6399	18612.6399	21844.8465	24664.8154	27752.6792	34620.4129	43584.0837	53424.5614	60319.7280	68046.4594	78470.0115	87407.5486	101642.3397
	130			15639.8460	18854.5021	21710.7329	24309.4015	27734.3284	31618.3302	39396.4061	48480.4779	58489.0744	66321.9694	76902.5870	86225.1406	101170.9382	
	140			17587.8585	21381.5781	24788.8589	27686.6042	31636.2692	36329.4121	44681.7986	54391.0982	64463.4816	73728.4989	85735.7063	97014.2222	113024.0881	
	150				23450.1385	27431.6329	30634.0322	35235.2495	40465.5162	50063.8236	60489.8240	72072.0200	80332.3889	94924.8127	112547.0768		
	160				25896.1636	29884.6907	33647.3665	38809.5358	44607.7125	56346.4064	66689.8547	79671.8383	88121.2426	107110.5042			
	170				27706.3807	32723.1873	36704.2416	42825.8181	49361.1473	62124.6976	69924.7047	86888.1800	97110.8374				
	180					34851.3310	40031.5739	46554.5215	53862.1230	66058.0246	76913.2761	95388.1253					
	190						43771.2946	50325.3291	58782.7000	71066.8106	83818.7915						
	200						47082.0794	55062.8943	63807.0390	76495.6472	93391.1845						
	201		9614.0711	17699.3381	27761.0379	36407.0888	47093.2585	55013.7993	64286.5743	76687.8780	84186.1909	101153.8650	102872.6284	116958.0325	121681.3761	121639.9770	106965.8908

Table 23, turbine exit enthalpy per Kg of gas.

As can be seen from table 24 and table 21 the actual change in the enthalpy is quite small from the input to the output of the turbine.

		total enthalpy contained in gasses exiting turbine Kw															
	rpm	800	1000	1250	1500	1750	2000	2250	2500	3000	3500	4000	4500	5000	5500	6000	6500
load	2	0.4325	0.8620	1.6252	2.4865	3.9187	6.6992	7.9747	11.2595	19.9994	29.5009	47.8525	64.7809				
	5	0.5985	1.0524	2.2179	3.5983	6.1228	8.5264	11.0468	13.9112	22.5922	34.6857	57.0892	80.6308	113.9898	151.5837	195.1502	269.0184
	10	1.1692	1.7966	3.5843	5.4907	8.4855	11.2487	14.4936	18.5152	33.0071	49.4435	81.6929	112.3346	158.4972	210.3223	282.9796	382.4233
	20	2.3823	3.9019	7.3761	11.5977	17.3426	23.7467	30.9185	40.6613	63.5094	98.9156	144.0599	206.8232	282.4792	376.5363	486.3440	642.6704
	30	6.0206	7.6078	13.3700	20.5000	29.5281	38.7204	53.2037	68.5211	108.4655	166.4860	233.7715	325.8149	445.7925	599.4328	767.2718	1009.9370
	40	8.6077	12.1377	21.0806	32.7335	44.3880	58.9924	80.3786	104.5617	166.7012	249.2528	352.3967	483.0320	657.7574	865.7215	1119.8415	1442.0271
	50		18.0238	31.2388	48.8555	66.4368	88.0574	116.6031	154.5531	239.8247	348.5117	498.8123	673.0238	906.0225	1177.5056	1554.5997	1980.6012
	60		26.0676	44.6861	68.8093	94.2519	123.5762	167.3924	225.8335	334.9120	474.5827	686.4855	912.0741	1250.7624	1630.3787	2095.9912	2679.2940
	70		36.6948	62.6842	94.8249	133.3015	172.0428	229.2167	297.6035	440.9899	631.9351	919.1945	1217.9558	1650.9701	2132.3874	2719.2749	3524.5082
	80		52.0264	84.7801	125.0930	170.7251	222.6470	292.8462	384.7360	580.8956	822.3742	1189.4784	1593.0725	2118.4325	2764.2104	3448.6237	4441.1739
	90		74.4508	121.5172	167.7354	228.3695	290.4635	380.6899	493.7736	747.1160	1062.4431	1490.4887	2017.7926	2613.2296	3377.4602	4309.3134	5590.3207
	100		102.6457	169.6257	225.2949	299.0022	387.5214	488.6438	628.5803	943.1721	1365.3121	1905.6634	2508.7897	3222.1079	4175.7853	5250.7706	6522.8307
	110		144.1837	231.9421	305.9408	383.2567	486.9544	617.9155	772.7905	1148.1419	1672.3968	2386.4398	3079.8039	3853.4324	4971.3995	6187.8699	7848.2598
	120			292.8228	374.0673	471.2617	612.2018	760.9781	941.9722	1382.4123	2058.7426	2968.9216	3723.7379	4687.2669	6033.4720	7379.8679	9596.7309
	130			351.1580	490.0076	620.3239	738.4656	933.1831	1175.5871	1721.9512	2487.1832	3495.3721	4414.0955	5769.8302	7142.5553	9446.2743	
	140			436.7163	617.3337	794.8961	920.0412	1161.3147	1482.8455	2129.9565	3037.2896	4141.2415	5305.3799	6964.1209	8759.0368	11534.1082	
	150				735.5527	957.5164	1089.8057	1393.9456	1776.9982	2593.3061	3657.9541	5036.6330	6193.4040	8329.3886	11266.2750		
	160				879.7502	1122.1701	1276.1698	1640.4575	2091.3583	3179.6590	4337.8045	6003.2730	7306.7197	10299.8651			
	170				992.8889	1323.1984	1487.3374	1947.6230	2491.6410	3773.3851	4912.9874	7006.8076	8664.7145				
	180					1410.6076	1734.1455	2261.2566	2902.8692	4228.4476	5645.8618	8269.8855					
	190						2030.1370	2600.7012	3391.2719	4895.9110	6462.4288						
	200						2304.9294	3046.2017	3914.3846	5571.0080	7831.1102						
	201		149.1249	445.0400	995.6959	1521.9174	2306.9156	3045.9307	3966.8388	5567.9660	6548.2825	9172.4077	9568.2975	11996.3204	12979.6848	13188.4766	10607.7480

Table 24, total enthalpy contained in exit gasses.

The most important table for the overall goal of this paper is the total power available from the turbine, table 25 shows that at the point of interest, marked in yellow the power output of the turbine is 32.8Kw, this unfortunately has to have the compressor power deducted.

		energy available from turbine Kw															
	rpm	800	1000	1250	1500	1750	2000	2250	2500	3000	3500	4000	4500	5000	5500	6000	6500
load	2	0.0032	0.0133	0.0216	0.0301	0.0472	0.0981	0.1004	0.1429	0.2330	0.3131	0.4433	0.5527				
	5	0.0098	0.0174	0.0371	0.0578	0.0837	0.1262	0.1511	0.1759	0.2481	0.3407	0.5016	0.6406	0.9413	0.8778	1.1012	1.1370
	10	0.0235	0.0327	0.0630	0.0786	0.1044	0.1294	0.1586	0.1899	0.3112	0.4465	0.6614	0.8179	1.0836	1.2401	1.5059	1.8570
	20	0.0417	0.0606	0.1032	0.1428	0.1872	0.2520	0.3052	0.3651	0.5360	0.6898	0.9245	1.2381	1.6205	1.9162	2.2274	2.7573
	30	0.0878	0.1012	0.1450	0.1679	0.1927	0.2600	0.3557	0.4145	0.6087	0.8080	1.1023	1.4388	1.9182	2.3432	2.8046	3.5818
	40	0.1053	0.1328	0.1792	0.1693	0.1904	0.2614	0.3745	0.4222	0.6615	0.9234	1.2562	1.6883	2.2318	2.7028	3.3470	4.3049
	50		0.1216	0.1661	0.1806	0.2013	0.2888	0.4123	0.4710	0.7260	1.0753	1.4638	1.9362	2.5531	3.1118	3.9054	4.9897
	60		0.1271	0.1823	0.1826	0.1993	0.3203	0.4951	0.5748	0.8343	1.2362	1.6986	2.2477	2.9794	3.5657	4.1914	5.4021
	70		0.1208	0.1927	0.2100	0.2488	0.3507	0.6075	0.6885	0.9622	1.4626	2.0261	2.6736	3.3642	3.7831	4.4804	5.7352
	80		0.1876	0.3708	0.3024	0.3980	0.4793	0.7478	0.8956	1.1908	1.7097	2.4114	3.0938	3.6464	3.8998	5.1974	6.9331
	90		0.3322	0.6462	0.5093	0.6884	0.8416	1.0263	1.1211	1.3957	2.0072	2.6182	3.3498	4.2101	4.7054	7.8348	11.8454
	100		0.5057	0.8788	0.9036	0.9817	1.2290	1.5830	1.7247	1.7093	2.4185	2.7465	4.5249	6.2177	8.1488	12.2216	21.1841
	110		0.7459	0.9482	1.0935	1.1792	1.5259	1.9946	2.2436	3.0143	3.9472	5.3086	6.3386	8.3738	11.6943	21.1432	29.9233
	120			1.1346	1.3073	1.2192	1.8118	2.3095	2.7134	3.7469	5.2100	7.1400	8.7503	11.9199	17.8976	28.7916	44.1394
	130			1.3900	1.5974	1.6542	2.0693	2.6040	3.2022	4.8543	6.8365	9.6374	12.5413	17.7908	27.2140	45.2147	
	140			1.8884	2.0425	2.2883	3.2392	3.6225	4.5278	6.7764	10.0808	13.1796	17.7200	26.2609	39.1013	62.0276	
	150				2.5779	2.9548	4.6240	5.2815	6.3563	9.3163	13.5397	18.5418	24.8750	38.7434	60.6520		
	160				3.3698	3.5890	6.1367	7.1385	8.8668	13.4441	17.9596	25.0256	33.2967	55.6327			
	170				3.9923	4.4566	7.5612	9.0838	11.5740	17.3382	22.7800	32.7731	43.4545				
	180					6.4797	9.4792	11.3921	14.8093	21.6872	29.4683	42.9514					
	190						11.7763	13.8615	18.1031	27.6397	36.0145						
	200						13.9809	17.2934	22.2933	31.4963	43.9976						
	201			1.9509	3.9931	7.2759	13.9846	17.8444	22.7256	31.8766	38.8727	49.4357	50.2352	69.4918	75.8509	76.8670	54.4632

Table 25, total turbine output power.

The excel model allows the author to switch to different fuels and lambda values, it is noted that gasoline is not the most powerful fuel with which to run a mathematical model, the best fuel is shown to be diesel, the turbine shaft output power with gasoline as the fuel is 25.4Kw but running the model on diesel commands an advantageous output of 42.5Kw, almost double that of gasoline.

Other fuels are modelled such as hydrogen, propane, ethanol and methanol but these would have to be run at a low lambda, fuel rich mixture to produce any meaningful power outputs.

Table 26 shows the total power available from the turbo shaft for all rpm/load sites running on gasoline, table 27 indicates power available running diesel.

		turbine energy less compressor offtake Kw															
	rpm	800	1000	1250	1500	1750	2000	2250	2500	3000	3500	4000	4500	5000	5500	6000	6500
load	2	-0.0145	-0.0098	-0.0036	-0.0001	0.0113	0.0584	0.0531	0.0873	0.1746	0.2388	0.2946	0.3812				
	5	-0.0062	-0.0067	0.0098	0.0301	0.0540	0.0889	0.1113	0.1304	0.1963	0.2689	0.3893	0.5190	0.8099	0.7329	0.9592	0.9755
	10	0.0045	0.0060	0.0310	0.0493	0.0706	0.0904	0.1163	0.1429	0.2568	0.3721	0.5588	0.7184	0.9823	1.1225	1.3740	1.6866
	20	0.0149	0.0247	0.0556	0.1011	0.1379	0.1970	0.2460	0.2973	0.4611	0.5975	0.8061	1.1108	1.4714	1.7422	2.0221	2.4900
	30	0.0434	0.0496	0.0758	0.1102	0.1259	0.1887	0.2758	0.3260	0.5009	0.6774	0.9387	1.2575	1.6914	2.0750	2.4793	3.1611
	40	0.0526	0.0631	0.0816	0.1005	0.1068	0.1697	0.2772	0.3089	0.5176	0.7493	1.0326	1.4337	1.9020	2.3086	2.8617	3.6842
	50		0.0645	0.0948	0.0971	0.1060	0.1758	0.2926	0.3321	0.5443	0.8562	1.1739	1.5863	2.0968	2.5655	3.2148	4.1176
	60		0.0687	0.1117	0.0960	0.0932	0.1936	0.3481	0.4029	0.6075	0.9539	1.3117	1.7747	2.3498	2.7959	3.2372	4.1797
	70		0.0555	0.1113	0.1096	0.1153	0.1968	0.4356	0.4919	0.6956	1.1069	1.5153	2.0277	2.5147	2.7511	3.2106	4.1319
	80		0.0796	0.2198	0.1676	0.2251	0.2899	0.5428	0.6621	0.8622	1.2589	1.7568	2.2629	2.5807	2.5704	3.5963	4.9225
	90		0.1599	0.3895	0.3083	0.4439	0.5633	0.7386	0.8350	0.9913	1.4438	1.8200	2.3132	2.8992	3.0497	5.4594	8.7836
	100		0.2274	0.4792	0.5142	0.5473	0.7696	1.0932	1.2052	1.1952	1.6581	1.7065	2.9892	4.2481	5.5890	8.9770	17.2965
	110		0.2522	0.3991	0.5268	0.5450	0.8149	1.2161	1.4969	2.0419	2.6489	3.5622	4.2341	5.7926	8.3581	16.9911	24.7330
	120			0.3254	0.5460	0.4435	0.8347	1.2430	1.6744	2.4195	3.4589	4.8225	6.0761	8.4984	13.4833	23.5001	37.2085
	130			0.3108	0.4838	0.5265	0.8927	1.3489	1.8219	3.0674	4.5615	6.6538	9.0098	13.1882	21.6541	37.9438	
	140			0.4170	0.4857	0.6903	1.5750	1.8853	2.6271	4.3138	6.9857	9.3631	13.1094	20.3931	31.8849	52.6377	
	150				0.5887	0.8831	2.4709	3.0081	3.8538	6.1046	9.5791	13.5929	19.2150	31.3385	50.7817		
	160				0.8644	1.0242	3.4376	4.2637	5.6691	9.2900	13.0614	18.8492	26.3314	46.0490			
	170				1.0744	1.3050	4.2955	5.5270	7.5826	12.2352	16.9738	25.3820	34.9474				
	180					2.8870	5.5537	7.1157	9.9758	15.7085	22.6359	34.0754					
	190						7.0935	8.8330	12.3370	20.6533	28.0582						
	200						8.5851	11.3178	15.5250	23.4172	34.5109						
	201		-0.5171	0.4360	1.0587	3.3398	8.5709	11.9340	15.8519	23.6597	30.0924	39.4728	40.7533	58.0421	64.0536	65.6527	46.4922

Table 26, total power available from the turbo shaft, gasoline.

		turbine energy less compressor offtake Kw															
	rpm	800	1000	1250	1500	1750	2000	2250	2500	3000	3500	4000	4500	5000	5500	6000	6500
load	2	-0.0128	-0.0028	0.0077	0.0157	0.0360	0.1097	0.1056	0.1620	0.2964	0.4025	0.5264	0.6702				
	5	-0.0010	0.0024	0.0293	0.0604	0.0978	0.1549	0.1903	0.2223	0.3260	0.4470	0.6515	0.8539	1.3021	1.1919	1.5350	1.5699
	10	0.0167	0.0231	0.0639	0.0904	0.1252	0.1581	0.1992	0.2422	0.4195	0.6055	0.9046	1.1461	1.5489	1.7709	2.1614	2.6575
	20	0.0367	0.0564	0.1096	0.1758	0.2357	0.3288	0.4056	0.4882	0.7414	0.9582	1.2895	1.7581	2.3186	2.7441	3.1867	3.9316
	30	0.0893	0.1025	0.1516	0.1980	0.2266	0.3247	0.4618	0.5427	0.8191	1.0999	1.5150	2.0097	2.6943	3.3001	3.9457	5.0339
	40	0.1077	0.1325	0.1752	0.1890	0.2063	0.3064	0.4730	0.5296	0.8635	1.2321	1.6894	2.3165	3.0689	3.7218	4.6117	5.9350
	50		0.1281	0.1816	0.1915	0.2112	0.3268	0.5082	0.5784	0.9239	1.4184	1.9393	2.5986	3.4317	4.1925	5.2567	6.7264
	60		0.1352	0.2070	0.1915	0.1974	0.3611	0.6070	0.7034	1.0437	1.6002	2.1998	2.9499	3.9075	4.6602	5.4287	7.0041
	70		0.1187	0.2121	0.2194	0.2454	0.3802	0.7533	0.8518	1.1988	1.8717	2.5746	3.4256	4.2736	4.7291	5.5531	7.1305
	80		0.1777	0.4137	0.3257	0.4331	0.5405	0.9338	1.1304	1.4848	2.1529	3.0175	3.8804	4.4872	4.6094	6.3137	8.5474
	90		0.3337	0.7274	0.5746	0.8038	1.0034	1.2752	1.4212	1.7210	2.4932	3.1889	4.0646	5.1004	5.5099	9.5558	14.9769
	100		0.4918	0.9386	0.9866	1.0605	1.4121	1.9209	2.1069	2.0889	2.9226	3.1425	5.3550	7.4990	9.8495	15.3670	28.3724
	110		0.6422	0.8949	1.0985	1.1615	1.6127	2.2590	2.6700	3.6178	4.7126	6.3377	7.5482	10.1707	14.4724	28.0457	40.3782
	120			0.9186	1.2296	1.0810	1.7819	2.4504	3.0931	4.3786	6.1829	8.5556	10.6511	14.7306	22.8409	38.5536	60.2865
	130			1.0375	1.3190	1.3914	1.9746	2.7103	3.4962	5.6055	8.1359	11.6926	15.5669	22.4900	35.8828	61.5840	
	140			1.4043	1.5536	1.8867	3.2686	3.7793	4.9944	7.8568	12.2564	16.2540	22.3742	34.1234	52.3287	85.0684	
	150				1.9366	2.4279	4.8885	5.7695	7.1771	10.9755	16.6582	23.2874	32.2207	51.5952	82.4931		
	160				2.6262	2.9006	6.6461	7.9960	10.3051	16.3192	22.4515	31.9337	43.7404	75.1361			
	170				3.1618	3.6351	8.2488	10.2764	13.6340	21.3003	28.8842	42.5171	57.6673				
	180					6.2748	10.5098	13.0719	17.7187	27.0475	38.0432	56.5322					
	190						13.2506	16.0804	21.8021	35.1045	46.8881						
	200						15.8949	20.3595	27.1808	39.8848	57.5147						
	201		-0.5171	1.4560	3.1465	7.1439	15.8827	21.2638	27.7338	40.3261	50.4167	65.3198	67.0184	94.3753	103.7117	105.8420	74.9679

Table 27, total power available from the turbo shaft, diesel.

The total power output of the engine from the Ford data, shown in table 28, this combined with the fuel power, calculated from its calorific value, see table 29, shows an alarming amount of power being lost, the losses documented in table 30 are pre turbine therefore the power extracted by the turbine must be deducted, see table 31.

	engine output power Kw															
	rpm	800	1000	1250	1500	1750	2000	2250	2500	3000	3500	4000	4500	5000	5500	6000	6500
load	2	0.1471	0.2941	0.1471	0.2941	0.3676	0.5147	0.5147	0.5147	0.6618	0.7353	0.8088	0.9559				
	5	0.4412	0.4412	0.5882	0.7353	1.1029	1.0294	1.1029	1.3235	1.3971	1.8382	2.0588	2.3529	2.5735	3.2353	3.3088	3.7500
	10	0.8824	0.8824	1.2500	1.5441	1.8382	2.0588	2.2794	2.5000	3.3088	3.6765	4.1912	4.5588	5.2206	5.9559	6.6912	7.2794
	20	1.6912	1.9853	2.5735	3.0147	3.6765	4.1912	4.7059	5.2206	6.2500	7.3529	8.3824	9.4118	10.4412	11.5441	12.6471	13.5294
	30	2.7941	3.0882	3.8971	4.6324	5.5147	6.2500	7.0588	7.8676	9.4118	11.0294	12.5735	14.1176	15.6618	17.2794	18.8971	20.4412
	40	3.4559	4.1176	5.2206	6.3235	7.2794	8.3824	9.4118	10.4412	12.5000	14.6324	16.7647	18.8235	20.9559	23.0882	25.0735	27.2059
	50		5.2206	6.5441	7.8676	9.1912	10.5147	11.7647	13.0882	15.7353	18.3088	20.8824	23.5294	26.1765	28.8235	31.3971	33.9706
	60		6.2500	7.8676	9.4853	10.9559	12.5000	14.1176	15.7353	18.8235	21.9853	25.0735	28.3088	31.3971	34.5588	37.7206	40.8088
	70		7.2794	9.1912	10.9559	12.7941	14.6324	16.4706	18.3088	21.9853	25.6618	29.4118	33.0147	36.6176	40.2941	43.9706	47.6471
	80		8.3824	10.4412	12.5735	14.6324	16.7647	18.8235	20.9559	25.0735	29.3382	33.4559	37.7206	41.8382	46.0294	50.2941	54.4118
	90		9.3382	11.7647	14.1176	16.4706	18.7500	21.1765	23.5294	28.2353	33.0147	37.5735	42.4265	47.2059	51.8382	56.5441	61.2500
	100		10.2941	13.0882	15.7353	18.3088	21.1029	23.6029	26.1765	31.3971	36.6176	42.0588	47.1324	52.4265	57.6471	62.9412	68.0882
	110		11.1765	14.4118	17.2794	20.1471	23.0147	25.8824	28.8235	34.5588	40.2941	45.8088	51.8382	57.6471	63.3088	69.1912	74.9265
	120			15.7353	18.8235	21.9853	25.0000	28.2353	31.3971	37.7206	43.9706	50.3676	56.5441	62.8676	69.0441	75.3676	81.6912
	130			16.9853	20.4412	23.8235	27.2059	30.6618	34.0441	40.8088	47.6471	54.4853	61.2500	68.0882	74.8529	81.7647	
	140			18.2353	21.9118	25.6618	29.4853	32.9412	36.6176	43.8971	51.3235	58.3088	65.9559	73.3088	80.5882	87.9412	
	150				23.5294	27.5000	31.4706	35.3676	39.2647	47.1324	55.0000	63.0147	70.6618	78.5294	86.3971		
	160				25.1471	29.3382	33.5294	37.7206	41.8382	50.2941	58.6765	66.9853	75.2941	83.8235			
	170				26.3235	31.1029	35.5147	40.0000	44.5588	53.4559	62.5735	71.1765	80.0735				
	180					33.0147	37.6471	42.4265	47.1324	56.4706	65.7353	75.4412					
	190						39.7794	44.7794	49.8529	59.5588	69.2647						
	200						41.4706	47.1324	52.3529	62.9412	72.2794						
	201		11.2500	18.3088	26.2500	33.8235	41.4706	47.1324	52.5000	63.5294	67.9412	78.8235	82.3529	86.7647	90.0000	92.0588	85.8824

Table 28, engine power extrapolated from Ford data.

	fuel power Kw																
	rpm	800	1000	1250	1500	1750	2000	2250	2500	3000	3500	4000	4500	5000	5500	6000	6500
load	2	3.9111	4.7667	5.6222	6.8444	8.0667	9.5333	10.5111	11.9778	14.9111	17.6000	22.3667	25.5444				
	5	4.4000	5.1333	6.4778	7.7000	9.6556	10.7556	11.9778	13.3222	16.1333	19.5556	24.3222	28.4778	33.3667	38.3778	43.5111	49.8667
	10	5.3778	6.2333	7.9444	9.5333	11.3667	12.8333	14.1778	15.7667	19.9222	23.4667	29.0889	33.2444	38.8667	44.4889	51.0889	58.5444
	20	7.4556	8.9222	11.3667	13.4444	15.8889	18.0889	20.1667	22.4889	27.0111	32.6333	38.2556	44.4889	51.0889	58.1778	65.6333	74.3111
	30	10.8778	11.6111	14.5444	17.3556	20.4111	22.9778	26.0333	28.8444	34.8333	41.6778	48.1556	55.6111	63.6778	72.6000	80.9111	91.7889
	40	12.7111	14.1778	17.8444	21.5111	24.5667	27.8667	31.4111	35.0778	42.2889	50.1111	58.3000	66.9778	76.6333	86.7778	97.0444	109.0222
	50		16.8667	21.1444	25.4222	29.0889	33.0000	37.0333	41.6778	49.9889	58.6667	68.4444	78.3444	89.3444	100.8333	114.0333	127.3556
	60		19.9222	24.6889	29.5778	33.9778	38.1333	43.2667	49.1333	58.0556	67.7111	79.4444	90.3222	104.0111	117.3333	131.5111	147.1556
	70		23.1000	28.4778	33.8556	39.2333	44.0000	49.7444	55.7333	66.0000	77.2444	91.0556	103.1556	118.6778	133.4667	148.8667	167.3222
	80		26.8889	32.5111	38.5000	43.8778	49.5000	55.6111	62.7000	74.6778	87.1444	102.5444	116.8444	133.8333	150.5778	166.7111	186.3889
	90		31.2889	36.6667	44.0000	50.2333	55.6111	62.7000	70.5222	84.3333	98.3889	114.4000	130.7778	148.0111	166.1000	185.1667	207.1667
	100		36.3000	41.9222	50.4778	56.9556	63.5556	70.6444	79.2000	94.2333	110.3667	128.7000	145.2000	163.5333	183.3333	205.0889	234.7889
	110		39.3556	47.7889	55.2444	64.0444	70.6444	78.5889	87.1444	102.9111	121.8556	142.3889	159.6222	178.2000	199.3444	228.0667	255.4444
	120			53.1667	60.2556	70.2778	78.1000	86.4111	95.2111	111.8333	133.8333	157.1778	174.0444	194.0889	220.0000	249.9444	284.7778
	130			57.8111	66.7333	75.2889	85.0667	94.4778	104.5000	122.8333	145.3222	169.1556	188.2222	211.4444	240.9000	280.2556	
	140			63.4333	73.8222	83.6000	93.2556	103.2778	115.3778	134.5667	158.0333	181.7444	203.5000	231.2444	264.3667	312.6444	
	150				79.6889	91.1778	99.8556	111.4667	124.5444	146.4222	171.1111	197.7556	221.8333	256.5444	299.0778		
	160				86.7778	98.7556	106.8222	119.4111	132.9778	159.5000	184.0667	213.4000	242.0000	289.4222			
	170				91.7889	107.1889	114.6444	128.5778	143.2444	171.8444	209.4889	231.1222	261.6778				
	180					111.3444	122.8333	137.6222	153.0222	186.2667	217.0667	251.9000					
	190						131.6333	147.1556	163.6556	206.6778	225.6222						
	200						138.6000	158.4000	174.1667	217.3111	237.9667						
	201		39.6000	63.8000	91.9111	114.7667	138.7222	157.9111	175.2667	220.9778	231.2444	263.2667	273.0444	312.2778	325.2333	337.5778	306.9000

Table 29, fuel power from calorific value.

		power loss Kw															
	rpm	800	1000	1250	1500	1750	2000	2250	2500	3000	3500	4000	4500	5000	5500	6000	6500
load	2	3.7785	4.4823	5.4787	6.5504	7.6877	8.9602	9.9433	11.3758	14.0748	16.6259	21.2632	24.2073				
	5	3.9650	4.6989	5.8797	6.9346	8.4986	9.6372	10.7635	11.8683	14.5400	17.4484	21.8741	25.6059	29.9832	34.4095	39.2431	45.1412
	10	4.4909	5.3450	6.6635	7.9400	9.4578	10.6841	11.7821	13.1237	16.3566	19.4181	24.3389	27.9672	32.6638	37.4105	43.0237	49.5785
	20	5.7495	6.9123	8.7375	10.3286	12.0746	13.7007	15.2148	16.9710	20.3000	24.6829	29.0671	33.9664	39.1764	44.8914	50.9641	58.2917
	30	8.0402	8.4733	10.5716	12.6130	14.7705	16.5391	18.6987	20.6508	24.9207	29.9709	34.6433	40.2360	46.3247	53.2456	59.5347	68.1866
	40	9.2026	9.9970	12.5423	15.0871	17.1804	19.3146	21.7221	24.3277	29.2712	34.7294	40.5027	46.7205	53.7754	61.3809	69.1092	78.1321
	50		11.5816	14.5056	17.4575	19.7917	22.3095	24.9760	28.2574	33.7093	39.5016	46.3882	53.2288	61.0711	69.4443	79.4215	89.2674
	60		13.6035	16.7095	19.9965	22.9287	25.4397	28.8009	32.9951	38.6245	44.7719	53.0592	60.2387	70.2643	79.9786	90.5533	102.1671
	70		15.7650	19.1753	22.7900	26.3239	29.1709	32.8382	36.9326	43.3191	50.4757	60.1285	68.1131	79.5455	90.4214	101.6855	115.5433
	80		18.4269	21.8501	25.7589	29.0204	32.4454	36.2447	41.0820	48.7420	56.5473	67.3318	76.8610	89.4144	101.9779	112.8207	127.0547
	90		21.7907	24.5124	29.5741	33.3188	36.2978	40.7850	46.1578	55.1068	63.9304	75.0065	86.0382	97.9060	111.2121	123.1631	137.1330
	100		25.7785	28.3548	34.2283	38.0995	41.6831	45.9483	51.8183	61.6411	72.0909	84.9346	95.0784	106.8588	120.0973	133.1707	149.4042
	110		27.9269	32.9780	37.4383	43.3524	46.8149	51.4904	56.8240	66.3104	78.9126	93.0179	103.5499	114.7604	127.6775	141.8844	155.7850
	120			37.1060	40.8860	47.8490	52.2653	56.9329	62.1397	71.6932	86.4039	101.9876	111.4242	122.7228	137.4726	151.0767	165.8781
	130			40.5151	45.8083	50.9389	56.9681	62.4672	68.6339	78.9571	93.1137	108.0165	117.9624	130.1680	144.3929	160.5470	
	140			44.7811	51.4248	57.2479	62.1953	68.4513	76.1331	86.3558	99.7241	114.0725	124.4347	137.5426	151.8936	172.0656	
	150				55.5707	62.7947	65.9141	73.0909	81.4260	93.1853	106.5320	121.1479	131.9566	146.6765	161.8991		
	160				60.7664	68.3932	69.8553	77.4268	85.4704	99.9159	112.3288	127.5655	140.3744	159.5497			
	170				64.3909	74.7809	74.8342	83.0507	91.1030	106.1534	129.9415	134.5638	146.6568				
	180					75.4428	79.6326	88.0801	95.9141	114.0875	128.6954	142.3834					
	190						84.7604	93.5432	101.4656	126.4656	128.2993						
	200						88.5443	99.9499	106.2888	130.9527	131.1763						
	201		28.8671	45.0552	64.6024	77.6033	88.6807	98.8448	106.9148	133.7887	133.2108	144.9704	149.9382	167.4710	171.1797	179.8663	174.5254

Table 30, power losses before turbine.

		power loss post turbine Kw															
	rpm	800	1000	1250	1500	1750	2000	2250	2500	3000	3500	4000	4500	5000	5500	6000	6500
load	2	3.7753	4.4690	5.4571	6.5203	7.6405	8.8622	9.8429	11.2329	13.8418	16.3128	20.8199	23.6546				
	5	3.9552	4.6815	5.8426	6.8768	8.4149	9.5110	10.6125	11.6925	14.2919	17.1078	21.3725	24.9653	29.0419	33.5318	38.1419	44.0042
	10	4.4675	5.3123	6.6005	7.8613	9.3534	10.5547	11.6235	12.9338	16.0454	18.9717	23.6776	27.1493	31.5801	36.1704	41.5178	47.7214
	20	5.7078	6.8516	8.6343	10.1858	11.8874	13.4486	14.9096	16.6059	19.7640	23.9930	28.1426	32.7283	37.5558	42.9752	48.7367	55.5344
	30	7.9524	8.3721	10.4266	12.4450	14.5779	16.2791	18.3430	20.2363	24.3120	29.1629	33.5410	38.7972	44.4065	50.9024	56.7301	64.6047
	40	9.0973	9.8642	12.3631	14.9178	16.9901	19.0532	21.3476	23.9055	28.6097	33.8060	39.2465	45.0322	51.5436	58.6781	65.7622	73.8272
	50		11.4599	14.3395	17.2769	19.5904	22.0207	24.5637	27.7865	32.9832	38.4264	44.9243	51.2925	58.5180	66.3325	75.5161	84.2777
	60		13.4764	16.5272	19.8139	22.7294	25.1194	28.3058	32.4204	37.7902	43.5358	51.3606	57.9909	67.2849	76.4129	86.3619	96.7650
	70		15.6443	18.9825	22.5800	26.0752	28.8201	32.2307	36.2442	42.3568	49.0131	58.1024	65.4396	76.1813	86.6383	97.2051	109.8081
	80		18.2393	21.4793	25.4564	28.6224	31.9661	35.4969	40.1864	47.5512	54.8376	64.9204	73.7672	85.7680	98.0782	107.6233	120.1215
	90		21.4585	23.8663	29.0648	32.6305	35.4562	39.7586	45.0367	53.7111	61.9232	72.3883	82.6883	93.6959	106.5067	115.3283	125.2877
	100		25.2727	27.4760	33.3247	37.1178	40.4540	44.3653	50.0937	59.9318	69.6724	82.1882	90.5535	100.6411	111.9485	120.9490	128.2201
	110		27.1810	32.0298	36.3448	42.1733	45.2889	49.4958	54.5804	63.2962	74.9654	87.7093	97.2113	106.3866	115.9832	120.7412	125.8617
	120			35.9714	39.5787	46.6298	50.4535	54.6234	59.4262	67.9463	81.1939	94.8476	102.6739	110.8030	119.5750	122.2850	121.7387
	130			39.1250	44.2109	49.2847	54.8988	59.8632	65.4317	74.1028	86.2772	98.3791	105.4211	112.3772	117.1789	115.3323	
	140			42.8927	49.3822	54.9596	58.9561	64.8288	71.6052	79.5794	89.6432	100.8929	106.7147	111.2816	112.7923	110.0379	
	150				52.9928	59.8400	61.2901	67.8094	75.0697	83.8690	92.9923	102.6061	107.0816	107.9331	101.2471		
	160				57.3966	64.8042	63.7185	70.2883	76.6036	86.4718	94.3692	102.5398	107.0777	103.9171			
	170				60.3986	70.3243	67.2730	73.9669	79.5290	88.8152	107.1615	101.7907	103.2024				
	180					68.9630	70.1533	76.6880	81.1048	92.4003	99.2271	99.4321					
	190						72.9842	79.6817	83.3624	98.8259	92.2849						
	200						74.5634	82.6565	83.9955	99.4564	87.1788						
	201		28.8671	43.1043	60.6093	70.3275	74.6961	81.0004	84.1892	101.9121	94.3381	95.5347	99.7030	97.9793	95.3288	102.9993	120.0622

Table 31, power loss post turbine

The losses documented above can be attributed partly to frictional losses which occur within the engine, but the majority of this power is lost to the atmosphere through the exhaust pipe.

The way the turbo will work in a turbine system differs from the setup on an engine, the compressor will be utilised in a slightly different way, it will be moving a volume of air, not trying to pressurise it, it will build pressure as backpressure this is why the system of the turbine, combustor and heat exchanger must be calculated holistically with the aim of not exceeding 2 bar pressure within the combustor.

The compressor at its most efficient point, highlighted in yellow in all tables, produces 2.1bar of pressure, this leads the author to conclude that this turbo is capable of running the system but only just, the better option maybe a variable vane turbo if they are available small enough to be packaged onto the motorcycle along with all the ancillaries required for its safe operation.

Solidworks modelling

A Solidworks model of the base electric motorcycle, produced by Simon Hughes in 2017/18, will form the base from whence to build a virtual prototype with the turbo range extender and its running gear.

The turbo and its components have been modelled in detail along with a combustor concept and an initial design of tube in tube heat exchanger, the heat exchanger has been selected as a tube in tube system as it is easily fitted to the bike and mimics an exhaust pipe, at this time the combustor is only at concept stage and has had no mathematical processing performed upon it, likewise the heat exchanger has not been mathematically modelled and these will require further work in the future.

The internal voids within the turbo sections are modelled with a degree of certainty but as these voids are inaccessible there is an element of best guess, the turbo insert was somewhat easier as in the university there is a cutaway part that reveals all the oil and coolant galleries within the structure, see figure 8, as with all sand or powder medium cast items there are always inconsistencies within the internal voids.

The cad version shown in figure 9 is an optimised representation of the cutaway part, there are some internal variances, but these would not affect the performance of the part in its duties.

All other parts associated with the turbo insert such as the bushings, lubrication plate and end cap are all modelled perfectly and placed in an assembly, these other small miscellaneous parts are pictured in appendix 3.

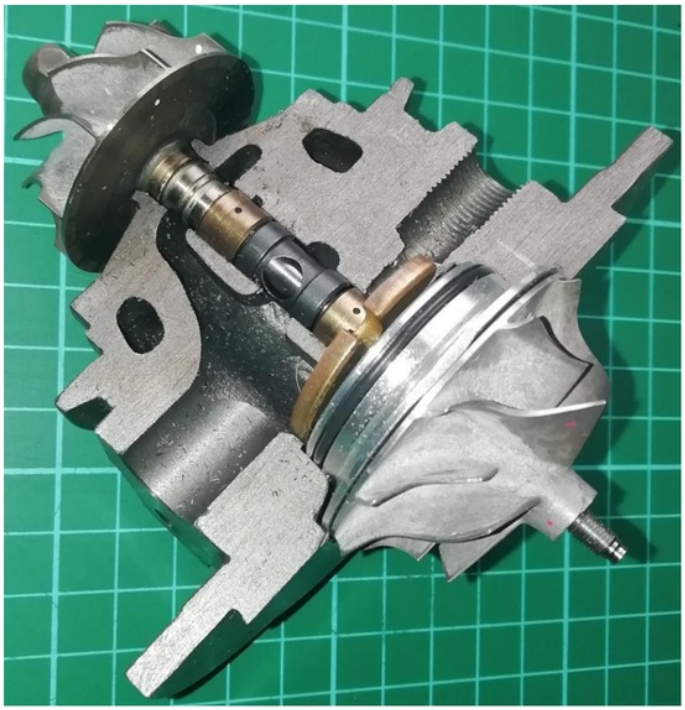


Figure 8, turbo insert cutaway view.

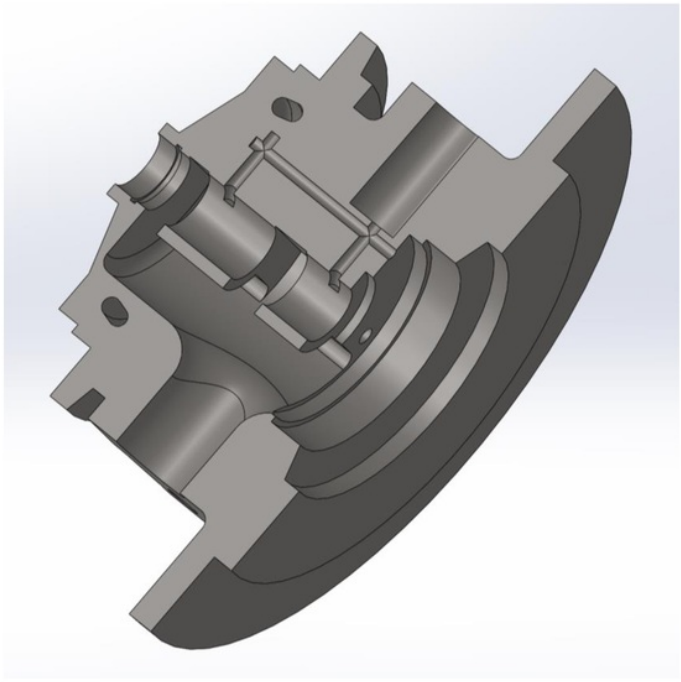


Figure 9, turbo insert cutaway cad model.

The scrolls in the turbine housing proved along with the impellers to be the most demanding parts to model, figure 10 shows the initial sketch for the scroll feature.

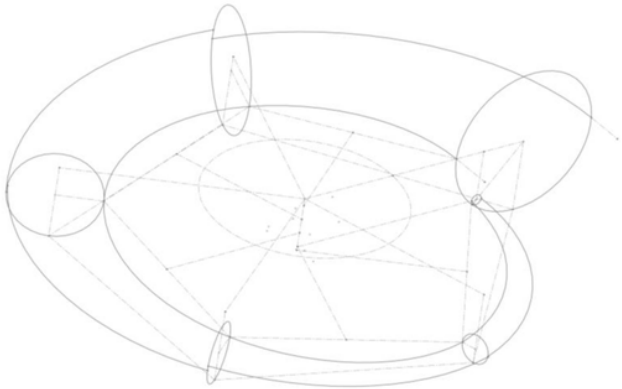


Figure 10, sketch of scroll feature.

The development of this begins with a surface feature to wrap the guide circles following along the guide curves, this had to be done for each individual section and then knitted together to form a continuous surface, this shape then removed from an extruded block began the basis for all other operations to create the part shown in figure 11.

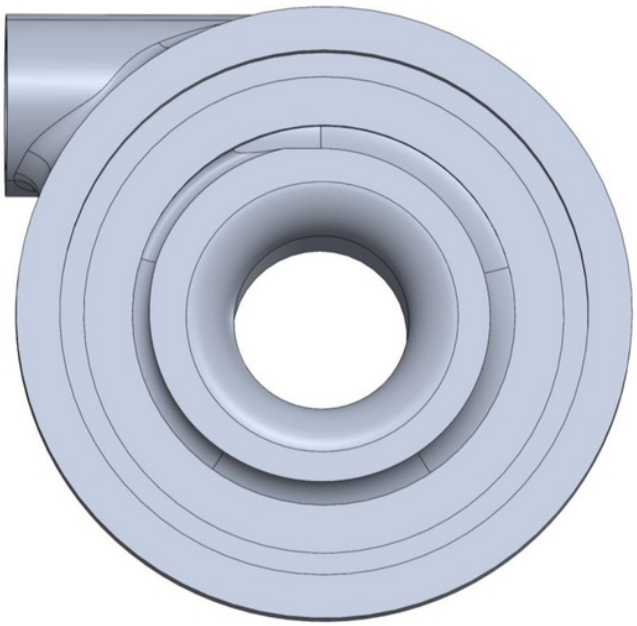


Figure 11, inside view of compressor housing.

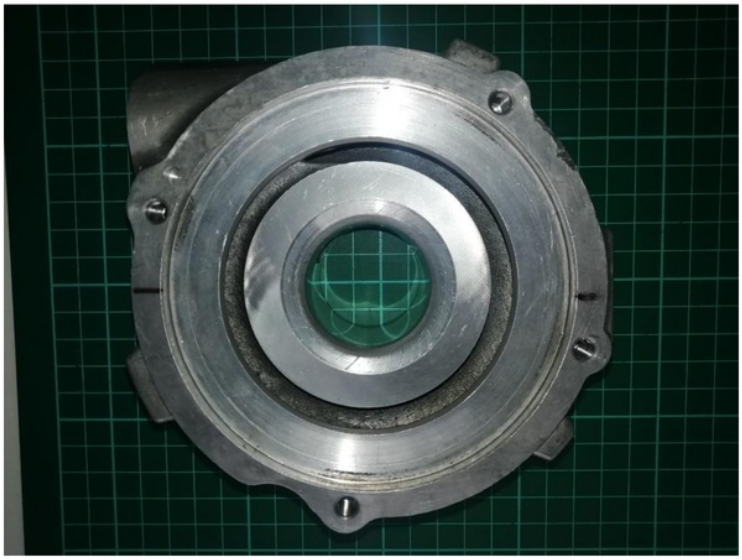


Figure 12, inside view of real compressor housing.

The picture in figure 12 shows the inside view of the actual housing for comparison to the cad model, figure 13 details the outside view.

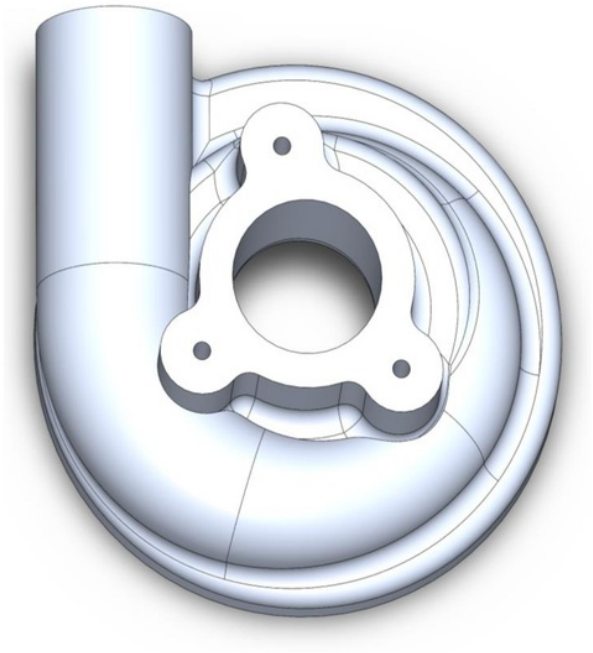


Figure 13, compressor housing outside cad view.

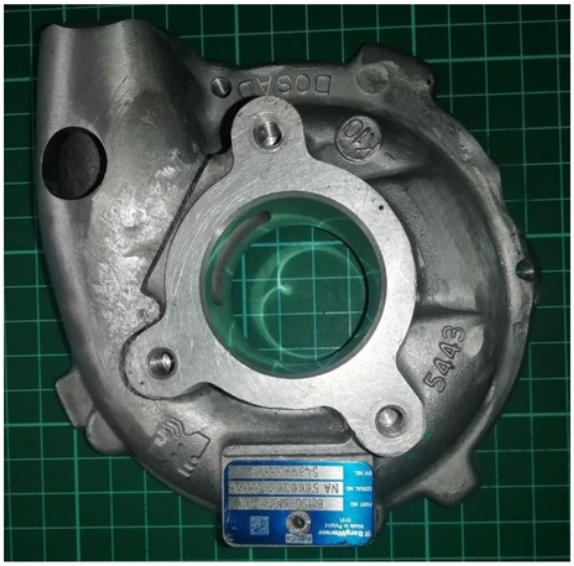


Figure 14, compressor outside view.

Figure 14, the outside view of the compressor housing, note holes in the bore and the outlet, these were ‘dump’ valves which are not required for this application and are in the process of being deleted.

The process above was recreated for the turbine housing, the initial process being exactly the same but after the scroll is made a complete surface the surface was then thickened instead of cutting the shape from a block, this change of process having less steps is more complex to complete, this change may have been unwarranted due to the increased difficulty, the result is pleasantly accurate, see figure 15.

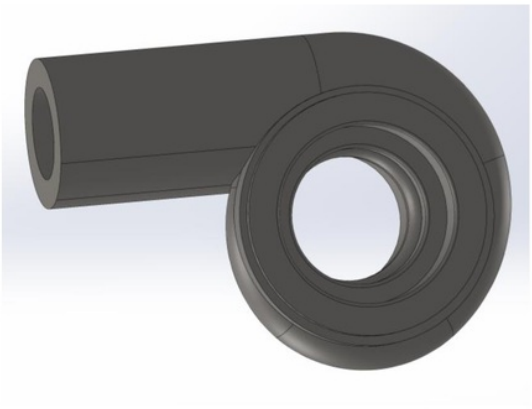


Figure 15, turbine housing.



Figure 16, turbine housing, for comparison.

The flange on the outlet of the turbine housing has been omitted for packaging reasons as the flange is overly large.

The impellers by their very design are difficult to cad, the multi-faceted nature with sweeping curves makes the use of multiple planes necessary, for the blades, splines have to be used to define the shape from where to extrude the blade, luckily Solidworks includes a rotational patterning feature which only requires one blade to be completely finished and then patterned. The compressor impeller is more complex as it has two blade profiles that are distinctly different, see figure 17.

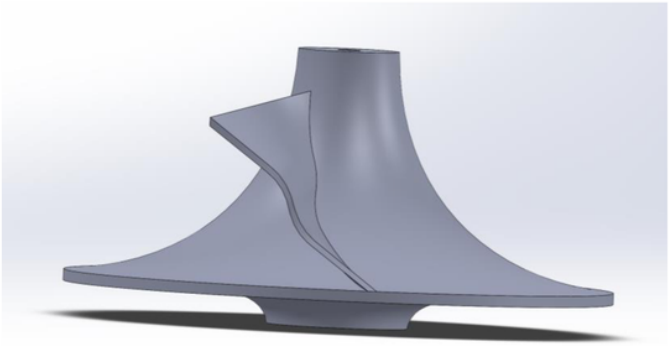


Figure 17, compressor impeller detailing one blade.

The pipework that form the heat exchanger is a concept to achieve the packaging of this system onto a motorcycle, Ariel cars in collaboration with Delta Motorsport have packaged a similar flowing system into a car but utilising a very large heat exchanger that forms a cube that would be impossible to fit onto a bike, this design of cross flow heat exchanger could be more efficient than a tube in tube but further research and calculation is required to examine this.

One of the aspirations is to make the system look as much like an engine motorcycle as possible, the tube exchanger makes this possible as it can mimic where the exhaust is on the standard bike. The original project based loosely on a KTM 690 SMCR was used again as a basis for this creation, so it is appropriate to model the exchanger where the exhaust is on that bike.

As the air from the compressor has to be fed to the combustion chamber through the heat exchanger, it has to return toward the turbine, this necessitated the compressed air going up and back in the exchanger, there were a few options explored for this, two internal tubes; this made the outer pipe over 100mm in diameter which was deemed to big when modelled, another option was to have a central tube which contained the turbine output and an outer tube divided into two using partitions that ran up the whole length of the pipe

essentially splitting it into two 'C' shapes, again this outer diameter would have to be 72mm, again too big.

The design deemed the most appropriate utilises smaller tubes but running either side of the bike, this made packaging twice as difficult, but the outcome looks interesting.

The hot gasses leaving the turbine are split into two streams and routed either side of the bike, this is in turn enveloped within a pipe leaving the compressor routed up one side to the back of the bike, it then jumps to the pipe on the other side to return in the same manner, enveloping the other turbine exhaust pipe and hence to the combustion chamber.

The idea of limiting heat loss as much as possible the heat exchanger also continues onto the combustion chamber as the combustor is within the feed airflow.

Careful consideration had to be taken as to the size of the pipes used to construct the exchanger, the turbine outlet must never be restricted therefore the pipe had to increase in size toward the outlet, if the gasses are fed into a larger volume, they slow therefore a greater heat transfer can potentially take place.

In a similar way the compressor output is exited into a larger volume to retard the velocity to give more time for heat transfer, the size only decreases as the compressed gas enters the combustor.

The turbine outlet has an inside diameter of 42mm and an area of 1385mm^2, this exits into a tube that is 45mm diameter and 1590mm^2, this has to then split into two, using the equation $\frac{\pi \times D^2}{4}$ backwards, $\sqrt{\frac{4\times(1590\div 2)}{\pi}}$ gives a new pipe inside size of 31.8mm so rounding up, a pipe of 32mm was chosen, this has an area of 795mm^2, this size is then run all the way to the back of the bike, if the exchanger is not efficient enough this size could be increased to slow the gasses to release more heat to be returned to the system.

Similar calculations were needed for the outer pipe but in a slightly differing way, the 32mm hot pipe has an outside diameter of 34.4mm, this reveals an area of 929.4mm^2, this size has to be deducted from the area of the outer pipe to not restrict the flow, to calculate the outside pipe inner diameter the compressor output size of 35mm is needed, 1052mm^2, the area of the inner pipe plus the area of the compressor output is put into the same equation. $\sqrt{\frac{4\times(929.4+1052)}{\pi}}$ reveals the outer pipes inner diameter needs to be 50.23mm and an outside diameter of 52.63mm, so rounded up to 53mm for the cad model.

The geometry of the assembly meant that some pipes could not take a direct route but had to be routed around existing parts, these were routed around concentric to existing components to maintain the aesthetic aspect.

The pipe work, on transition from one size to another have to be done with a loft tool within Solidworks; for this to be achieved a sketch has to be done on the end of the pipe and another sketch where it is to end, another sketch of guide curves are required to give the correct path; the loft tool is not an effective tool to use as it does not like hollow sections therefore a lofted cut has to be done post loft; the lofted cut also needs the same set of sketches but with the pipes inside constraints: lofts, if not done correctly can initially work but break if the part is closed and reopened or rebuilt.

The parallel pipework can be most effectively be produced with a tool called a sweep, this tool only requires a beginning sketch and a centreline sketch, this is a very good tool and repeatedly produces hollow sections such as pipes with reliability and repeatability.

Care has to be taken as to how things are mated together in assemblies within Solidworks as there are many ways that will initially show the correct outcome, but on adding further mates these prove to be problematic to the point that it gets difficult to ascertain which is the problem.

The result is the assembly in figure 18, the turbo is a little prominent, but this is to keep the combustor tucked up and protected, on manipulation of the front wheel the turbo is back enough to have good clearance, figure 19 shows the position of the combustor giving plenty of ground clearance.

In figures 20 and 21 it can be seen that the addition of all the tubing does not increase the width of the bike by a great deal and on the back, it is narrower than the swing arm.



Figure 18, system in position on motorcycle, left hand view.



Figure 19, system in position, right hand side.

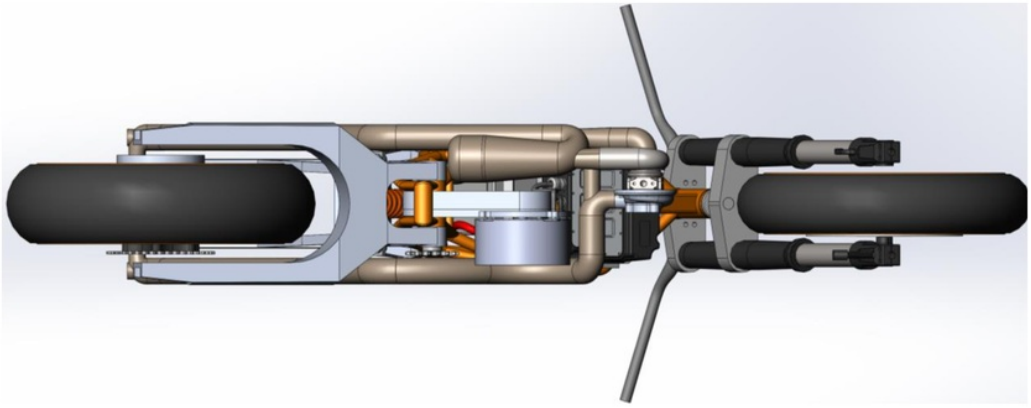


Figure 20, bottom view.

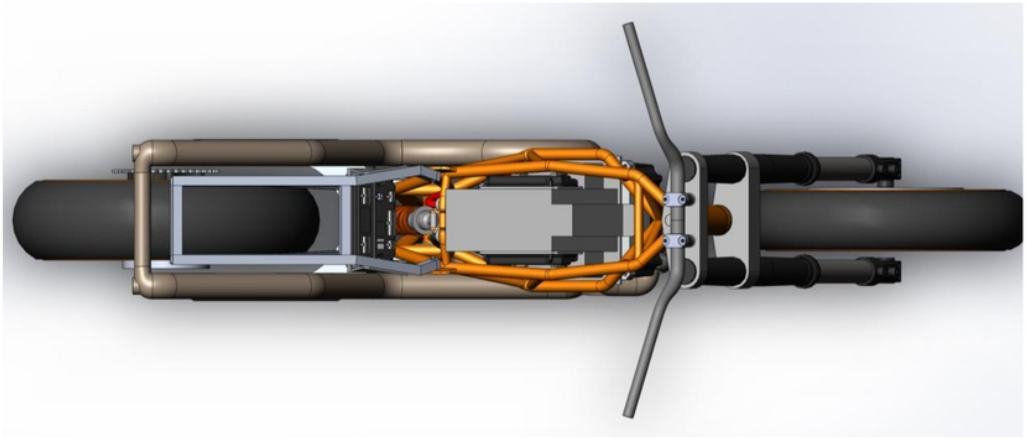


Figure 21, top view.

The original thought of the 2018 project was to keep the bike as light as possible, the range extender adds an extra 12.3Kg to the 100Kg of the bike, the original bike weighs 153Kg so even with the extender added there is still almost 40Kg of weight saving.

There needs to be an alternator attached to the turbine which has not been investigated as yet, its weight along with other ancillaries such as radiators, fuel tank and fuel and oil pumps would have to be added, the author does not expect these to exceed 20Kg so the bike will still be lighter than its petrol burning protégé.

Further work

This is a first iteration of the complete turbine system in position on the bike, this is likely to change as more calculations are performed, the efficiency of the heat exchanger will need to be investigated thermodynamically as will the combustor, the combustor, at this point is proving difficult to research, it is a design based on the authors knowledge of flame composition and air flow, the combustors internal design utilises a cool wall feature that is commonplace in commercial aircraft engines, see figure 22, the design is modified to be practically incorporated into a small combustor, this will likely need to be refined to gain efficiency.

The cone in the combustor where the fuel jet would be is to provide a haven for the flame so it does not blow out, there is a limit to how small this can be to perform its task, in this instance it may be too small but there is scope for enlargement, the swirl fins around the cone should help with flame stability as it forms a 'dead' air zone down the center of the combustor.

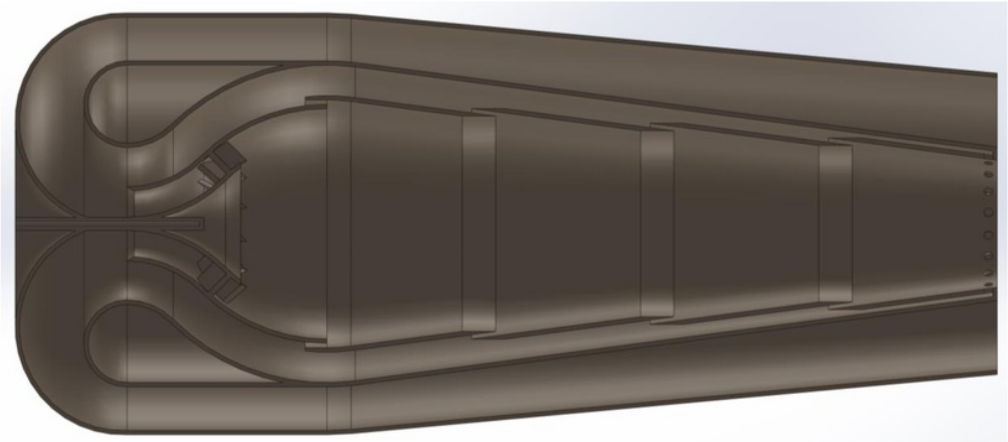


Figure 22, combustor internal features.

Investigation is required into high speed alternators, the Emrax motors are effective as motors and alternators (alternator mode used usually used for regenerative braking) so this should also be included in the investigation.

The other possibility is the use of an epicyclic gearbox between the turbo and alternator, an investigation into the power losses associated with this kind of device may be prudent.

Ultimately the final outcome of this research will be to build and test the system to verify outputs and operating parameters, as with all mathematical and computer aided

design projects the only way to fully verify findings is to go ahead and build the system, run tests and record data that can be verified against the mathematical models.

The picture in figure 17 shows a compressor impeller with one blade, this is as yet unfinished, the geometry of the twin profile of the blades makes the process very complicated and as yet the author has not completed it, further investigation into simplifying the process is required.

A further look into fuels may also be advantageous, aeroplanes run on jet A1 or kerosene, a comparison of the chemical makeup and the fuel ratios used within a commercial jet engine could shed light on the processes within bigger engines, why don't they use diesel.

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Appendix 1.

Included with express permission of Simon Hughes 2019

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Introduction

Following a lengthy debate, a change in the design brief was effected by the team; a cumulative decision was made to concentrate efforts on the design of the motorcycle frame and the incorporation of an electric motor, battery and the associated components.

The initial design brief was to design a carbon fibre frame, also to contain the above. On further discussion, and taking into consideration the opinion of lecturers, it was decided that the time available was not enough to achieve the desired result.

Both the authors of this report had pivotal roles, Simon did the computer aided design where Robert did the research into the motor, battery and ancillaries, the overall design was agreed on through many daily impromptu meetings, as both team members work in the same room.

As there were so many interactions concerning the design, minutes of meetings were impossible to compile.

The Design

There are other solely electric motorcycles on the market; a lot of these have quite radical designs from some niche manufacturers, but they look so different from conventional motorcycles that they alienate themselves from the wider market. However, there are some that have more conventional designs such as Alta motors and KTM.

The original design called for a design of frame that could, with a simple fitting kit, contain an engine of several different types, as the brief changed to focus solely on an electric bike, this original idea became much harder to achieve.

The design of any electrically propelled vehicle has many similarities to its hydrocarbon burning counterpart; one of the biggest problems being weight.

It was decided early on that the EMP (electric motorcycle project) should have a weight cap. Looking at the weight of available off the shelf components, it should be reasonably practical to make the EMP with a weight of around one hundred kilogrammes.

The power output of the EMP had to be comparable to its petrol burning counterpart. As one of the team members has a KTM motorcycle, the statistics of this bike were investigated and a power to weight ratio obtained. It was found to produce 67 horse power and have a mass of 153 kilograms giving a power to weight ratio of 0.429 Horse power per kilogram; this recalculated to be relevant to the one hundred kilograms of the project, to maintain the power, the power required is 43 horse power.

It was also agreed to use the geometry of the KTM frame as it is a tried and tested design that has been produced for quite a few years.

The frame (simon)

The frame is a tubular trellis frame similar in style to its KTM counterpart, there are differences in key positions to allow the fitting of the required components.

There has been an adaption of the lower tubes where it attaches to the headstock tube, this is to allow the use of a standard twin radiator setup. The bike that is the inspiration for this uses a single curved radiator, this radiator is short and wide and could be more vulnerable and expensive if the rider were to come off.

The twin radiator setup is very robust and can be made more so by fitting a strengthening upgrade that is readily available.

Although there are many subtle differences the only other major change is to the bottom of the frame to incorporate the electric motor, gearbox and swing arm.

The material the team has selected for the frame is 4130 chromoly steel, the reason for this is it is the same material as the frame that the new frame has been modelled off.

The team did explore other materials before deciding on this, aluminium wasn't considered for a material as when the frame design was agreed upon the team also made the decision that steel would be used, this is due to previous discussions stating that steel frames can be made with the same strength as aluminium frames but lighter, as weight is a key issue this is essential.

The electric motor can supply large amounts of torque at low running speeds, this could, if set up as a conventional motorcycle produce large deviations of the rear suspension, this is called squat. This is produced because the front sprocket is in front of the rear suspension pivot and it tries to pull the front and rear sprockets together, the higher the torque the worse the squat.

To try and minimise the effects of squat it was decided by the team to try and incorporate the front sprocket shaft into the pivot of the rear suspension, this required a new design for parts of the swing arm, modification of the bottom of the frame and the inclusion of a simple gearbox.

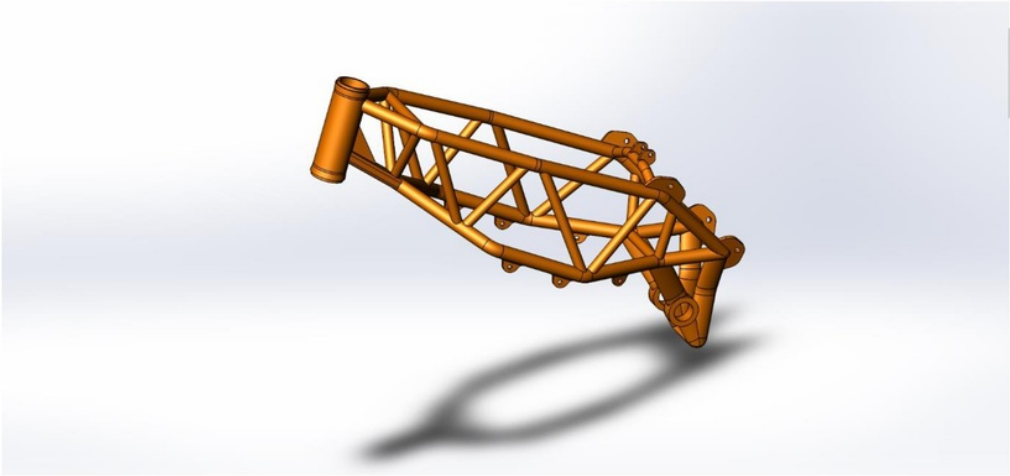


Figure 1, finalised frame design

The mounting of the engine in the standard KTM frame comprised of a few wide tabs welded on with a hole for the engine fitting kit to mount to, the team decided that this would still be a suitable mounting method to hold the battery and ancillary equipment, the 690 engines fitted in the standard KTM bike, weighs 40 kilograms, the battery and controller weighs 33.78 kilograms.

The motor is mounted on the gearbox, two extra tabs welded to the frame the same as above hold the gearbox and motor in place.

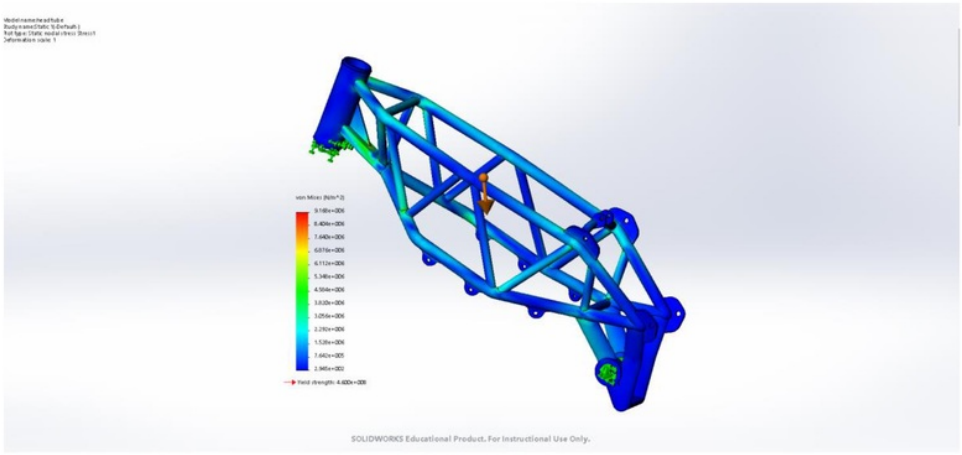


Figure 1, von mises stress evaluation

A stress analysis shown in figure 2 shows the redesign of the frame is well within acceptable yield limits.

Swing arm (simon)

Figure 3, shows the redesigned swing arm, this was needed because it must accommodate the front sprocket on the outside of its pivot point, a new design of bearing carrier had to be made as it needs to carry bearings externally for the swing arm and internally for the final drive.

The space restrictions imposed by incorporating the final drive through the swing arm pivot does not allow the use of suspension with a lower linkage so a progressive damping system must be used on this bike.

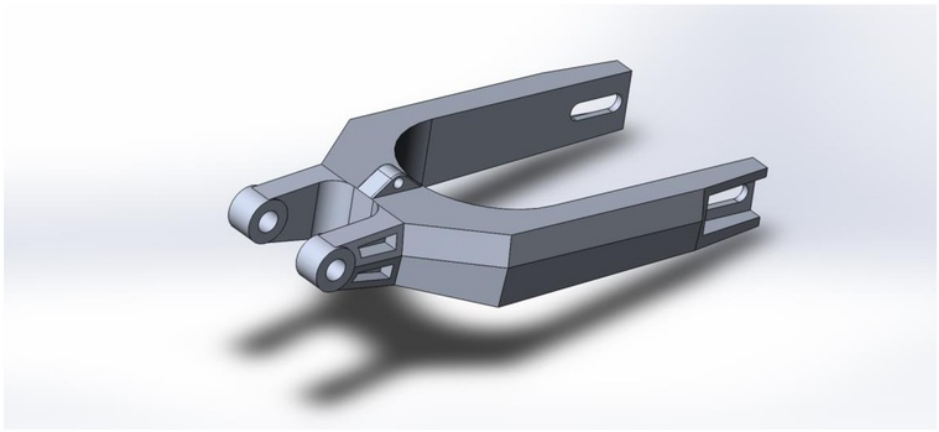


Figure 1, redesigned swing arm

The gearbox (robert)

A simple gearbox shown in figure 4, is all that is required for this build, it contains just three gears to move the drive axis to a point where the motor can be mounted, this also incorporates some guiding for the motor cables,

At this stage, there is no change in gearing through the gearbox, this could be changed if the motorcycles use required it.

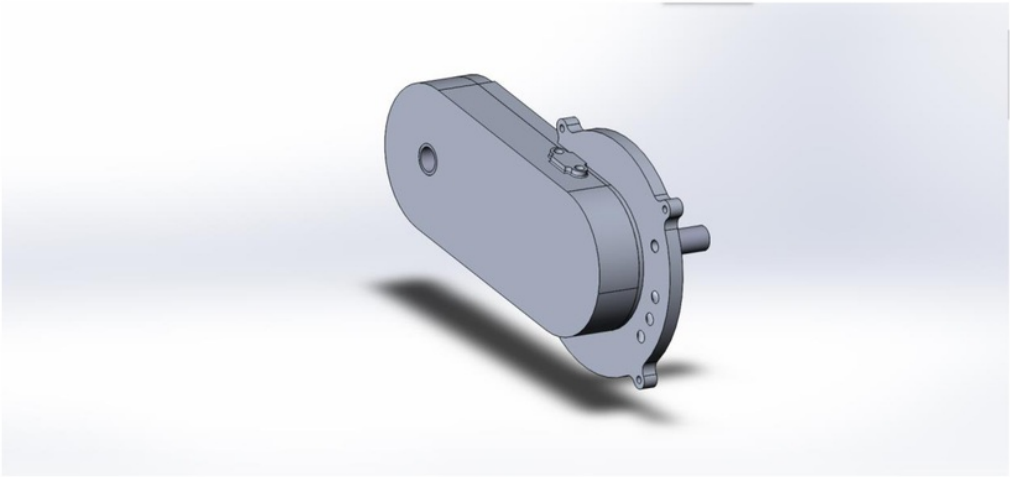


Figure 1, gear box

Electrical

Early in the design process it was decided that where possible, standard, off the shelf products should be used, such as bearings and bushes. For the electrical components, this ethos is carried on.

The trawl for the appropriate sizes and formats of components has been long.

The Motor (robert)

The motor should be compact, lightweight and of a suitable capacity to give the power, torque and required speed.

Most motors available off the shelf are aimed at the electric and hybrid car market; they are mainly cylindrical in section and long, they also are generally over engineered and having many parts made of steel, this makes them far too heavy for this application.

their website it is in fact no longer produced, a lot of time was wasted both in calculations and computer aided design due to this.

Emrax is a company that manufacture a range of compact and lightweight motors capable of powering everything from a race car to a golf cart. Emrax produce several different motors of varying sizes, the smallest being their 188 motor. Their 188 motor runs on a voltage that initially was thought to be much too high to be achievable on a lightweight project such as this, 400 volts is the maximum the 188 motor can accept.

The following figures 5, 6 and 7 are for the Emrax208 motor which produces 8% more power and torque than the Emrax188 motor.

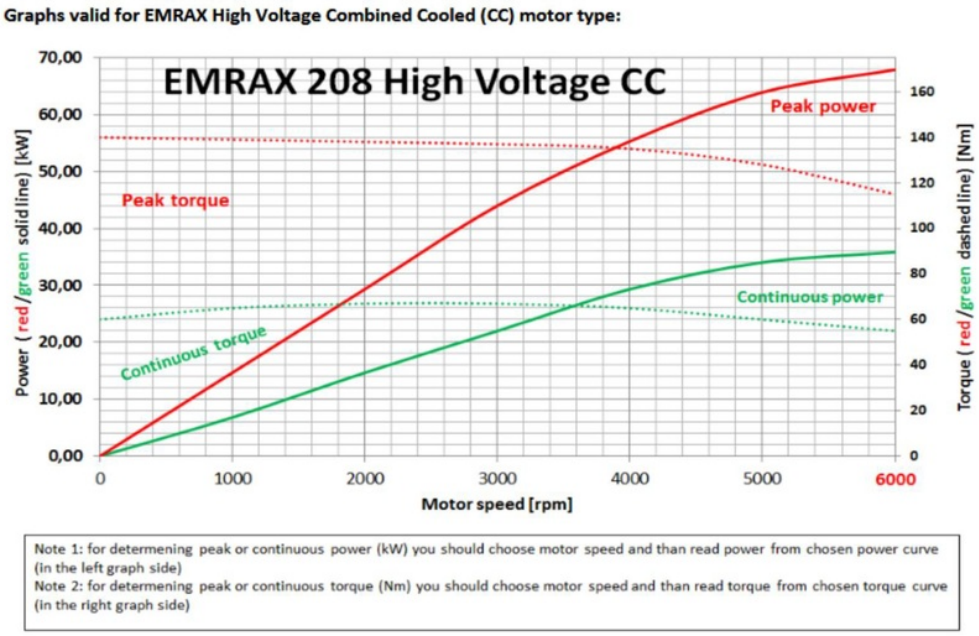


Figure 1, Emrax 208 statistics

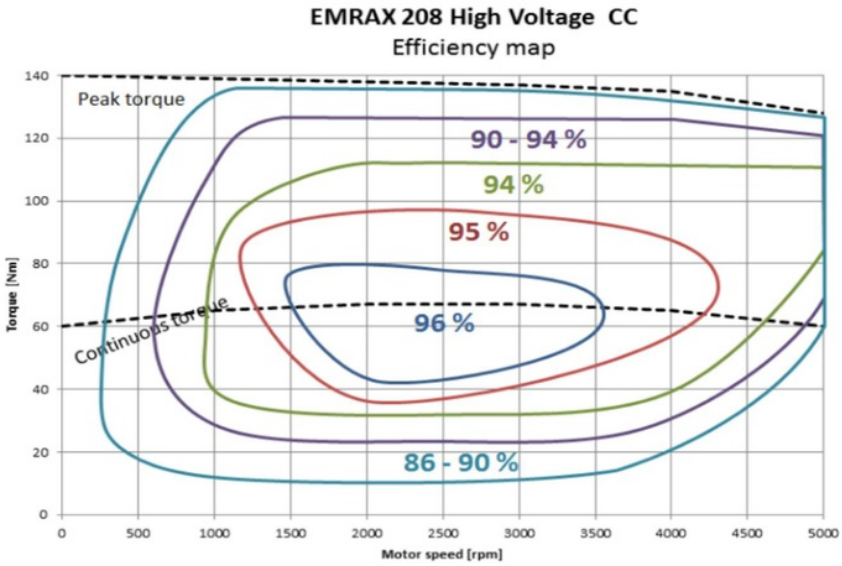


Figure 1, Emrax 208 efficiency

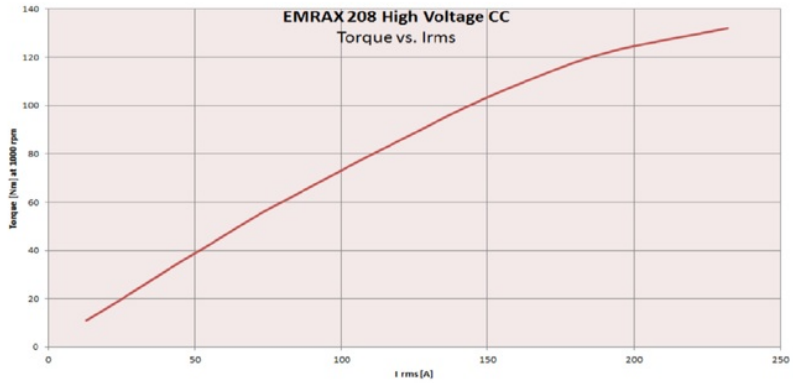


Figure 2, Emrax 208 motor torque to ampere's

The motor is capable of running at lower voltages, Emrax in their product data sheet give three examples of running voltages, 400 volts, 270 volts and their lowest being 100 volts, but, with a lower voltage comes another part of the problem, lower voltages require higher current draw. (Emrax, 2018)

The Battery (robert)

A battery that can supply 400 volts, have enough capacity and is lightweight!

The above sentence contains a quandary, to have the voltage and capacity is one thing, but to be lightweight as well, is impossible with current technology.

At a lower voltage, to maintain the motors capabilities, the required amperage draw from the battery must rise, this severely impacts on the battery capacity. From the equation R=V/I if the voltage is cut the current draw must rise as the resistance of the motor does not change, it is in fact directly proportional, if the voltage is halved the current draw will double.

This amperage increase directly impacts on the length of time the battery can last between charges, severely shortening the available ride time.

Battery types (robert)

Lead acid batteries by their very nature are one of the heaviest batteries available, there specific energy measured in watt hours per kilogram is generally 25(nominal), newer batteries like the lead calcium battery can sometimes achieve 75Wh/Kg(maximum)

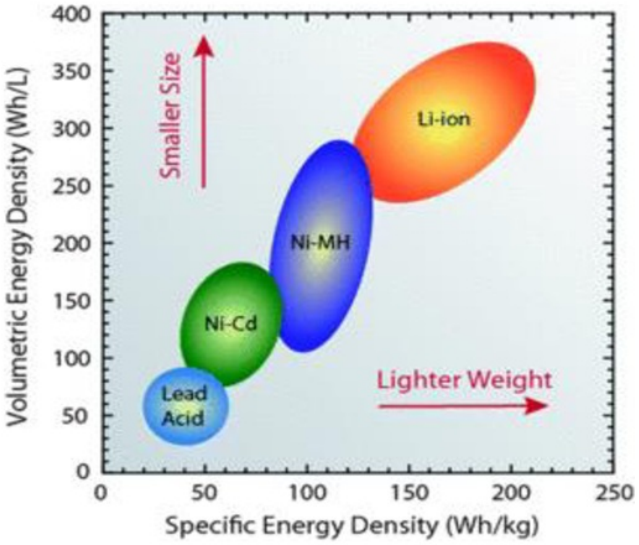


Figure 1, from EnergyEducation.ca 20/05/2018

Nickel cadmium batteries fair a little better, with a watt hours per kilogram still at 25Wh/Kg (nominal) to 100Wh/Kg(maximum), they weigh a lot less than its lead counterpart, shown in figure 8.

Other battery types are much more suited to this application although nickel metal hydride are too low in capacity although they are lighter in weight with a watt hours per kilogram of around 75Wh/Kg (nominal) to 175Wh/Kg (maximum).

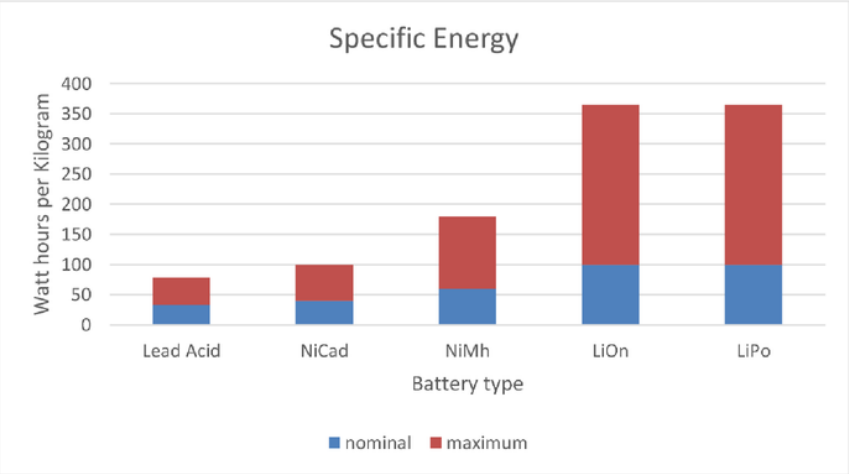


Figure 1, specific energy, R Hughes, 2018

As can be seen from figure 9, lithium ion and lithium polymer batteries would both be particularly suited for this project, both coming in with the same specific energy from a nominal 100Wh/Kg to a maximum of 360Wh/Kg. Figure two shows a graphical representation of the watt hours per litre versus watt hours per kilogram, as it can be seen from this the lithium series of batteries is smaller and lighter.

As shown in figure 10 the best battery readily available is the lithium polymer battery, with a specific power peak of 3250watts per kilogram.

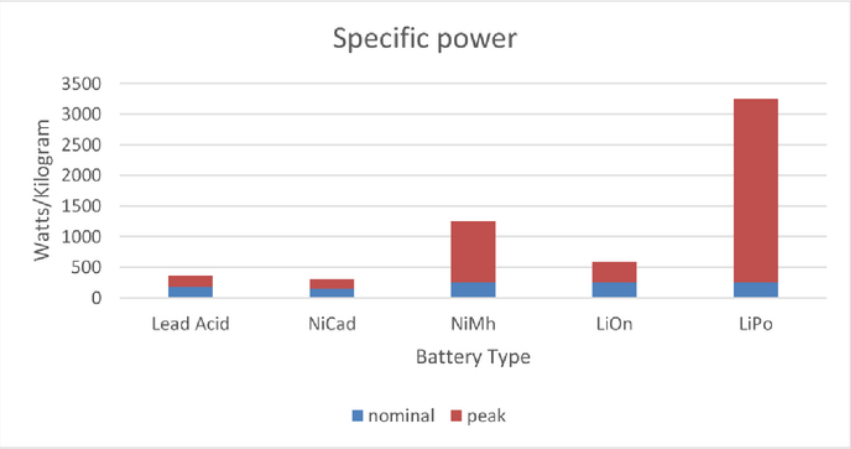


Figure 1, specific power, R Hughes, 2018

By far the most readily available lithium polymer batteries that would suit this application are produced for remote controlled cars, helicopters and airplanes, there are many different voltages, capacities, discharge rates and physical sizes.

The advantage with this type of battery is they are manufactured with weight in mind, and they can with the appropriate controllers be connected to each other to achieve the required capacities.

To achieve 400 volts from a battery pack, the batteries need to be connected in series. After much research a battery pack of 22.2 volts was agreed on, our battery will contain 18 cell packs that have a capacity of 10 amp/hours each. The cell packs are made up of 6 individual lithium polymer pouches each producing 3.7volts, this makes the whole battery pack for the EMP 108 cells of 3.7 volts all connected to give a final 399.6 volts.

The weight of this cell array comes to 25Kg.

Unfortunately, this battery, with its array of cells is still only a 10 amp/hour battery, all the cells are connected in series to increase the voltage to 400 volts, to increase the amp hour capacity another set of cells would need to be connected in parallel.

The motor controller and ancillaries (robert)

Batteries produce direct current; motors are made that will run on direct current but they are heavy, smaller dc motors are inherently inefficient. The

most efficient motors do not run on direct current; they run on alternating current, it must be a closely controlled 3-phase alternating current.

A conventional household supply is alternating current, it swaps its polarity 50 times every second, this is single phase, figure 11 shows industry standard 3-phase supply, it still alternates at 50 hertz but there are three peaks 120 degrees apart.

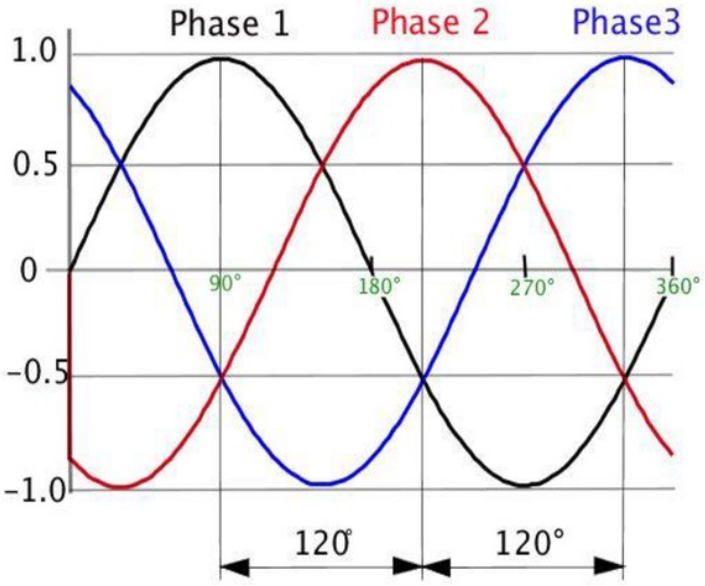


Figure 1, Electronics Stack Exchange.com, 25/05/2018

Single and tri-phase are great at running motors at a set speed, the motor for the EMP needs its supply frequency to be controlled precisely, for this a controller is required that can not only turn direct current into a phased output but must be able to control the angle of offset of the modulated phase to control the speed.

It also needs to meet the ethos of the project, freely available and lightweight, the EMDrive H300 from the company Emsiso, shown in figure 13, was found to be able to handle the voltage and current requirements, and, is small and light enough to be incorporated into the design.

The diagram in figure 12, shows a basic circuit for controlling a motor, this is an indication of what is contained in the H300 unit.

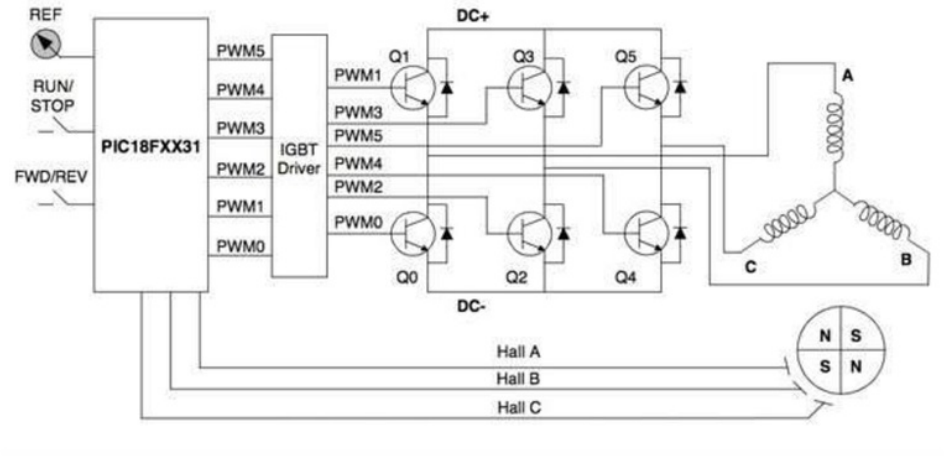


Figure 1, from Digikey.co.uk, 25/05/2018



Figure 2, from emdrive-mobility.com, 20/01/2018

The H300 can take an input from a potentiometer attached to the throttle to govern the speed of the motor, it can limit the motor to run within pre-set limits, such as max torque or max rpm, also it can monitor the health of the battery.

Emsiso can also supply a compact battery charge management system, with lithium cells the charging must be controlled in a specific way, each cell

must be monitored and balanced to maximise its lifespan and charge carrying ability. Shown in figure 14, is the EMBMS from Emsiso.



Figure 1, from emdrive-mobility.com, 20/01/2018

Figure 15, shows a typical wiring system that can be used to connect the whole system together (excluding the main motor wiring), as the major components are made by the same company it is sensible to use the wiring diagram supplied by them. (Emsiso, 2018)

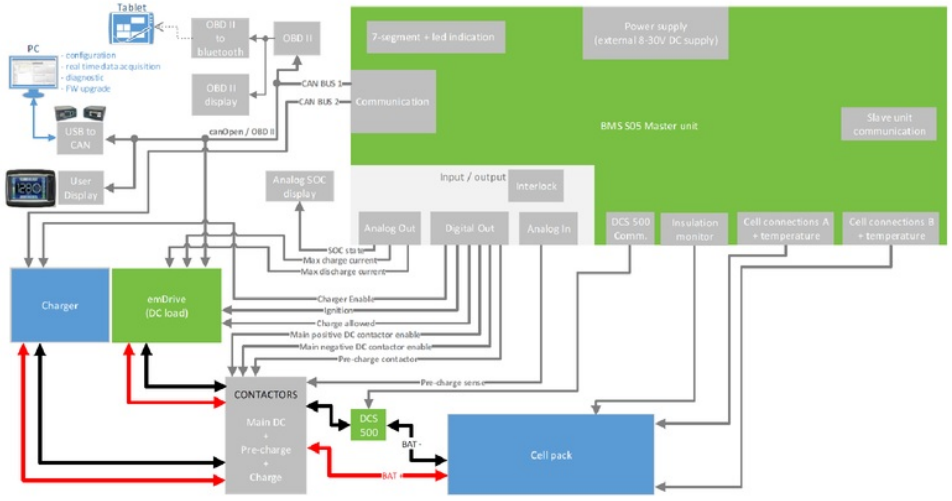


Figure 1, typical wiring system, Emsiso (2018)

Conclusion

The electric motorcycle market is expanding; other manufacturers are bringing out electric models to complement their existing ranges, the market is buoyant, but unit prices remain high, this is excluding a lot of people who would use them for short commuting and weekend fun bikes.

If this motorcycle could be made to a price that was comparable to petrol models it would sell, bulk purchasing through good, stable supply chains could make this a viable proposition.

The manufacturers of electrical motorcycles that are currently available on the market are not very forthcoming with the run times available from their batteries, although it is a very subjective question.

If the bike is accelerating hard and doing high speeds the battery will go flat faster, there are other factors to consider such as heat and drag, the greater your frontal area the harder the motor must work, the more heat will be created within the system, this all reduces the available power in the battery.

The said manufacturers are also very protective of the technology behind there drive systems, this has made it difficult to compare the EMP setup with others.

Battery technology is advancing at a pace currently with large companies investing millions to try and better the batteries they currently have, super capacitors may also be a viable option in the future, being much lighter than batteries. (etfstream.com, 2018)

*As of the 27th May 2018 GensAce batteries have listed a new higher capacity lithium polymer battery, it supplies the same voltage but has more than double the capacity, initial looks at the size indicate it could be suitable but at this moment there is no time for it to be implemented. *

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Appendix 2a

y = 1.972430581579900E-10x4 - 2.569721086548820E-06x3 + 1.257476141463060E-02x2 + 3.498535384698690E+01x - 1.164107273520790E+04

turbine input enthalpy, carbon dioxide, Kj/Kmol

load	rpm	800	1000	1250	1500	1750	2000	2250	2500	3000	3500	4000	4500	5000	5500	6000	6500
	2	9254.8592	12241.3672	16356.3494	16798.3221	19457.6228	23509.4596	23271.4510	24954.2940	28953.4321	30591.0787	31122.1926	31992.6122				
	5	9779.8933	12675.1748	17036.8519	19126.4319	21358.8360	23818.8336	24490.1013	25036.0297	27835.9166	29240.2814	31106.3984	32130.0787	33658.3420	33786.1529	33919.3631	35529.0648
	10	12864.2343	14879.9105	18240.0730	19447.7266	20898.9597	21694.5321	22766.1026	23620.9761	26590.5664	28791.9272	31238.0515	32813.3585	34346.1398	34730.8923	35277.0100	36534.4711
	20	13661.2241	15862.5240	18107.5506	20455.2760	21840.0378	23059.0298	24230.4567	25511.8217	27706.3695	29809.9234	31675.7024	33642.3705	35116.2597	36087.7204	36556.0213	37809.0624
	30	16099.5457	17627.4966	19744.8766	21338.8154	22448.4727	23291.6948	25010.4834	26286.8820	28698.2079	30701.4020	32421.1489	33972.6682	35577.3601	36922.6562	37673.7427	38785.4331
	40	17109.9471	18943.8293	20923.9208	22433.3618	23347.3769	24291.5166	25973.4019	27178.6814	29846.5583	31739.0485	33344.4361	34698.8061	36227.5808	37203.3811	38231.7118	39307.6359
	50		19789.4962	22076.1186	23763.0058	24796.0325	25896.3946	27142.5186	28474.4947	30774.9819	32558.8756	34340.8004	35470.0500	36771.6247	37484.4136	38785.4331	39863.5850
	60		20719.3499	23337.2516	24959.4014	26101.8159	27256.1952	28646.1599	30014.1124	31871.0772	33344.4361	35180.5471	36238.3425	37435.7514	38389.0245	39487.3773	40612.0801
	70		21784.8315	24612.4133	26281.7389	27582.0825	28422.5032	29846.5583	30843.3284	32511.1915	34170.0015	35904.9444	36960.4281	38041.9770	38910.4515	40054.6132	41362.5909
	80		22695.4686	25593.7990	26879.2458	28318.5597	29245.5004	30612.0883	31633.4816	33642.3705	35014.5060	36653.0201	37641.2764	38443.2920	39803.5751	40568.3167	42076.5950
	90		23752.8571	26657.5434	27411.3134	28765.8898	30276.1783	31380.3252	32140.6565	34047.3156	35733.0428	37025.1930	38345.6185	38921.3255	40021.8561	41433.9111	43228.1948
	100		24082.9789	27364.7653	28105.6405	29224.6249	30648.8601	31818.2564	32648.9726	34586.5378	36647.6303	37814.4767	39051.8471	39661.7858	40978.8680	42236.1151	43311.0191
	110		25547.6824	28090.0698	29391.6875	29663.4469	31269.6600	32452.9246	33216.8664	35389.5982	37511.4521	39215.0885	40005.4790	40229.3839	41571.1155	42742.7589	44168.2143
	120			28703.4134	29605.9302	30433.5712	32357.6108	33222.1804	34004.6571	36136.1247	38546.4310	40223.9206	40907.6626	41384.5337	42830.9606	43515.4174	45355.6768
	130			28817.9679	30040.3046	31501.5933	33248.7523	34287.4126	35416.4125	37630.4553	39525.5196	40995.3025	41774.2991	43029.5109	43758.6678	45672.7315	
	140			29334.2447	30690.8926	32077.1971	34698.8061	35926.4405	37149.3716	39209.6455	40814.5752	42093.0930	43023.9938	44395.3635	45261.1788	46754.2142	
	150				31001.1325	32638.3711	35937.1892	37203.3811	38535.5723	40497.2158	41977.6269	43333.1094	43813.9794	45589.2650	47492.1492		
	160				31644.0361	33073.4342	37089.9743	38421.5836	39869.0411	41922.6592	43090.2058	44495.1410	44750.2757	47033.5384			
	170				32119.5014	33658.3420	37911.9525	39460.1360	41039.1328	43001.9265	41796.2735	45400.1564	45895.4170				
	180					35947.9385	38725.6625	40207.5315	41999.6169	43427.0118	44123.9122	46424.9221					
	190						39596.3695	40891.2332	42864.0430	43432.5364	45867.5727						
	200						40393.3319	41845.7222	43808.4478	44256.8377	47039.1273						
	201		25552.8059	29146.3601	32156.5242	36383.6711	40376.9327	41779.7926	43885.8998	44517.3182	45672.7315	47106.2021	46681.6294	48214.9168	48237.3533	47408.2090	45472.4491

y = 6.333448977730600E-11x4 - 8.758043070368190E-07x3 + 4.659983355521140E-03x2 + 2.612963609827380E+01x - 8.216812776960540E+03

turbine input enthalpy carbon monoxide, Kj/Kmol

load	rpm	800	1000	1250	1500	1750	2000	2250	2500	3000	3500	4000	4500	5000	5500	6000	6500
	2	6282.0507	8237.9370	10903.1503	11187.5603	12891.9305	15467.9816	15317.3033	16381.0688	18894.9121	19919.0630	20250.5985	20793.3108				
	5	6627.3367	8520.4561	11340.9147	12680.2895	14103.6275	15663.7265	16088.0112	16432.6422	18194.3416	19074.5122	20240.7435	20878.9520	21829.8061	21909.2255	21991.9836	22990.7280
	10	8643.4623	9950.5497	12113.0241	12885.6090	13811.0298	14317.0214	14997.1228	15538.5543	17411.9321	18793.7516	20322.8819	21304.3557	22257.0105	22495.7958	22834.4955	23613.3557
	20	9161.2185	10584.9687	12028.1017	13528.4392	14409.4656	15182.7591	15923.9689	16732.6888	18113.0363	19430.9054	20595.8045	21819.8806	22734.8269	23336.8014	23626.6916	24401.4345
	30	10737.7402	11720.2338	13075.3563	14090.8957	14795.6980	15330.1222	16416.5240	17220.8579	18735.0361	19987.9540	21060.2259	22025.0952	23020.6567	23853.5160	24317.8311	25004.2113
	40	11387.8893	12563.5272	13826.9193	14786.1120	15365.3787	15962.5542	17023.5027	17781.6517	19453.8137	20635.2915	21634.6847	22475.8876	23423.3985	24027.1132	24662.4587	25326.2857
	50		13103.8366	14559.3909	15628.4129	16281.1850	16975.0034	17758.9298	18594.8391	20033.8936	21145.9707	22253.6958	22954.1536	23760.0919	24200.8342	25004.2113	25668.9374
	60		13696.6681	15358.9679	16384.2917	17104.3618	17830.3503	18702.4236	19558.5694	20717.5790	21634.6847	22774.6893	23430.0611	24170.7583	24759.5761	25437.0933	26129.8849
	70		14374.3949	16165.2570	17217.6210	18035.0142	18562.2489	19453.8137	20076.5606	21116.2861	22147.6498	23223.6065	23876.8776	24545.2984	25081.3376	25786.6196	26591.6488
	80		14952.3424	16784.3571	17593.4625	18497.0840	19077.7791	19932.1834	20569.4838	21819.8806	22671.7255	23686.7127	24297.7706	24793.0737	25631.9627	26102.9458	27030.5655
	90		15621.9930	17454.0582	17927.7832	18777.4401	19722.3543	20411.6263	20885.5412	22071.4595	23117.1193	23916.9314	24732.7813	25088.0453	25766.4417	26635.5079	27737.7128
	100		15830.7540	17898.5484	18363.5613	19064.7118	19955.1460	20684.6603	21202.0525	22406.2224	23683.3778	24404.7792	25168.5522	25544.5891	26355.6097	27128.5761	27788.5356
	110		16755.2920	18353.7947	19169.2730	19339.2969	20342.5997	21080.0102	21555.3615	22904.2887	24217.5446	25269.2218	25756.3533	25894.2617	26719.8727	27439.7421	28314.2533
	120			18738.2976	19303.3188	19820.6860	21020.6626	21558.6661	22044.9644	23366.7738	24856.7314	25890.8972	26311.7971	26605.1432	27493.8944	27913.9388	29041.7084
	130			18810.0645	19574.9422	20487.2521	21575.1897	22220.5512	22920.9091	24291.0841	25460.6041	26365.7213	26844.7818	27615.7764	28063.1411	29235.7841	
	140			19133.3242	19981.3920	20846.0092	22475.8876	23236.9208	23993.7195	25265.8655	26254.5148	27040.7029	27612.3900	28453.4803	28983.8517	29897.3001	
	150				20175.0553	21195.4539	23243.5782	24027.1132	24850.0298	26059.1755	26969.7494	27802.0900	28097.0619	29184.6988	30348.2586		
	160				20576.0637	21466.1562	23956.9917	24779.6741	25672.2990	26935.9686	27653.0290	28514.6262	28670.9483	30068.0368			
	170				20872.3631	21829.8061	24464.9919	25420.3012	26392.6875	27598.8451	26858.2890	29068.9392	29372.0558				
	180					23250.2358	24967.3332	25880.8040	26983.2629	27859.7034	28287.0951	29695.9583					
	190						25504.2729	26301.6876	27514.2043	27863.0928	29355.0183						
	200						25995.2169	26888.6827	28093.6697	28368.5775	30071.4526						
	201		16758.5212	19015.7168	20895.4253	23520.0246	25985.1196	26848.1585	28141.1652	28528.2160	29235.7841	30112.4446	29852.9248	30789.6282	30803.3244	30296.9787	29113.1947

y = 7.375068711828600E-11x4 - 1.324271262140440E-06x3 + 9.550379011160640E-03x2 + 2.632170883124980E+01x - 8.610658448420330E+03

turbine input enthalpy, water vapour, Kj/Kmol

load	rpm	800	1000	1250	1500	1750	2000	2250	2500	3000	3500	4000	4500	5000	5500	6000	6500
	2	7210.9995	9495.9182	12655.8003	12996.0085	15046.4244	18182.0033	17997.4284	19303.5176	22417.2372	23696.3746	24111.7307	24792.9845				
	5	7612.1927	9828.3968	13179.6837	14790.7424	16515.9673	18421.9948	18943.0033	19367.0169	21545.7283	22641.1183	24099.3753	24900.6378	26098.5991	26198.8816	26303.4160	27567.8692
	10	9973.3424	11520.4727	14106.9185	15038.7832	16160.2251	16775.7623	17605.6941	18268.5008	20575.8210	22291.2174	24202.3713	25435.9817	26638.4297	26940.5959	27369.7204	28358.8268
	20	10584.6810	12275.8683	14004.7342	15817.1790	16888.3989	17832.7377	18741.4323	19736.7679	21444.7705	23085.9308	24544.8694	26086.0687	27243.3791	28007.2528	28375.7905	29362.8749
	30	12458.1995	13634.7003	15268.2614	16500.4764	17359.5871	18013.1255	19347.1698	20339.5109	22218.1001	23782.6320	25128.6376	26345.2508	27605.8424	28664.4596	29256.2077	30133.0048
	40	13235.9786	14649.8111	16179.5294	17347.8810	18056.3034	18788.8300	20095.6630	21033.6887	23114.5475	24594.4572	25852.3661	26915.3918	28117.2975	28885.5702	29696.1403	30545.2595
	50		15302.7259	17071.1886	18378.6812	19180.5832	20035.7742	21005.5260	22043.5967	23840.1672	25236.5476	26634.2373	27521.4705	28545.5305	29106.9952	30133.0048	30984.4301
	60		16021.3348	18048.4517	19307.4854	20195.5425	21094.0585	22177.4971	23245.4445	24697.8216	25852.3661	27293.9028	28125.7658	29068.6492	29820.2253	30687.2148	31576.1501
	70		16845.6613	19037.9786	20335.5096	21347.9259	22003.0480	23114.5475	23893.6144	25199.1848	26500.1437	27863.4680	28694.2061	29546.5113	30231.6783	31135.3979	32169.9809
	80		17550.9578	19800.4946	20800.5300	21921.9885	22645.1924	23712.8004	24511.8207	26086.0687	27163.4182	28452.1504	29230.6183	29863.0357	30937.0118	31541.5389	32735.4081
	90		18370.8077	20627.9497	21214.8845	22270.9029	23450.2264	24313.6935	24908.9222	26403.8397	27728.2655	28745.2135	29785.9853	30240.2614	31109.5078	32226.4389	33648.3638
	100		18626.9663	21178.6246	21755.9751	22628.8968	23741.5502	24656.4667	25307.1485	26827.2111	28447.9072	29367.1431	30343.2950	30824.9866	31866.3009	32861.7980	33714.0718
	110		19764.6442	21743.8361	22759.3177	22971.5251	24227.1018	25153.5326	25752.3236	27458.2227	29128.3026	30472.1795	31096.5644	31273.5467	32335.0650	33263.3745	34394.4946
	120			22222.1611	22926.6069	23573.2447	25078.8607	25756.4907	26370.3574	28045.3362	29944.4070	31269.2278	31809.9636	32187.3506	33333.3092	33876.2570	35338.2029
	130			22311.5349	23265.9087	24408.5941	25777.3277	26592.3199	27479.3023	29222.0895	30717.3424	31879.3045	32495.9595	33490.7653	34069.3206	35590.3965	
	140			22714.4710	23774.4146	24859.2229	26915.3918	27880.3768	28843.0245	30467.8817	31736.3203	32748.4786	33486.3896	34574.9149	35263.0548	36451.3405	
	150				24017.0339	25298.8407	27888.8319	28885.5702	29935.8397	31485.3111	32657.0061	33731.5981	34113.2281	35523.9960	37039.4202		
	160				24520.0821	25639.8590	28796.2377	29845.9102	30988.7416	32613.4650	33538.9053	34654.1814	34856.9107	36673.8814			
	170				24892.3538	26098.5991	29443.9903	30665.6984	31913.9857	33468.8879	32513.3626	35373.5774	35767.5822				
	180					27897.2875	30085.8346	31256.2718	32674.4257	33806.1045	34359.3119	36189.0830					
	190						30773.3085	31796.9654	33359.5420	33810.4882	35745.4247						
	200						31403.1663	32552.5261	34108.8369	34464.8808	36678.3350						
	201		19768.6271	22567.8063	24921.3498	28240.1333	31390.1997	32500.3101	34170.3243	34671.8009	35590.3965	36731.7854	36393.5232	37615.9059	37633.8092	36972.5004	35431.0758

y = 4.462463678167200E-11x4 - 6.203547654049370E-07x3 + 3.925881969085400E-03x2 + 2.824087448085080E+01x - 8.824216855764490E+03

turbine input enthalpy, oxygen, Kj/Kmol

load	rpm	800	1000	1250	1500	1750	2000	2250	2500	3000	3500	4000	4500	5000	5500	6000	6500
	2	6596.7806	8650.7098	11443.2048	11740.8148	13522.9101	16212.4437	16055.2461	17164.7508	19784.2831	20850.6528	21195.7637	21760.6080				
	5	6959.6895	8947.0483	11901.2583	13301.7403	14788.5399	16416.6373	16859.1577	17218.5253	19054.5692	19971.3191	21185.5058	21849.7318	22839.0809	22921.7020	23007.7941	24046.6112
	10	9076.0458	10445.8774	12708.7671	13516.3045	14483.0127	15011.3269	15721.1665	16286.0651	18239.3373	19678.9282	21271.0012	22292.3958	23283.4839	23531.8578	23884.1295	24694.0780
	20	9618.8538	11110.1733	12619.9746	14187.8790	15107.8309	15914.8690	16688.0774	17531.3483	18969.8670	20342.4266	21555.0600	22828.7552	23780.4706	24406.5036	24707.9448	25513.4552
	30	11270.0859	12298.0285	13714.5675	14775.2467	15510.9651	16068.6202	17201.7193	18040.2011	19617.7760	20922.3682	22038.3685	23042.2391	24077.7363	24943.7922	25426.5386	26140.0748
	40	11950.4005	13179.7066	14499.6058	15500.9607	16105.4031	16728.3195	17834.4990	18624.6042	20366.2789	21596.1559	22636.0849	23511.1509	24496.5536	25124.2865	25784.8139	26474.8573
	50		13744.3237	15264.3285	16379.8013	17060.6000	17783.9454	18600.9287	19471.7546	20970.1902	22127.5919	23280.0359	24008.5745	24846.6533	25304.9022	26140.0748	26831.0068
	60		14363.5816	16098.7148	17168.1113	17918.7804	18675.3456	19583.8094	20475.3485	21681.7944	22636.0849	23821.9292	24503.4818	25273.6331	25885.7726	26590.0324	27310.0781
	70		15071.2207	16939.7125	18036.8274	18888.5821	19437.8092	20366.2789	21014.6048	22096.7033	23169.7259	24288.7923	24968.0824	25663.0169	26220.2461	26953.3197	27789.9615
	80		15674.4371	17585.2117	18428.5098	19369.9331	19974.7211	20864.3113	21527.6665	22828.7552	23714.8413	24770.3547	25405.6827	25920.5945	26792.5767	27282.0807	28246.0705
	90		16373.1045	18283.2383	18776.8621	19661.9398	20645.8689	21363.3698	21856.5888	23090.4699	24178.0533	25009.7280	25857.9182	26227.2187	26932.3480	27835.5399	28980.8605
	100		16590.8562	18746.4024	19230.8490	19961.1133	20888.2154	21647.5354	22185.9476	23438.6896	24766.8871	25516.9324	26310.9027	26701.7628	27544.6645	28347.9163	29033.6676
	110		17554.9119	19220.6754	20069.9976	20247.0410	21291.5245	22058.9557	22553.5568	23956.7152	25322.2755	26415.5434	26921.8627	27065.1953	27923.2109	28671.2499	29579.8935
	120			19621.1729	20209.5785	20748.2392	21997.1992	22556.9949	23062.9083	24437.6713	25986.7685	27061.6985	27499.1326	27803.9849	28727.5184	29163.9656	30335.6812
	130			19695.9177	20492.3951	21442.0816	22574.1863	23245.5590	23974.0005	25398.7311	26614.4695	27555.1729	28053.0131	28854.1621	29318.9892	30537.3079	
	140			20032.5630	20915.5373	21815.4496	23511.1509	24302.6380	25089.5667	26412.0547	27439.6019	28256.6046	28850.6435	29724.5469	30275.5727	31224.5423	
	150				21117.1310	22179.0815	24309.5611	25124.2865	25979.8021	27236.5909	28182.8739	29047.7511	29354.2332	30484.2353	31693.0185		
	160				21534.5146	22460.7449	25051.3800	25906.6652	26834.5007	28147.7706	28892.8697	29788.0753	29950.4869	31401.9126			
	170				21842.8750	22839.0809	25579.5304	26572.5785	27583.1972	28836.5694	28067.0493	30363.9716	30678.8800				
	180					24316.4844	26101.7402	27051.2084	28196.9164	29107.6134	29551.6766	31015.3757					
	190						26659.8586	27488.6263	28748.6219	29111.1351	30661.1799						
	200						27170.1190	28098.6332	29350.7086	29636.3353	31405.4610						
	201		17558.2784	19910.0910	21866.8747	24597.0301	27159.6249	28056.5221	29400.0566	29802.1946	30537.3079	31448.0454	31178.4426	32151.5250	32165.7529	31639.7472	30409.9492

y = 5.759805181505400E-11x4 - 8.196601466420560E-07x3 + 4.520153459081880E-03x2 + 2.588379148402900E+01x - 8.117644636389040E+03

turbine input enthalpy, nitrogen, Kj/Kmol

load	rpm	800	1000	1250	1500	1750	2000	2250	2500	3000	3500	4000	4500	5000	5500	6000	6500
	2	6225.6929	8158.9910	10793.2217	11074.3168	12758.8048	15304.8005	15155.8789	16207.2487	18691.8844	19704.1834	20031.8892	20568.3408				
	5	6567.0036	8438.2350	11225.8834	12549.6337	13956.3607	15498.2636	15917.6044	16258.2217	17999.4387	18869.4038	20022.1481	20652.9951	21592.9094	21671.4167	21753.2245	22740.5243
	10	8559.8145	9851.7142	11988.9874	12752.5571	13667.1774	14167.2645	14839.4321	15374.5505	17226.1177	18591.8963	20103.3382	21073.5001	22015.2104	22251.2583	22586.0793	23356.0396
	20	9071.5600	10478.7471	11905.0557	13387.8849	14258.6301	15022.9035	15755.4733	16554.7754	17919.0772	19221.6709	20373.1118	21583.0979	22487.5516	23082.6423	23369.2235	24135.1421
	30	10629.7390	11600.7791	12940.0899	13943.7775	14640.3567	15168.5483	16242.2911	17037.2651	18533.8614	19772.2782	20832.1807	21785.9560	22770.1107	23593.4614	24052.4896	24731.0740
	40	11272.3103	12434.2339	13682.8815	14630.8825	15203.3938	15793.6090	16842.2054	17591.5409	19244.3142	20412.1434	21400.0301	22231.5782	23168.2505	23765.0808	24393.1999	25049.4985
	50		12968.2378	14406.8062	15463.3617	16108.5282	16794.2702	17569.0829	18395.2898	19817.6871	20916.9382	22011.9337	22704.3683	23501.1023	23936.8239	24731.0740	25388.2731
	60		13554.1504	15197.0578	16210.4341	16922.1239	17639.6738	18501.6269	19347.8579	20493.4820	21400.0301	22526.9576	23174.8371	23907.0903	24489.2146	25159.0516	25844.0151
	70		14223.9686	15993.9504	17034.0658	17841.9609	18363.0776	19244.3142	19859.8612	20887.5953	21907.1042	22970.7406	23616.5567	24277.3707	24807.3257	25504.6252	26300.5759
	80		14795.1739	16605.8423	17405.5382	18298.6685	18872.6329	19717.1521	20347.0946	21583.0979	22425.1726	23428.5598	24032.6573	24522.3319	25351.7165	25817.3798	26734.5581
	90		15457.0166	17267.7541	17735.9751	18575.7738	19509.7485	20191.0584	20659.5083	21831.7882	22865.4705	23656.1541	24462.7240	24813.9574	25484.6753	26343.9414	27433.7787
	100		15663.3446	17707.0797	18166.6947	18859.7169	19739.8493	20460.9429	20972.3743	22162.7115	23425.2630	24138.4488	24893.5518	25265.3311	26067.1949	26831.4682	27484.0330
	110		16577.1154	18157.0415	18963.0672	19131.1226	20122.8284	20851.7372	21321.6187	22655.0738	23953.3441	24993.0809	25474.7010	25611.0514	26427.3571	27139.1444	28003.8786
	120			18537.0851	19095.5610	19606.9433	20793.0730	21324.8853	21805.5972	23112.2724	24585.2671	25607.7249	26023.8761	26313.9183	27192.6900	27608.0339	28723.2364
	130			18608.0201	19364.0413	20265.8115	21341.2189	21979.1692	22671.5042	24026.0468	25182.2964	26077.1926	26550.8617	27313.2070	27755.5691	28915.1574	
	140			18927.5347	19765.7921	20620.4318	22231.5782	22983.9027	23732.0674	24989.7626	25967.2395	26744.5816	27309.8586	28141.5533	28666.0224	29569.3474	
	150				19957.2184	20965.8517	22990.4840	23765.0808	24578.6415	25774.1035	26674.4250	27497.4357	27789.1111	28864.6391	30015.3281		
	160				20353.5986	21233.4392	23695.7580	24509.0844	25391.5967	26641.0237	27350.0425	28202.0178	28356.5991	29738.1979			
	170				20646.4820	21592.9094	24197.9770	25142.4496	26103.8550	27296.4652	26564.2170	28750.1647	29049.9177				
	180					22997.0656	24694.6141	25597.7457	26687.7867	27554.4048	27977.0233	29370.2324					
	190						25225.4710	26013.8805	27212.7723	27557.7563	29033.0691						
	200						25710.8667	26594.2691	27785.7567	28057.5970	29741.5759						
	201		16580.3071	18811.2895	20669.2786	23263.7736	25700.8834	26554.2004	27832.7220	28215.4562	28915.1574	29782.1154	29525.4626	30451.8389	30465.3846	29964.6136	28793.9288

turbine input energy, carbon dioxide, Kj

load	rpm	800	1000	1250	1500	1750	2000	2250	2500	3000	3500	4000	4500	5000	5500	6000	6500
	2	74038.8735	97930.9373	130850.7954	134386.5764	155660.9825	188075.6769	186171.6080	199634.3516	231627.4568	244728.6296	248977.5407	255940.8976				
	5	78239.1464	101401.3983	136294.8151	153011.4553	170870.6882	190550.6689	195920.8103	200288.2373	222687.3329	233922.2509	248851.1869	257040.6296	269266.7360	270289.2233	271354.9047	284232.5181
	10	102913.8745	119039.2840	145920.5838	155581.8129	167191.6777	173556.2568	182128.8205	188967.8090	212724.5309	230335.4179	249904.4122	262506.8680	274769.1186	277847.1384	282216.0802	292275.7685
	20	109289.7927	126900.1922	144860.4047	163642.2080	174720.3023	184472.2381	193843.6535	204094.5737	221650.9556	238479.3875	253405.6192	269138.9642	280930.0777	288701.7633	292448.1703	302472.4994
	30	128796.3653	141019.9725	157959.0130	170710.5231	179587.7818	186333.5581	200083.8674	210295.0559	229585.6631	245611.2159	259369.1909	271781.3457	284618.8807	295381.2499	301389.9414	310283.4652
	40	136879.5771	151550.6342	167391.3661	179466.8946	186779.0154	194332.1331	207787.2155	217429.4508	238772.4667	253912.3880	266755.4891	277590.4484	289820.6460	297627.0485	305853.6945	314461.0870
	50		158315.9695	176608.9492	190104.0463	198368.2598	207171.1572	217140.1485	227795.9579	246199.8554	260471.0045	274726.4031	283760.4001	294172.9975	299875.3089	310283.4652	318908.6802
	60		165754.7994	186698.0129	199675.2111	208814.5271	218049.5616	229169.2794	240112.8991	254968.6173	266755.4891	281444.3770	289906.7399	299486.0112	307112.1958	315899.0181	324896.6406
	70		174278.6518	196899.3064	210253.9110	220656.6598	227380.0260	238772.4667	246746.6270	260089.5321	273360.0122	287239.5554	295683.4251	304335.8159	311283.6123	320436.9059	330900.7275
	80		181563.7487	204750.3918	215033.9664	226548.4779	233964.0036	244896.7068	253067.8532	269138.9642	280116.0482	293224.1606	301130.2114	307546.3359	318428.6007	324546.5333	336612.7603
	90		190022.8570	213260.3473	219290.5071	230127.1187	242209.4266	251042.6013	257125.2521	272378.5245	285864.3422	296201.5440	306764.9480	311370.6038	320174.8488	331471.2886	345825.5586
	100		192663.8315	218918.1222	224845.1242	233796.9992	245190.8809	254546.0509	261191.7807	276692.3028	293181.0422	302515.8134	312414.7768	317294.2865	327830.9438	337888.9208	346488.1526
	110		204381.4594	224720.5583	235133.4996	237307.5751	250157.2798	259623.3964	265734.9312	283116.7856	300091.6171	313720.7078	320043.8320	321835.0709	332568.9238	341942.0714	353345.7141
	120			229627.3073	236847.4414	243468.5697	258860.8862	265777.4432	272037.2564	289088.9979	308371.4476	321791.3648	327261.3010	331076.2695	342647.6845	348123.3395	362845.4146
	130			230543.7433	240322.4366	252012.7467	265990.0182	274299.3007	283331.3003	301043.6420	316204.1565	327962.4204	334194.3928	344236.0875	350069.3421	365381.8520	
	140			234673.9578	245527.1408	256617.5764	277590.4484	287411.5240	297194.9726	313677.1640	326516.6014	336744.7442	344191.9508	355162.9081	362089.4303	374033.7138	
	150				248009.0600	261106.9688	287497.5140	297627.0485	308284.5786	323977.7263	335821.0149	346664.8755	350511.8354	364714.1200	379937.1939		
	160				253152.2887	264587.4736	296719.7944	307372.6692	318952.3290	335381.2739	344721.6461	355961.1283	358002.2058	376268.3072			
	170				256956.0110	269266.7360	303295.6202	315681.0884	328313.0620	344015.4120	334370.1884	363201.2510	367163.3356				
	180					287583.5076	309805.2996	321660.2518	335996.9348	347416.0941	352991.2979	371399.3769					
	190						316770.9559	327129.8654	342912.3440	347460.2909	366940.5815						
	200						323146.6549	334765.7775	350467.5824	354054.7017	376313.0187						
	201		204422.4475	233170.8807	257252.1933	291069.3686	323015.4615	334238.3405	351087.1982	356138.5459	365381.8520	376849.6165	373453.0353	385719.3341	385898.8262	379265.6719	363779.5931

turbine input energy, carbon monoxide, Kj

	rpm	800	1000	1250	1500	1750	2000	2250	2500	3000	3500	4000	4500	5000	5500	6000	6500
load	2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000				
	5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	10	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	20	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	30	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	40	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	50		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	60		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	70		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	80		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	90		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	100		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	110		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	120			0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	130			0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
	140			0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
	150				0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
	160				0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000			
	170				0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000				
	180					0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000					
	190						0.0000	0.0000	0.0000	0.0000	0.0000						
	200						0.0000	0.0000	0.0000	0.0000	0.0000						
	201		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

turbine input energy, water vapour, Kj

	rpm	800	1000	1250	1500	1750	2000	2250	2500	3000	3500	4000	4500	5000	5500	6000	6500
load	2	64898.9951	85463.2640	113902.2029	116964.0769	135417.8200	163638.0297	161976.8560	173731.6588	201755.1348	213267.3718	217005.5766	223136.8607				
	5	68509.7340	88455.5708	118617.1530	133116.6819	148643.7058	165797.9529	170487.0300	174303.1520	193911.5543	203770.0649	216894.3774	224105.7401	234887.3922	235789.9342	236730.7444	248110.8229
	10	89760.0812	103684.2547	126962.2667	135349.0485	145442.0257	150981.8603	158451.2470	164416.5069	185182.3893	200620.9562	217821.3418	228923.8356	239745.8673	242465.3628	246327.4833	255229.4415
	20	95262.1291	110482.8151	126042.6078	142354.6111	151995.5898	160494.6393	168672.8910	177630.9113	193002.9341	207773.3769	220903.8247	234774.6183	245190.4120	252065.2754	255382.1149	264265.8740
	30	112123.7958	122712.3028	137414.3524	148504.2874	156236.2841	162118.1296	174124.5280	183055.5985	199962.9010	214043.6877	226157.7384	237107.2574	248452.5816	257980.1363	263305.8694	271197.0435
	40	119123.8074	131848.3001	145615.7642	156130.9290	162506.7309	169099.4701	180860.9670	189303.1985	208030.9272	221350.1145	232671.2950	242238.5258	253055.6779	259970.1321	267265.2623	274907.3358
	50		137724.5329	153640.6973	165408.1308	172625.2486	180321.9675	189049.7339	198392.3702	214561.5045	227128.9280	239708.1357	247693.2349	256909.7744	261962.9564	271197.0435	278859.8713
	60		144192.0132	162436.0653	173767.3683	181759.8823	189846.5269	199597.4738	209209.0004	222280.3948	232671.2950	245645.1253	253131.8923	261617.8424	268382.0278	276184.9330	284185.3506
	70		151610.9515	171341.8072	183019.5860	192131.3328	198027.4319	208030.9272	215042.5297	226792.6632	238501.2936	250771.2123	258247.8553	265918.6020	272085.1046	280218.5808	289529.8284
	80		157958.6200	178204.4514	187204.7698	197297.8968	203806.7317	213415.2036	220606.3864	234774.6183	244470.7635	256069.3534	263075.5651	268767.3211	278433.1062	283873.8501	294618.6730
	90		165337.2696	185651.5470	190933.9606	200438.1262	211052.0374	218823.2411	224180.3000	237634.5570	249554.3891	258706.9217	268073.8676	272162.3530	279985.5706	290037.9505	302835.2745
	100		167642.6966	190607.6218	195803.7756	203660.0715	213673.9521	221908.2000	227764.3365	241444.9001	256031.1646	264304.2877	273089.6552	277424.8794	286796.7082	295756.1818	303426.6466
	110		177881.7982	195694.5249	204833.8590	206743.7263	218043.9163	226381.7934	231770.9125	247124.0040	262154.7230	274249.6152	279869.0792	281461.9205	291015.5854	299370.3705	309550.4511
	120			199999.4500	206339.4620	212159.2021	225709.7467	231808.4159	237333.2170	252408.0262	269499.6631	281423.0504	286289.6723	289686.1556	299999.7830	304886.3126	318043.8259
	130			200803.8145	209393.1781	219677.3471	231995.9494	239330.8792	247313.7210	262998.8053	276456.0818	286913.7407	292463.6351	301416.8880	306623.8852	320313.5682	
	140			204430.2392	213969.7316	223733.0062	242238.5258	250923.3915	259587.2207	274210.9350	285626.8828	294736.3074	301377.5066	311174.2338	317367.4929	328062.0647	
	150				216153.3051	227689.5662	250999.4875	259970.1321	269422.5569	283367.8000	293913.0551	303584.3832	307019.0533	319715.9636	333354.7820		
	160				220680.7393	230758.7306	259166.1390	268613.1914	278898.6743	293521.1850	301850.1480	311887.6324	313712.1964	330064.9330			
	170				224031.1845	234887.3922	264995.9123	275991.2860	287225.8717	301219.9911	292620.2632	318362.1969	321908.2402				
	180					251075.5876	270772.5112	281306.4461	294069.8311	304254.9401	309233.8070	325701.7473					
	190						276959.7768	286172.6883	300235.8780	304294.3935	321708.8219						
	200						282628.4963	292972.7348	306979.5321	310183.9270	330105.0147						
	201		177917.6439	203110.2567	224292.1482	254161.1997	282511.7976	292502.7907	307532.9186	312046.2083	320313.5682	330586.0686	327541.7092	338543.1528	338704.2832	332752.5037	318879.6818

turbine input energy, oxygen, Kj

load \ rpm	800	1000	1250	1500	1750	2000	2250	2500	3000	3500	4000	4500	5000	5500	6000	6500
2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000				
5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
10	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
20	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
30	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
40	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
50		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
60		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
70		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
80		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
90		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
100		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
110		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
120			0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
130			0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
140			0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
150				0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
160				0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000			
170				0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000				
180					0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000					
190						0.0000	0.0000	0.0000	0.0000	0.0000						
200						0.0000	0.0000	0.0000	0.0000	0.0000						
201		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

turbine input energy, nitrogen, Kj

load \ rpm	800	1000	1250	1500	1750	2000	2250	2500	3000	3500	4000	4500	5000	5500	6000	6500
2	292607.5678	383472.5772	507281.4202	520492.8904	599663.8262	719325.6248	712326.3084	761740.6911	878518.5668	926096.6179	941498.7938	966712.0180				
5	308649.1705	396597.0448	527616.5186	589832.7829	655948.9515	728418.3903	748127.4057	764136.4180	845973.6179	886861.9793	941040.9587	970690.7693	1014866.7414	1018556.5845	1022401.5521	1068804.6443
10	402311.2808	463030.5663	563482.4099	599370.1837	642357.3398	665861.4324	697453.3068	722603.8715	809627.5329	873819.1265	944856.8941	990454.5031	1034714.8888	1045809.1379	1061545.7264	1097733.8634
20	426363.3208	492501.1151	559537.6177	629230.5898	670155.6152	706076.4660	740507.2467	778074.4417	842196.6292	903418.5321	957536.2524	1014405.6025	1056914.9246	1084884.1900	1098353.5032	1134351.6801
30	499597.7317	545236.6156	608184.2235	655357.5406	688096.7655	712921.7713	763387.6834	800751.4607	871091.4839	929297.0770	979112.4937	1023939.9332	1070195.2051	1108892.6835	1130467.0127	1162360.4763
40	529798.5822	584408.9952	643095.4308	687651.4762	714559.5088	742299.6248	791583.6517	826802.4200	904482.7662	959370.7381	1005801.4128	1044884.1756	1088907.7748	1116958.7953	1146480.3972	1177326.4286
50		609507.1786	677119.8926	726777.9993	757100.8248	789330.7015	825746.8945	864578.6222	931431.2930	983096.0937	1034560.8835	1067105.3122	1104551.8091	1125030.7222	1162360.4763	1193248.8372
60		637045.0706	714261.7149	761890.4049	795339.8233	829064.6678	869576.4654	909349.3212	963193.6558	1005801.4128	1058767.0065	1089217.3424	1123633.2428	1150993.0851	1182475.4268	1214668.7100
70		668526.5242	751715.6691	800601.0936	838572.1612	863064.6454	904482.7662	933413.4774	981716.9797	1029633.8974	1079624.8074	1109978.1667	1141036.4244	1165944.3084	1198717.3850	1236127.0669
80		695373.1746	780474.5875	818060.2939	860037.4203	887013.7450	926706.1491	956313.4476	1014405.6025	1053983.1137	1101142.3118	1129534.8911	1152549.5971	1191530.6747	1213416.8525	1256524.2288
90		726479.7801	811584.4437	833590.8275	873061.3695	916958.1799	948979.7438	970996.8917	1026094.0445	1074677.1124	1111839.2410	1149748.0278	1166255.9985	1197779.7397	1238165.2458	1289387.5976
100		736177.1949	832232.7468	853834.6500	886406.6966	927772.9194	961664.3149	985701.5937	1041647.4391	1100987.3596	1134507.0946	1169996.9344	1187470.5611	1225158.1598	1261079.0077	1291749.5493
110		779124.4260	853380.9495	891264.1585	899162.7630	945772.9359	980031.6483	1002116.0791	1064788.4707	1125807.1747	1174674.8016	1197310.9450	1203719.4157	1242085.7831	1275539.7873	1316182.2925
120			871242.9991	897491.3654	921526.3363	977274.4328	1002269.6086	1024863.0698	1086276.8024	1155507.5520	1203563.0703	1223122.1760	1236754.1623	1278056.4280	1297577.5943	1349992.1108
130			874576.9439	910109.9402	952493.1412	1003037.2899	1033020.9540	1065560.6961	1129224.2011	1183567.9303	1225628.0512	1247890.4978	1283720.7287	1304511.7489	1359012.3989	
140			889594.1290	928992.2267	969160.2956	1044884.1756	1080243.4270	1115407.1677	1174518.8424	1220460.2563	1256995.3345	1283563.3523	1322653.0053	1347303.0541	1389759.3277	
150				937989.2631	985395.0299	1080552.7500	1116958.7953	1155196.1524	1211382.8643	1253697.9740	1292379.4781	1306088.2232	1356638.0365	1410720.4194		
160				956619.1349	997971.6437	1113700.6258	1151926.9669	1193405.0462	1252128.1140	1285451.9998	1325494.8388	1332760.1569	1397695.3014			
170				970384.6561	1014866.7414	1137304.9189	1181695.1296	1226881.1847	1282933.8665	1248518.2001	1351257.7410	1365346.1299				
180					1080862.0817	1160646.8629	1203094.0463	1254325.9743	1295057.0275	1314920.0962	1380400.9229					
190						1185597.1361	1222652.3825	1279000.2995	1295214.5482	1364554.2468						
200						1208410.7367	1249930.6482	1305930.5669	1318707.0593	1397854.0686						
201		779274.4338	884130.6073	971456.0927	1093397.3578	1207941.5212	1248047.4204	1308137.9327	1326126.4427	1359012.3989	1399759.4218	1387696.7433	1431236.4280	1431873.0744	1408336.8390	1353314.6516

mass through turbine, carbon dioxide, Kg																
	rpm	800	1000	1250	1500	1750	2000	2250	2500	3000	3500	4000	4500	5000	5500	6000	6500
load	2	0.0002	0.0002	0.0003	0.0003	0.0004	0.0004	0.0005	0.0005	0.0007	0.0008	0.0010	0.0011				
	5	0.0002	0.0002	0.0003	0.0003	0.0004	0.0005	0.0005	0.0006	0.0007	0.0009	0.0011	0.0013	0.0015	0.0017	0.0019	0.0022
	10	0.0002	0.0003	0.0004	0.0004	0.0005	0.0006	0.0006	0.0007	0.0009	0.0011	0.0013	0.0015	0.0017	0.0020	0.0023	0.0026
	20	0.0003	0.0004	0.0005	0.0006	0.0007	0.0008	0.0009	0.0010	0.0012	0.0015	0.0017	0.0020	0.0023	0.0026	0.0029	0.0033
	30	0.0005	0.0005	0.0007	0.0008	0.0009	0.0010	0.0012	0.0013	0.0016	0.0019	0.0022	0.0025	0.0029	0.0033	0.0036	0.0041
	40	0.0006	0.0006	0.0008	0.0010	0.0011	0.0012	0.0014	0.0016	0.0019	0.0023	0.0026	0.0030	0.0034	0.0039	0.0044	0.0049
	50		0.0008	0.0010	0.0011	0.0013	0.0015	0.0017	0.0019	0.0022	0.0026	0.0031	0.0035	0.0040	0.0045	0.0051	0.0057
	60		0.0009	0.0011	0.0013	0.0015	0.0017	0.0019	0.0022	0.0026	0.0030	0.0036	0.0040	0.0047	0.0053	0.0059	0.0066
	70		0.0010	0.0013	0.0015	0.0018	0.0020	0.0022	0.0025	0.0030	0.0035	0.0041	0.0046	0.0053	0.0060	0.0067	0.0075
	80		0.0012	0.0015	0.0017	0.0020	0.0022	0.0025	0.0028	0.0033	0.0039	0.0046	0.0053	0.0060	0.0067	0.0075	0.0083
	90		0.0014	0.0017	0.0020	0.0023	0.0025	0.0028	0.0032	0.0038	0.0044	0.0051	0.0059	0.0066	0.0074	0.0082	0.0092
	100		0.0017	0.0020	0.0023	0.0026	0.0029	0.0032	0.0035	0.0042	0.0049	0.0057	0.0065	0.0073	0.0082	0.0090	0.0099
	110		0.0019	0.0023	0.0026	0.0029	0.0032	0.0035	0.0039	0.0046	0.0054	0.0063	0.0071	0.0079	0.0088	0.0097	0.0108
	120			0.0026	0.0029	0.0032	0.0035	0.0039	0.0042	0.0050	0.0059	0.0069	0.0077	0.0086	0.0096	0.0106	0.0118
	130			0.0028	0.0032	0.0036	0.0038	0.0042	0.0046	0.0055	0.0064	0.0075	0.0083	0.0094	0.0104	0.0117	
	140			0.0031	0.0036	0.0040	0.0042	0.0046	0.0051	0.0060	0.0070	0.0080	0.0090	0.0102	0.0113	0.0128	
	150				0.0039	0.0044	0.0044	0.0049	0.0055	0.0065	0.0076	0.0087	0.0096	0.0110	0.0125		
	160				0.0042	0.0047	0.0047	0.0053	0.0059	0.0071	0.0081	0.0094	0.0104	0.0120			
	170				0.0045	0.0051	0.0051	0.0057	0.0063	0.0076	0.0088	0.0101	0.0112				
	180					0.0051	0.0054	0.0061	0.0067	0.0080	0.0092	0.0108					
	190						0.0058	0.0065	0.0072	0.0086	0.0096						
	200						0.0061	0.0069	0.0077	0.0091	0.0105						
	201		0.0019	0.0031	0.0045	0.0052	0.0061	0.0069	0.0077	0.0091	0.0097	0.0113	0.0116	0.0128	0.0133	0.0136	0.0124

mass through turbine, carbon monoxide, Kg																
	rpm	800	1000	1250	1500	1750	2000	2250	2500	3000	3500	4000	4500	5000	5500	6000	6500
load	2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000				
	5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	10	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	20	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	30	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	40	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	50		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	60		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	70		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	80		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	90		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	100		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	110		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	120			0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	130			0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
	140			0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
	150				0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
	160				0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000			
	170				0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000				
	180					0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000					
	190						0.0000	0.0000	0.0000	0.0000	0.0000						
	200						0.0000	0.0000	0.0000	0.0000	0.0000						
	201		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

mass through turbine, water vapour, Kg																	
	rpm	800	1000	1250	1500	1750	2000	2250	2500	3000	3500	4000	4500	5000	5500	6000	6500
load	2	0.0002	0.0002	0.0003	0.0003	0.0004	0.0005	0.0005	0.0006	0.0008	0.0009	0.0011	0.0013				
	5	0.0002	0.0003	0.0003	0.0004	0.0005	0.0005	0.0006	0.0007	0.0008	0.0010	0.0012	0.0014	0.0017	0.0019	0.0022	0.0025
	10	0.0003	0.0003	0.0004	0.0005	0.0006	0.0007	0.0007	0.0008	0.0010	0.0012	0.0015	0.0017	0.0020	0.0022	0.0026	0.0029
	20	0.0004	0.0004	0.0006	0.0007	0.0008	0.0009	0.0010	0.0011	0.0014	0.0017	0.0019	0.0023	0.0026	0.0029	0.0033	0.0037
	30	0.0006	0.0006	0.0007	0.0009	0.0010	0.0012	0.0013	0.0015	0.0018	0.0021	0.0024	0.0028	0.0032	0.0037	0.0041	0.0046
	40	0.0006	0.0007	0.0009	0.0011	0.0012	0.0014	0.0016	0.0018	0.0021	0.0025	0.0029	0.0034	0.0039	0.0044	0.0049	0.0055
	50		0.0009	0.0011	0.0013	0.0015	0.0017	0.0019	0.0021	0.0025	0.0030	0.0035	0.0040	0.0045	0.0051	0.0058	0.0064
	60		0.0010	0.0012	0.0015	0.0017	0.0019	0.0022	0.0025	0.0029	0.0034	0.0040	0.0046	0.0053	0.0059	0.0066	0.0074
	70		0.0012	0.0014	0.0017	0.0020	0.0022	0.0025	0.0028	0.0033	0.0039	0.0046	0.0052	0.0060	0.0067	0.0075	0.0084
	80		0.0014	0.0016	0.0019	0.0022	0.0025	0.0028	0.0032	0.0038	0.0044	0.0052	0.0059	0.0067	0.0076	0.0084	0.0093
	90		0.0016	0.0019	0.0022	0.0025	0.0028	0.0032	0.0035	0.0042	0.0049	0.0058	0.0066	0.0074	0.0084	0.0093	0.0104
	100		0.0019	0.0023	0.0026	0.0029	0.0032	0.0035	0.0040	0.0047	0.0055	0.0064	0.0073	0.0082	0.0092	0.0102	0.0112
	110		0.0021	0.0026	0.0029	0.0033	0.0036	0.0040	0.0044	0.0052	0.0061	0.0071	0.0080	0.0089	0.0100	0.0110	0.0122
	120			0.0029	0.0032	0.0036	0.0039	0.0043	0.0048	0.0056	0.0066	0.0078	0.0087	0.0097	0.0108	0.0119	0.0133
	130			0.0032	0.0037	0.0040	0.0043	0.0047	0.0052	0.0061	0.0072	0.0084	0.0094	0.0106	0.0116	0.0131	
	140			0.0035	0.0041	0.0045	0.0047	0.0052	0.0057	0.0067	0.0079	0.0090	0.0101	0.0114	0.0127	0.0144	
	150				0.0044	0.0049	0.0050	0.0056	0.0062	0.0073	0.0085	0.0098	0.0108	0.0123	0.0141		
	160				0.0048	0.0053	0.0053	0.0059	0.0066	0.0079	0.0091	0.0106	0.0117	0.0135			
	170				0.0050	0.0057	0.0057	0.0064	0.0071	0.0085	0.0099	0.0113	0.0125				
	180					0.0057	0.0061	0.0068	0.0076	0.0090	0.0103	0.0122					
	190						0.0065	0.0073	0.0081	0.0097	0.0108						
	200						0.0069	0.0078	0.0086	0.0102	0.0118						
	201		0.0022	0.0035	0.0050	0.0059	0.0069	0.0078	0.0087	0.0102	0.0109	0.0128	0.0131	0.0144	0.0150	0.0152	0.0139

mass through turbine, oxygen, Kg																	
	rpm	800	1000	1250	1500	1750	2000	2250	2500	3000	3500	4000	4500	5000	5500	6000	6500
load	2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000				
	5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	10	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	20	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	30	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	40	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	50		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	60		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	70		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	80		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	90		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	100		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	110		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	120			0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	130			0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
	140			0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
	150				0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
	160				0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000			
	170				0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000				
	180					0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000					
	190						0.0000	0.0000	0.0000	0.0000	0.0000						
	200						0.0000	0.0000	0.0000	0.0000	0.0000						
	201		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

mass through turbine, nitrogen, Kg

	rpm	800	1000	1250	1500	1750	2000	2250	2500	3000	3500	4000	4500	5000	5500	6000	6500
load	2	0.0010	0.0012	0.0015	0.0018	0.0021	0.0025	0.0028	0.0032	0.0039	0.0047	0.0059	0.0068				
	5	0.0012	0.0014	0.0017	0.0020	0.0025	0.0028	0.0032	0.0035	0.0043	0.0052	0.0064	0.0075	0.0087	0.0100	0.0114	0.0131
	10	0.0014	0.0016	0.0021	0.0025	0.0030	0.0034	0.0038	0.0042	0.0053	0.0062	0.0077	0.0088	0.0102	0.0117	0.0134	0.0154
	20	0.0020	0.0023	0.0030	0.0035	0.0042	0.0048	0.0053	0.0060	0.0072	0.0086	0.0101	0.0118	0.0135	0.0153	0.0173	0.0196
	30	0.0029	0.0031	0.0039	0.0046	0.0054	0.0061	0.0069	0.0076	0.0092	0.0110	0.0127	0.0147	0.0168	0.0191	0.0214	0.0242
	40	0.0033	0.0038	0.0047	0.0057	0.0065	0.0073	0.0083	0.0093	0.0112	0.0133	0.0154	0.0177	0.0202	0.0229	0.0257	0.0288
	50		0.0045	0.0056	0.0067	0.0077	0.0087	0.0098	0.0110	0.0132	0.0155	0.0181	0.0206	0.0235	0.0266	0.0301	0.0335
	60		0.0053	0.0065	0.0078	0.0090	0.0100	0.0114	0.0130	0.0153	0.0179	0.0209	0.0238	0.0274	0.0309	0.0346	0.0386
	70		0.0061	0.0075	0.0089	0.0104	0.0116	0.0131	0.0147	0.0174	0.0204	0.0240	0.0272	0.0313	0.0351	0.0391	0.0439
	80		0.0071	0.0086	0.0102	0.0116	0.0130	0.0146	0.0165	0.0197	0.0230	0.0270	0.0309	0.0352	0.0396	0.0438	0.0488
	90		0.0083	0.0101	0.0117	0.0133	0.0146	0.0165	0.0185	0.0222	0.0258	0.0301	0.0344	0.0389	0.0436	0.0485	0.0541
	100		0.0097	0.0118	0.0134	0.0151	0.0168	0.0185	0.0208	0.0247	0.0289	0.0337	0.0380	0.0428	0.0480	0.0530	0.0584
	110		0.0112	0.0136	0.0152	0.0170	0.0187	0.0207	0.0228	0.0270	0.0317	0.0370	0.0417	0.0465	0.0520	0.0573	0.0635
	120			0.0151	0.0168	0.0186	0.0206	0.0227	0.0249	0.0293	0.0347	0.0408	0.0453	0.0506	0.0565	0.0620	0.0693
	130			0.0165	0.0191	0.0210	0.0223	0.0247	0.0273	0.0321	0.0377	0.0439	0.0489	0.0551	0.0608	0.0686	
	140			0.0182	0.0212	0.0235	0.0244	0.0270	0.0300	0.0350	0.0410	0.0472	0.0528	0.0597	0.0663	0.0749	
	150				0.0230	0.0256	0.0261	0.0291	0.0322	0.0380	0.0444	0.0513	0.0566	0.0644	0.0735		
	160				0.0249	0.0276	0.0279	0.0310	0.0344	0.0414	0.0478	0.0553	0.0609	0.0706			
	170				0.0263	0.0297	0.0298	0.0334	0.0371	0.0446	0.0516	0.0592	0.0655				
	180					0.0297	0.0318	0.0357	0.0396	0.0470	0.0539	0.0637					
	190						0.0341	0.0380	0.0424	0.0506	0.0566						
	200						0.0360	0.0406	0.0451	0.0535	0.0616						
	201		0.0114	0.0185	0.0263	0.0307	0.0360	0.0407	0.0453	0.0533	0.0571	0.0666	0.0683	0.0753	0.0783	0.0796	0.0728

turbine input enthalpy total, carbon dioxide, Kj/Kg

	rpm	800	1000	1250	1500	1750	2000	2250	2500	3000	3500	4000	4500	5000	5500	6000	6500
load	2	12.6483	20.7083	32.9853	41.3425	55.9947	80.8464	87.6558	107.9966	155.3834	194.0834	249.2369	294.0654				
	5	15.3762	23.3082	39.4214	53.2884	73.5100	91.8348	105.9877	120.2425	161.7576	205.4942	272.0946	328.7086	400.4408	462.1195	525.3732	631.4304
	10	24.7994	33.1078	51.9335	66.3384	85.5116	100.3372	116.7395	134.4427	190.7873	243.2918	326.0905	392.1196	476.8389	552.2212	645.5693	764.0779
	20	36.4679	50.3635	74.0901	98.8672	124.9735	150.3961	176.0073	207.2127	270.2141	350.0182	435.8049	538.6517	643.6030	753.4314	861.8082	1008.0316
	30	63.0118	74.1824	104.1542	134.0789	165.0586	192.6741	234.3343	272.7994	359.1262	460.6063	561.4262	678.9815	813.4368	961.4249	1099.0268	1280.0270
	40	77.6601	97.1397	134.6106	173.6093	206.3000	242.7802	293.4273	342.5269	453.9993	573.0662	699.0291	835.4701	996.9629	1159.5054	1337.4727	1539.7674
	50		120.8259	168.2078	218.3556	260.2206	306.4407	361.3725	426.4056	553.0093	686.4496	844.2113	997.2010	1178.8370	1357.2481	1587.2939	1817.3365
	60		148.6613	206.9236	265.6790	318.1521	372.6528	445.1295	529.5823	665.3087	810.8255	1002.6456	1173.6190	1397.7054	1616.6045	1859.8555	2133.7136
	70		180.8746	251.7987	320.2722	389.2904	449.2335	532.0149	616.5239	771.2377	947.4582	1172.3962	1369.9999	1619.0031	1861.4328	2133.7983	2470.1510
	80		220.0200	299.0209	372.2029	446.7253	518.7014	609.2656	710.2595	900.9614	1094.4951	1347.9148	1581.5610	1843.6762	2144.0859	2418.7732	2797.5092
	90		269.5949	365.8007	435.5353	521.0621	603.4211	703.7038	811.2837	1028.0398	1257.1083	1516.5930	1796.9183	2060.7761	2376.7424	2734.0627	3183.8766
	100		318.8988	438.0643	511.6007	601.2155	701.5184	803.2342	923.0590	1164.5095	1443.8148	1733.4786	2022.8857	2311.1804	2676.1477	3048.9782	3444.5494
	110		389.7441	518.9640	610.0408	685.8848	794.5968	912.5582	1032.7677	1300.7643	1617.8898	1977.6387	2269.8664	2546.5200	2942.4266	3332.2730	3818.0967
	120			589.6160	677.0712	770.5611	906.8220	1024.9965	1154.1747	1442.9355	1820.7835	2235.3327	2525.3664	2850.7046	3293.2250	3674.0309	4282.3318
	130			647.0434	780.7141	900.0705	1010.0232	1153.6762	1316.8019	1644.7645	2027.7689	2449.9248	2780.3117	3228.4086	3624.7979	4264.4376	
	140			728.3856	886.1143	1028.6088	1153.0606	1318.7998	1516.3135	1869.1020	2279.1539	2704.1305	3095.9349	3606.1367	4086.4558	4771.2676	
	150				972.4022	1139.2605	1278.4655	1471.8071	1692.2468	2097.7558	2538.4804	3028.2621	3377.9361	4000.3314	4754.0961		
	160				1075.0182	1241.9075	1406.7403	1624.0590	1869.1935	2365.7190	2802.7785	3352.7089	3710.5437	4522.7973			
	170				1151.0380	1361.0125	1536.2766	1794.5593	2071.5642	2611.8892	2936.6526	3661.1443	4095.0186				
	180					1454.9928	1677.5742	1952.9692	2263.5460	2779.8113	3238.9403	4024.9118					
	190						1836.5016	2113.1681	2472.8981	2992.1398	3536.3899						
	200						1977.4780	2314.9983	2687.5266	3223.1271	3944.3615						
	201		396.3524	732.8690	1153.3473	1520.9385	1977.9089	2313.2078	2708.0038	3232.2046	3552.5773	4271.4857	4341.9102	4945.3772	5145.4517	5140.1034	4509.4775

turbine input enthalpy total, carbon monoxide, Kj/Kg

load	rpm	800	1000	1250	1500	1750	2000	2250	2500	3000	3500	4000	4500	5000	5500	6000	6500
	2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000				
	5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	10	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	20	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	30	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	40	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	50		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	60		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	70		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	80		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	90		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	100		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	110		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	120			0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	130			0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
	140			0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
	150				0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
	160				0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000			
	170				0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000				
	180					0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000					
	190						0.0000	0.0000	0.0000	0.0000	0.0000						
	200						0.0000	0.0000	0.0000	0.0000	0.0000						
	201		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

turbine input enthalpy total, water vapour, Kj/Kg

load	rpm	800	1000	1250	1500	1750	2000	2250	2500	3000	3500	4000	4500	5000	5500	6000	6500
	2	12.4728	20.3309	32.3020	40.4805	54.8019	79.1343	85.7971	105.7320	152.2621	190.2745	244.3856	288.4218				
	5	15.1471	22.8741	38.5969	52.1547	71.9412	89.8936	103.7573	117.7227	158.4621	201.3821	266.7970	322.4146	392.9776	453.5272	515.6292	620.0832
	10	24.3334	32.4418	50.8345	64.9252	83.6860	98.1972	114.2582	131.5974	186.8461	238.3941	319.7549	384.6994	468.0663	542.1374	633.9084	750.6338
	20	35.7605	49.3289	72.5237	96.7566	122.3090	147.2037	172.2967	202.8878	264.7005	343.0696	427.3971	528.6097	631.9400	740.0479	846.6516	990.7906
	30	61.7119	72.6208	101.9335	131.2175	161.5459	188.5890	229.4227	267.1468	351.8878	451.5820	550.7294	666.4011	798.8333	944.6507	1080.1712	1258.6297
	40	76.0345	95.0750	131.7368	169.9144	201.9273	237.6640	287.3287	335.4956	444.9912	562.0218	685.9259	820.2045	979.3057	1139.4003	1314.8198	1514.3528
	50		118.2494	164.6236	213.7383	254.7571	300.0670	353.9513	417.7864	542.1869	673.4018	828.6785	979.2591	1158.2014	1333.8622	1560.7602	1787.7532
	60		145.4875	202.5375	260.1080	311.5478	365.0096	436.1517	519.0998	652.5145	795.6268	984.4996	1152.8378	1373.5959	1589.3248	1829.2936	2099.6413
	70		177.0176	246.5046	313.6355	381.3357	440.1469	521.4588	604.4711	756.5662	929.9687	1151.4905	1346.1169	1591.4605	1830.4100	2099.2312	2431.4851
	80		215.3420	292.7843	364.5374	437.6776	508.3226	597.3125	696.5474	884.1649	1074.6209	1324.2587	1554.4066	1812.6046	2109.1308	2380.1048	2754.5695
	90		263.8938	358.2495	426.6181	510.5691	591.5228	690.0625	795.7525	1009.0186	1234.6119	1490.1923	1766.5649	2026.4401	2338.2076	2691.3482	3136.5927
	100		312.1690	429.0905	501.2118	589.1822	687.7630	787.7741	905.5412	1143.1850	1418.4727	1703.8335	1989.2875	2273.3668	2633.8245	3002.3874	3393.5189
	110		381.6120	508.4235	597.8588	672.2401	779.1663	895.1808	1013.3640	1277.3222	1590.0298	1944.9226	2233.0491	2505.4509	2896.6282	3282.0816	3762.9727
	120			577.7328	663.5909	755.4028	889.5256	1005.7407	1132.8026	1417.3302	1790.1726	2199.2772	2485.3522	2806.1083	3243.7477	3619.9295	4222.7772
	130			634.0224	765.2666	882.6567	991.0577	1132.4277	1293.0837	1616.5180	1994.4794	2411.1962	2737.2768	3180.1837	3571.8089	4205.7422	
	140			713.8289	868.7505	1008.8960	1131.9920	1295.2940	1489.9901	1838.1773	2242.9520	2662.6432	3049.6814	3554.4363	4029.4514	4707.9469	
	150				953.4387	1117.6356	1255.6838	1446.2870	1663.7895	2064.1573	2499.4091	2983.4281	3328.6382	3945.1201	4692.6196		
	160				1054.2678	1218.5143	1382.2869	1596.6746	1838.7702	2329.2511	2760.9856	3304.7906	3657.9332	4463.3546			
	170				1128.9947	1335.6468	1510.0626	1765.0505	2038.8549	2572.8423	2891.2254	3610.3019	4039.0682				
	180					1429.0712	1649.4911	1921.4549	2228.7277	2738.7699	3192.1143	3970.8895					
	190						1806.4052	2079.6706	2435.7808	2947.9708	3488.0274						
	200						1945.7206	2279.2363	2648.2980	3176.7196	3892.5313						
	201		388.0829	718.1852	1131.2735	1494.0906	1946.1311	2277.4084	2668.5688	3186.0405	3503.6799	4215.4889	4284.1432	4883.0882	5080.6966	5073.4358	4447.0014

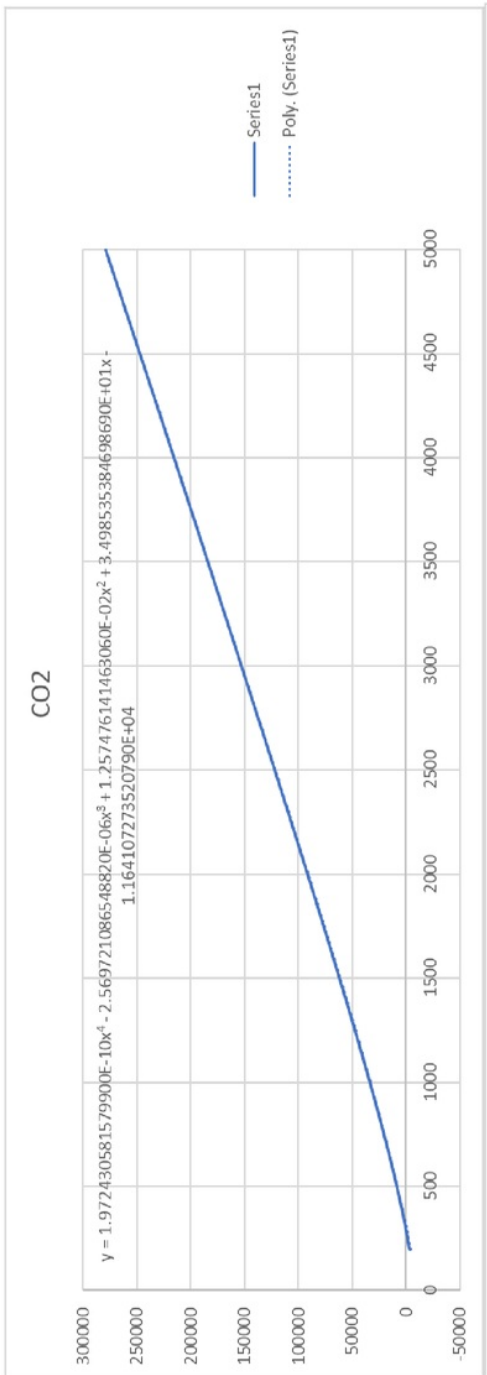
turbine input enthalpy total, oxygen, Kj/Kg

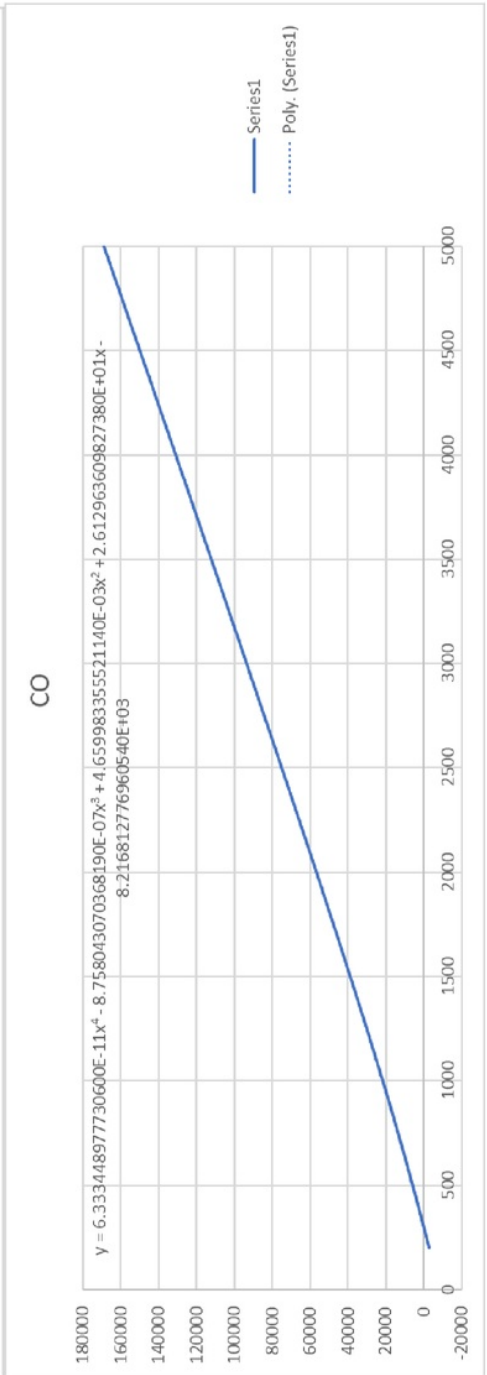
load	rpm	800	1000	1250	1500	1750	2000	2250	2500	3000	3500	4000	4500	5000	5500	6000	6500
	2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000				
	5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	10	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	20	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	30	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	40	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	50		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	60		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	70		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	80		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	90		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	100		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	110		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	120			0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	130			0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
	140			0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
	150				0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
	160				0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000			
	170				0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000				
	180					0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000					
	190						0.0000	0.0000	0.0000	0.0000	0.0000						
	200						0.0000	0.0000	0.0000	0.0000	0.0000						
	201		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

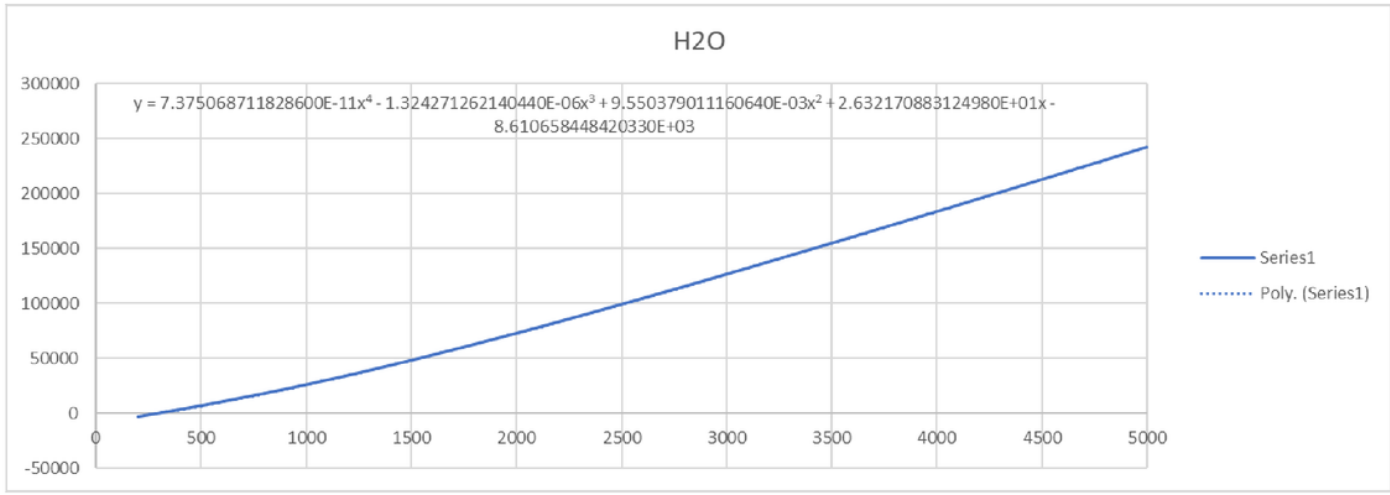
turbine input enthalpy total, nitrogen, Kj/Kg

load	rpm	800	1000	1250	1500	1750	2000	2250	2500	3000	3500	4000	4500	5000	5500	6000	6500
	2	293.6744	476.3948	751.2785	940.7276	1267.3104	1816.6094	1970.3984	2420.9733	3462.3698	4314.8706	5537.0672	6525.4320				
	5	356.3665	535.5781	896.5588	1206.8276	1657.8939	2062.4610	2377.7074	2695.1397	3610.2218	4577.1162	6045.0037	7292.8621	8866.9136	10231.0119	11629.4627	13949.4778
	10	569.5568	756.5847	1178.2016	1501.4431	1930.1667	2261.5880	2626.4082	3020.3525	4266.0413	5422.4573	7243.3287	8692.0121	10549.5111	12211.4558	14266.1794	16859.6961
	20	835.8313	1148.3356	1681.3085	2233.4409	2816.1661	3381.9347	3950.1755	4641.0249	6031.9775	7789.9851	9674.7318	11927.5431	14225.5061	16633.5725	19015.6741	22209.7591
	30	1435.9749	1685.0509	2356.0012	3024.0313	3715.5135	4330.9379	5252.6308	6102.6715	8005.2324	10238.6838	12451.3022	15028.6739	17969.2928	21204.5886	24218.3913	28171.4508
	40	1765.9493	2200.7159	3038.2910	3908.0929	4636.7903	5448.2344	6567.2927	7652.1928	10103.6692	12720.8229	15484.6707	18475.7653	22006.3819	25564.9762	29454.0965	33868.2679
	50		2732.8884	3788.8443	4904.3636	5834.8683	6859.3660	8073.6471	9508.0008	12291.4568	15221.3485	18677.3264	22031.6026	26004.2849	29915.1236	34933.9268	39949.1839
	60		3356.6801	4650.8854	5955.7079	7119.2580	8324.2555	9923.0601	11783.0201	14765.8340	17961.1511	22159.6626	25905.4555	30808.5702	35594.8608	40900.7164	46865.8623
	70		4076.2418	5647.6881	7164.7196	8691.7058	10017.7681	11839.8914	13701.8941	17102.4983	20966.0096	25888.7375	30214.5307	35661.6969	40961.5870	46895.9676	54212.1659
	80		4950.6103	6696.4313	8318.8992	9963.3319	11553.3155	13544.8320	15768.4217	19950.2850	24194.5392	29738.1547	34852.9168	40592.1065	47134.9676	53129.5412	61350.7226
	90		6055.3225	8178.5450	9726.6735	11613.8003	13421.0600	15628.1395	17999.2227	22752.6557	27765.0575	33445.0316	39567.0015	45347.6676	52237.1811	59999.6929	69741.3746
	100		7158.8439	9783.8279	11413.7755	13391.5892	15594.9608	17828.1879	20465.5438	25755.7728	31854.1352	38193.1518	44507.4146	50816.2152	58757.0752	66854.4835	75444.9576
	110		8728.7636	11578.3127	13584.9701	15268.1271	17649.3380	20237.8662	22881.2590	28741.1549	35658.8184	43504.0099	49889.0993	55956.0255	64562.9613	73028.0853	83554.7252
	120			13142.9502	15073.1416	17134.8303	20113.1477	22708.9324	25545.6461	31853.9828	40083.4235	49118.4328	55450.7535	62562.6908	72165.8112	80454.5979	93604.7264
	130			14420.6882	17369.9854	19985.9023	22376.4385	25525.6160	29094.5706	36246.1854	44591.4868	53789.2191	60992.8146	70731.1178	79357.0620	93185.0146	
	140			16221.6949	19697.4577	22822.7154	25499.0287	29120.8591	33434.0394	41116.6727	50049.5178	59301.8647	67829.1366	78898.4332	89331.3969	104152.6899	
	150				21606.4850	25259.3870	28229.8627	32450.6587	37254.2236	46081.7613	55675.8346	66325.6552	73948.4590	87420.8954	103706.2583		
	160				23866.0697	27519.8477	31020.1394	35757.6829	41088.8736	51889.6781	61402.2035	73346.4640	81154.3343	98702.8884			
	170				25537.7528	30136.7410	33844.4963	39465.9503	45480.0169	57225.4210	64421.0464	80023.1373	89463.7718				
	180					32127.3587	36923.3302	42914.6362	49644.6324	60878.2476	70883.6670	87887.7422					
	190						40382.2927	46400.7192	54187.8120	65527.9059	77261.4879						
	200						43444.4639	50781.2536	58834.6093	70528.2769	86078.9920						
	201		8876.6934	16325.8707	25587.7487	33566.1125	43454.7001	50745.4781	59278.2931	70708.6705	77629.6903	93212.0698	94786.6742	107807.0764	112166.3118	112135.3978	98558.6050

Appendix 2b


CO2
y = 1.97243058157990OE-10x⁴ - 2.56972108654882OE-06x³ + 1.25747614146306OE-02x² + 3.49853538469869OE+01x + 1.16410727352079OE+04
Series1
Poly. (Series1)
300000
250000
200000
150000
100000
50000
0
-50000
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000


CO
y = 6.33344897773060OE-11x⁴ - 8.75804307036819OE-07x³ + 4.65998335552114OE-03x² + 2.61296360982738OE+01x - 8.21681277696054OE+03
Series1
Poly. (Series1)
180000
160000
140000
120000
100000
80000
60000
40000
20000
0
-20000
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000


H2O
y = 7.375068711828600E-11x⁴ - 1.324271262140440E-06x³ + 9.550379011160640E-03x² + 2.632170883124980E+01x - 8.610658448420330E+03
300000
250000
200000
150000
100000
50000
0
-50000
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
Series1
Poly. (Series1)

y = 1.9724305815799OOE-10x4 - 2.5697210865488820E-06x3 + 1.2574761414630 60E-02x2 + 3.4985353846986 90E+01x - 1.1641072735207 90E+04

turbine output enthalpy CO2 Kj/Kmol

load \ rpm	800	1000	1250	1500	1750	2000	2250	2500	3000	3500	4000	4500	5000	5500	6000	6500
2	7530.6809	7585.0172	11051.2016	11823.0783	13756.4183	15216.3203	16191.5557	17324.5645	20864.0205	22811.5250	24210.1079	25450.3619				
5	5828.2877	7530.6809	10098.7973	11677.7009	14295.5136	15331.8445	16424.2594	17412.4504	20490.1296	22342.7238	24551.2472	26009.3492	27008.2573	29094.1998	29329.0234	31929.1944
10	6552.6855	8280.1129	10474.2337	12689.3449	14664.0698	15645.1915	16735.1025	17759.6068	20544.9144	22539.1655	25168.9261	27085.7046	28724.2368	29825.6233	30780.2386	32288.7979
20	7811.7024	9849.1486	11945.1349	14343.3228	16123.7532	17134.3201	18446.4434	19978.0248	22071.0923	24806.2388	26791.5661	28812.7595	30291.9125	31691.5372	32548.2782	33930.0232
30	10367.5111	11912.2621	14534.7248	17085.5781	18884.6518	19492.2643	20958.8725	22438.3986	24811.3422	27111.5271	28745.0623	30370.6003	31908.0591	33466.7561	34378.1789	35496.8731
40	11996.8091	13894.5682	16594.1709	19606.1387	20908.9437	21674.4720	23038.8124	24520.6717	26987.6098	28906.5307	30486.0610	31786.5699	33280.6425	34420.9045	35496.8731	36502.1492
50		16526.1829	19215.3413	21624.3321	22968.0695	23834.0624	24816.4458	26374.3357	28526.4994	30139.8641	31918.6265	33020.3337	34287.4126	35110.9032	36453.6741	37462.7848
60		18249.8939	21018.8066	23347.3769	24760.3146	25542.5590	26595.7176	28167.9354	29956.5009	31253.8552	33089.3667	34095.3156	35298.4514	36378.2870	37597.9944	38655.0417
70		20032.6396	22771.1489	24867.4888	26333.1761	27018.5819	27934.4280	29120.2783	30801.2665	32267.6289	34004.6571	35014.5060	36184.5385	37257.4019	38475.8578	39754.4858
80		20699.4052	22877.1559	25301.9163	26719.3887	27721.9107	28724.2368	29857.0266	31982.0413	33264.6968	34869.9820	35888.8236	36857.9174	38459.5744	39106.2499	40508.1532
90		21173.7352	23225.9109	25394.0413	26667.8496	28157.5516	29339.4661	30381.0942	32516.4892	34111.3177	35464.6857	36820.1608	37419.5327	38687.6335	39634.5271	41044.6120
100		21198.7370	23935.6199	25378.6840	26905.0414	28302.9728	29334.2447	30491.3107	33078.7449	35089.4783	36507.5359	37365.4778	37830.7201	39068.1668	39890.8666	39961.8115
110		22342.7238	25312.1502	26853.4536	27457.8723	28906.5307	29930.3189	30895.9171	33158.4203	35389.5982	37127.7710	38036.5580	38139.5378	39236.8615	39264.0802	40163.8319
120			26014.4851	27106.3624	28531.7006	30050.7823	30796.0093	31649.3135	33786.1529	36211.4390	37911.9525	38611.5920	38872.3963	39803.5751	39476.4804	40404.2652
130			26060.7141	27675.2905	29475.2685	31006.3946	31987.3267	33099.9890	35089.4783	36928.0519	38296.7953	38943.0747	39869.0411	39792.6656	40486.2788	
140			26271.4531	28240.6367	29851.7924	31765.4480	33238.1232	34431.5870	36227.5808	37581.7655	38899.5781	39601.8203	40415.1989	40464.4061	40798.1512	
150				28380.9195	30213.2533	32283.5055	33828.7720	35239.4921	37025.1930	38275.0990	39536.4184	39629.0757	40557.3769	41439.3980		
160				28724.2368	30528.0620	32823.9681	34426.2457	35835.0950	37700.8010	38845.2172	40087.3743	39907.2369	41017.2168			
170				29010.7704	30932.7368	33307.2211	35068.0553	36496.7626	38302.2197	37181.7759	40360.5345	40437.0677				
180					31992.6122	33674.3146	35378.8733	36901.0748	38134.1168	38655.0417	40710.5729					
190						34121.9864	35700.8245	37424.9388	37608.8143	39809.0300						
200						34559.8150	36195.2983	37884.8722	38318.4934	40781.7282						
201		22519.0075	26060.7141	29052.4810	32220.0059	34549.1268	35958.6881	37917.3689	38470.4299	39247.7486	41093.9301	40874.8047	41609.5445	41571.1155	40869.3288	39934.5228

y = 1.9724305815799OOE-10x4 - 2.5697210865488820E-06x3 + 1.2574761414630 60E-02x2 + 3.4985353846986 90E+01x - 1.1641072735207 90E+04

turbine output enthalpy CO Kj/Kmol

load \ rpm	800	1000	1250	1500	1750	2000	2250	2500	3000	3500	4000	4500	5000	5500	6000	6500
2	2567.7047	2580.0585	3408.3472	3602.9657	4105.4047	4498.2534	4766.7846	5084.6347	6115.6408	6705.7136	7138.7007	7528.8107				
5	2191.2565	2567.7047	3173.1427	3566.0429	4249.1654	4529.8127	4831.5586	5109.5470	6004.1401	6562.2762	7245.4382	7706.4576	8026.6498	8706.1811	8783.5706	9651.9666
10	2348.8915	2739.8784	3265.1978	3825.5017	4348.3345	4615.7550	4918.4955	5208.3073	6020.4410	6622.2750	7439.7943	8051.6191	8584.6141	8947.8097	9265.6915	9773.6697
20	2631.8170	3112.4150	3634.0604	4261.9894	4747.9617	5030.8332	5405.3490	5852.3844	6479.5656	7325.5030	7956.8971	8613.6617	9102.7291	9571.7435	9861.7218	10333.8475
30	3238.9415	3625.6773	4313.4499	5017.0765	5532.1878	5709.4804	6144.0206	6591.4789	7327.1079	8059.9489	8591.4454	9128.9389	9644.8255	10174.9530	10488.1263	10875.6266
40	3647.2507	4142.0971	4879.0214	5742.8884	6129.0772	6359.3296	6775.5669	7235.8539	8019.9965	8644.4592	9167.4319	9603.8025	10111.2882	10502.8635	10875.6266	11226.6765
50		4860.0129	5628.4754	6344.1751	6753.8035	7021.5468	7328.7129	7823.0481	8519.8210	9052.1383	9648.3958	10022.4076	10456.8351	10741.5512	11209.6883	11564.5729
60		5348.7410	6161.9723	6870.7208	7311.0656	7558.0341	7893.9930	8402.6559	8991.2238	9424.4399	10045.9597	10390.6853	10806.6507	11183.2807	11612.3191	11987.1519
70		5868.5153	6693.3258	7344.7706	7809.8768	8029.9773	8326.5827	8714.7669	9272.7252	9766.4948	10359.5019	10708.1277	11115.4794	11492.1343	11923.4198	12379.8920
80		6066.4772	6725.8635	7481.8226	7933.6992	8257.5054	8584.6141	8958.2217	9669.8282	10105.8381	10658.0641	11012.1840	11351.5415	11917.6320	12147.9817	12650.7614
90		6208.4463	6833.2196	7510.9739	7917.1455	8399.2692	8787.0163	9132.4357	9850.9240	10396.1919	10864.4304	11338.2745	11549.3091	11998.7526	12336.9010	12844.3638
100		6215.9554	7053.1337	7506.1122	7993.4046	8446.7314	8785.2934	9169.1830	10042.3349	10734.1205	11228.5647	11530.2395	11694.6078	12134.3884	12428.8094	12454.2733
110		6562.2762	7485.0594	7976.8022	8171.8923	8644.4592	8982.5346	9304.4022	10069.5323	10838.3224	11446.4682	11767.5013	11804.0089	12194.6285	12204.3545	12526.8479
120			7708.0949	8058.2827	8521.5237	9022.5317	9270.9666	9557.5081	10284.4377	11124.8873	11723.3622	11971.6906	12064.5651	12397.4944	12280.3119	12613.3456
130			7722.8371	8242.3720	8831.8567	9341.4105	9671.6150	10049.5849	10734.1205	11376.1949	11859.8089	12089.7626	12420.9780	12393.5820	12642.8812	
140			7790.1361	8426.3778	8956.4861	9596.6748	10096.7571	10506.5490	11130.5334	11606.5858	12074.2542	12325.1854	12617.2823	12635.0027	12755.3371	
150				8472.2002	9076.5481	9771.8758	10299.0685	10786.1753	11410.3624	11852.1068	12301.7659	12334.9481	12668.4983	12987.2552		
160				8584.6141	9181.4446	9955.4878	10504.7062	10993.4407	11648.6535	12054.8788	12499.3697	12434.6840	12834.4612			
170				8678.7283	9316.7321	10120.3740	10726.6916	11224.7885	11861.7347	11465.4878	12597.6032	12625.1569				
180					9673.4020	10246.0686	10834.5945	11366.7105	11802.0864	11987.1519	12723.7353					
190						10399.8635	10946.6336	11551.2166	11616.1419	12399.4508						
200						10550.8122	11119.2422	11713.7745	11867.5129	12749.4096						
201		6616.1112	7722.8371	8692.4505	9750.3587	10547.1210	11036.5676	11725.2800	11921.4904	12198.5185	12862.1951	12783.0111	13048.9472	13035.0078	12781.0337	12444.4773

y = 7.375068711828600E-11x4 - 1.3242712621404 40E-06x3 + 9.550379011160640E-03x2 + 2.632170883124980E+01x - 8.610658448420330E+03

turbine output enthalpy H2O Kj/Kmol

load \ rpm	800	1000	1250	1500	1750	2000	2250	2500	3000	3500	4000	4500	5000	5500	6000	6500
2	7210.9995	9495.9182	12655.8003	12996.0085	15046.4244	18182.0033	17997.4284	19303.5176	22417.2372	23696.3746	24111.7307	24792.9845				
5	7612.1927	9828.3968	13179.6837	14790.7424	16515.9673	18421.9948	18943.0033	19367.0169	21545.7283	22641.1183	24099.3753	24900.6378	26098.5991	26198.8816	26303.4160	27567.8692
10	9973.3424	11520.4727	14106.9185	15038.7832	16160.2251	16775.7623	17605.6941	18268.5008	20575.8210	22291.2174	24202.3713	25435.9817	26638.4297	26940.5959	27369.7204	28358.8268
20	10584.6810	12275.8683	14004.7342	15817.1790	16888.3989	17832.7377	18741.4323	19736.7679	21444.7705	23085.9308	24544.8694	26086.0687	27243.3791	28007.2528	28375.7905	29362.8749
30	12458.1995	13634.7003	15268.2614	16500.4764	17359.5871	18013.1255	19347.1698	20339.5109	22218.1001	23782.6320	25128.6376	26345.2508	27605.8424	28664.4596	29256.2077	30133.0048
40	13235.9786	14649.8111	16179.5294	17347.8810	18056.3034	18788.8300	20095.6630	21033.6887	23114.5475	24594.4572	25852.3661	26915.3918	28117.2975	28885.5702	29696.1403	30545.2595
50		15302.7259	17071.1886	18378.6812	19180.5832	20035.7742	21005.5260	22043.5967	23840.1672	25236.5476	26634.2373	27521.4705	28545.5305	29106.9952	30133.0048	30984.4301
60		16021.3348	18048.4517	19307.4854	20195.5425	21094.0585	22177.4971	23245.4445	24697.8216	25852.3661	27293.9028	28125.7658	29068.6492	29820.2253	30687.2148	31576.1501
70		16845.6613	19037.9786	20335.5096	21347.9259	22003.0480	23114.5475	23893.6144	25199.1848	26500.1437	27863.4680	28694.2061	29546.5113	30231.6783	31135.3979	32169.9809
80		17550.9578	19800.4946	20800.5300	21921.9885	22645.1924	23712.8004	24511.8207	26086.0687	27163.4182	28452.1504	29230.6183	29863.0357	30937.0118	31541.5389	32735.4081
90		18370.8077	20627.9497	21214.8845	22270.9029	23450.2264	24313.6935	24908.9222	26403.8397	27728.2655	28745.2135	29785.9853	30240.2614	31109.5078	32226.4389	33648.3638
100		18626.9663	21178.6246	21755.9751	22628.8968	23741.5502	24656.4667	25307.1485	26827.2111	28447.9072	29367.1431	30343.2950	30824.9866	31866.3009	32861.7980	33714.0718
110		19764.6442	21743.8361	22759.3177	22971.5251	24227.1018	25153.5326	25752.3236	27458.2227	29128.3026	30472.1795	31096.5644	31273.5467	32335.0650	33263.3745	34394.4946
120			22222.1611	22926.6069	23573.2447	25078.8607	25756.4907	26370.3574	28045.3362	29944.4070	31269.2278	31809.9636	32187.3506	33333.3092	33876.2570	35338.2029
130			22311.5349	23265.9087	24408.5941	25777.3277	26592.3199	27479.3023	29222.0895	30717.3424	31879.3045	32495.9595	33490.7653	34069.3206	35590.3965	
140			22714.4710	23774.4146	24859.2229	26915.3918	27880.3768	28843.0245	30467.8817	31736.3203	32748.4786	33486.3896	34574.9149	35263.0548	36451.3405	
150				24017.0339	25298.8407	27888.8319	28885.5702	29935.8397	31485.3111	32657.0061	33731.5981	34113.2281	35523.9960	37039.4202		
160				24520.0821	25639.8590	28796.2377	29845.9102	30988.7416	32613.4650	33538.9053	34654.1814	34856.9107	36673.8814			
170				24892.3538	26098.5991	29443.9903	30665.6984	31913.9857	33468.8879	32513.3626	35373.5774	35767.5822				
180					27897.2875	30085.8346	31256.2718	32674.4257	33806.1045	34359.3119	36189.0830					
190						30773.3085	31796.9654	33359.5420	33810.4882	35745.4247						
200						31403.1663	32552.5261	34108.8369	34464.8808	36678.3350						
201		19768.6271	22567.8063	24921.3498	28240.1333	31390.1997	32500.3101	34170.3243	34671.8009	35590.3965	36731.7854	36393.5232	37615.9059	37633.8092	36972.5004	35431.0758

y = 4.462463678167200E-11x4 - 6.203547654049370E-07x3 + 3.925881969085400E-03x2 + 2.824087448085080E+01x - 8.824216855764490E+03

turbine output enthalpy O2 Kj/Kmol

load \ rpm	800	1000	1250	1500	1750	2000	2250	2500	3000	3500	4000	4500	5000	5500	6000	6500
2	6596.7806	8650.7098	11443.2048	11740.8148	13522.9101	16212.4437	16055.2461	17164.7508	19784.2831	20850.6528	21195.7637	21760.6080				
5	6959.6895	8947.0483	11901.2583	13301.7403	14788.5399	16416.6373	16859.1577	17218.5253	19054.5692	19971.3191	21185.5058	21849.7318	22839.0809	22921.7020	23007.7941	24046.6112
10	9076.0458	10445.8774	12708.7671	13516.3045	14483.0127	15011.3269	15721.1665	16286.0651	18239.3373	19678.9282	21271.0012	22292.3958	23283.4839	23531.8578	23884.1295	24694.0780
20	9618.8538	11110.1733	12619.9746	14187.8790	15107.8309	15914.8690	16688.0774	17531.3483	18969.8670	20342.4266	21555.0600	22828.7552	23780.4706	24406.5036	24707.9448	25513.4552
30	11270.0859	12298.0285	13714.5675	14775.2467	15510.9651	16068.6202	17201.7193	18040.2011	19617.7760	20922.3682	22038.3685	23042.2391	24077.7363	24943.7922	25426.5386	26140.0748
40	11950.4005	13179.7066	14499.6058	15500.9607	16105.4031	16728.3195	17834.4990	18624.6042	20366.2789	21596.1559	22636.0849	23511.1509	24496.5536	25124.2865	25784.8139	26474.8573
50		13744.3237	15264.3285	16379.8013	17060.6000	17783.9454	18600.9287	19471.7546	20970.1902	22127.5919	23280.0359	24008.5745	24846.6533	25304.9022	26140.0748	26831.0068
60		14363.5816	16098.7148	17168.1113	17918.7804	18675.3456	19583.8094	20475.3485	21681.7944	22636.0849	23821.9292	24503.4818	25273.6331	25885.7726	26590.0324	27310.0781
70		15071.2207	16939.7125	18036.8274	18888.5821	19437.8092	20366.2789	21014.6048	22096.7033	23169.7259	24288.7923	24968.0824	25663.0169	26220.2461	26953.3197	27789.9615
80		15674.4371	17585.2117	18428.5098	19369.9331	19974.7211	20864.3113	21527.6665	22828.7552	23714.8413	24770.3547	25405.6827	25920.5945	26792.5767	27282.0807	28246.0705
90		16373.1045	18283.2383	18776.8621	19661.9398	20645.8689	21363.3698	21856.5888	23090.4699	24178.0533	25009.7280	25857.9182	26227.2187	26932.3480	27835.5399	28980.8605
100		16590.8562	18746.4024	19230.8490	19961.1133	20888.2154	21647.5354	22185.9476	23438.6896	24766.8871	25516.9324	26310.9027	26701.7628	27544.6645	28347.9163	29033.6676
110		17554.9119	19220.6754	20069.9976	20247.0410	21291.5245	22058.9557	22553.5568	23956.7152	25322.2755	26415.5434	26921.8627	27065.1953	27923.2109	28671.2499	29579.8935
120			19621.1729	20209.5785	20748.2392	21997.1992	22556.9949	23062.9083	24437.6713	25986.7685	27061.6985	27499.1326	27803.9849	28727.5184	29163.9656	30335.6812
130			19695.9177	20492.3951	21442.0816	22574.1863	23245.5590	23974.0005	25398.7311	26614.4695	27555.1729	28053.0131	28854.1621	29318.9892	30537.3079	
140			20032.5630	20915.5373	21815.4496	23511.1509	24302.6380	25089.5667	26412.0547	27439.6019	28256.6046	28850.6435	29724.5469	30275.5727	31224.5423	
150				21117.1310	22179.0815	24309.5611	25124.2865	25979.8021	27236.5909	28182.8739	29047.7511	29354.2332	30484.2353	31693.0185		
160				21534.5146	22460.7449	25051.3800	25906.6652	26834.5007	28147.7706	28892.8697	29788.0753	29950.4869	31401.9126			
170				21842.8750	22839.0809	25579.5304	26572.5785	27583.1972	28836.5694	28067.0493	30363.9716	30678.8800				
180					24316.4844	26101.7402	27051.2084	28196.9164	29107.6134	29551.6766	31015.3757					
190						26659.8586	27488.6263	28748.6219	29111.1351	30661.1799						
200						27170.1190	28098.6332	29350.7086	29636.3353	31405.4610						
201		17558.2784	19910.0910	21866.8747	24597.0301	27159.6249	28056.5221	29400.0566	29802.1946	30537.3079	31448.0454	31178.4426	32151.5250	32165.7529	31639.7472	30409.9492

y = 5.759805181505400E-11x4 - 8.196601466420560E-07x3 + 4.520153459081880E-03x2 + 2.588379148402900E+01x - 8.117644636389040E+03

turbine output enthalpy N2 Kj/Kmol

load	rpm	800	1000	1250	1500	1750	2000	2250	2500	3000	3500	4000	4500	5000	5500	6000	6500
	2	6225.6929	8158.9910	10793.2217	11074.3168	12758.8048	15304.8005	15155.8789	16207.2487	18691.8844	19704.1834	20031.8892	20568.3408				
	5	6567.0036	8438.2350	11225.8834	12549.6337	13956.3607	15498.2636	15917.6044	16258.2217	17999.4387	18869.4038	20022.1481	20652.9951	21592.9094	21671.4167	21753.2245	22740.5243
	10	8559.8145	9851.7142	11988.9874	12752.5571	13667.1774	14167.2645	14839.4321	15374.5505	17226.1177	18591.8963	20103.3382	21073.5001	22015.2104	22251.2583	22586.0793	23356.0396
	20	9071.5600	10478.7471	11905.0557	13387.8849	14258.6301	15022.9035	15755.4733	16554.7754	17919.0772	19221.6709	20373.1118	21583.0979	22487.5516	23082.6423	23369.2235	24135.1421
	30	10629.7390	11600.7791	12940.0899	13943.7775	14640.3567	15168.5483	16242.2911	17037.2651	18533.8614	19772.2782	20832.1807	21785.9560	22770.1107	23593.4614	24052.4896	24731.0740
	40	11272.3103	12434.2339	13682.8815	14630.8825	15203.3938	15793.6090	16842.2054	17591.5409	19244.3142	20412.1434	21400.0301	22231.5782	23168.2505	23765.0808	24393.1999	25049.4985
	50		12968.2378	14406.8062	15463.3617	16108.5282	16794.2702	17569.0829	18395.2898	19817.6871	20916.9382	22011.9337	22704.3683	23501.1023	23936.8239	24731.0740	25388.2731
	60		13554.1504	15197.0578	16210.4341	16922.1239	17639.6738	18501.6269	19347.8579	20493.4820	21400.0301	22526.9576	23174.8371	23907.0903	24489.2146	25159.0516	25844.0151
	70		14223.9686	15993.9504	17034.0658	17841.9609	18363.0776	19244.3142	19859.8612	20887.5953	21907.1042	22970.7406	23616.5567	24277.3707	24807.3257	25504.6252	26300.5759
	80		14795.1739	16605.8423	17405.5382	18298.6685	18872.6329	19717.1521	20347.0946	21583.0979	22425.1726	23428.5598	24032.6573	24522.3319	25351.7165	25817.3798	26734.5581
	90		15457.0166	17267.7541	17735.9751	18575.7738	19509.7485	20191.0584	20659.5083	21831.7882	22865.4705	23656.1541	24462.7240	24813.9574	25484.6753	26343.9414	27433.7787
	100		15663.3446	17707.0797	18166.6947	18859.7169	19739.8493	20460.9429	20972.3743	22162.7115	23425.2630	24138.4488	24893.5518	25265.3311	26067.1949	26831.4682	27484.0330
	110		16577.1154	18157.0415	18963.0672	19131.1226	20122.8284	20851.7372	21321.6187	22655.0738	23953.3441	24993.0809	25474.7010	25611.0514	26427.3571	27139.1444	28003.8786
	120			18537.0851	19095.5610	19606.9433	20793.0730	21324.8853	21805.5972	23112.2724	24585.2671	25607.7249	26023.8761	26313.9183	27192.6900	27608.0339	28723.2364
	130			18608.0201	19364.0413	20265.8115	21341.2189	21979.1692	22671.5042	24026.0468	25182.2964	26077.1926	26550.8617	27313.2070	27755.5691	28915.1574	
	140			18927.5347	19765.7921	20620.4318	22231.5782	22983.9027	23732.0674	24989.7626	25967.2395	26744.5816	27309.8586	28141.5533	28666.0224	29569.3474	
	150				19957.2184	20965.8517	22990.4840	23765.0808	24578.6415	25774.1035	26674.4250	27497.4357	27789.1111	28864.6391	30015.3281		
	160				20353.5986	21233.4392	23695.7580	24509.0844	25391.5967	26641.0237	27350.0425	28202.0178	28356.5991	29738.1979			
	170				20646.4820	21592.9094	24197.9770	25142.4496	26103.8550	27296.4652	26564.2170	28750.1647	29049.9177				
	180					22997.0656	24694.6141	25597.7457	26687.7867	27554.4048	27977.0233	29370.2324					
	190						25225.4710	26013.8805	27212.7723	27557.7563	29033.0691						
	200						25710.8667	26594.2691	27785.7567	28057.5970	29741.5759						
	201		16580.3071	18811.2895	20669.2786	23263.7736	25700.8834	26554.2004	27832.7220	28215.4562	28915.1574	29782.1154	29525.4626	30451.8389	30465.3846	29964.6136	28793.9288

total CO2 energy Kj

load	rpm	800	1000	1250	1500	1750	2000	2250	2500	3000	3500	4000	4500	5000	5500	6000	6500
	2	60245.4471	60680.1373	88409.6124	94584.6266	110051.3467	121730.5627	129532.4455	138596.5164	166912.1639	182492.2003	193680.8631	203602.8955				
	5	46626.3020	60245.4471	80790.3781	93421.6074	114364.1085	122654.7561	131394.0749	139299.6032	163921.0371	178741.7905	196409.9776	208074.7938	216066.0585	232753.5985	234632.1874	255433.5553
	10	52421.4842	66240.9034	83793.8696	101514.7589	117312.5584	125161.5321	133880.8199	142076.8544	164359.3155	180313.3243	201351.4087	216685.6370	229793.8943	238604.9867	246241.9087	258310.3833
	20	62493.6195	78793.1889	95561.0794	114746.5828	128990.0257	137074.5609	147571.5475	159824.1985	176568.7383	198449.9108	214332.5292	230502.0762	242335.2996	253532.2979	260386.2259	271440.1852
	30	82940.0886	95298.0971	116277.7981	136684.6249	151077.2146	155938.1143	167670.9797	179507.1892	198490.7380	216892.2170	229960.4981	242964.8023	255264.4730	267734.0487	275025.4316	283974.9851
	40	95974.4730	111156.5458	132753.3674	156849.1093	167271.5495	173395.7761	184310.4989	196165.3737	215900.8785	231252.2453	243888.4879	254292.5588	266245.1402	275367.2357	283974.9851	292017.1934
	50		132209.4631	153722.7306	172994.6568	183744.5563	190672.4989	198531.5662	210994.6858	228211.9951	241118.9129	255349.0122	264162.6697	274299.3007	280887.2256	291629.3930	299702.2787
	60		145999.1516	168150.4526	186779.0154	198082.5165	204340.4724	212765.7411	225343.4829	239652.0068	250030.8415	264714.9338	272762.5245	282387.6112	291026.2963	300783.9554	309240.3333
	70		160261.1165	182169.1914	198939.9105	210665.4090	216148.6549	223475.4241	232962.2266	246410.1319	258141.0314	272037.2564	280116.0482	289476.3077	298059.2154	307806.8627	318035.8867
	80		165595.2416	183017.2472	202415.3304	213755.1095	221775.2858	229793.8943	238856.2129	255856.3306	266117.5748	278959.8562	287110.5886	294863.3395	307676.5953	312849.9990	324065.2256
	90		169389.8815	185807.2871	203152.3303	213342.7968	225260.4125	234715.7291	243048.7533	260131.9140	272890.5418	283717.4859	294561.2860	299356.2617	309501.0684	317076.2168	328356.8961
	100		169589.8959	191484.9595	203029.4721	215240.3309	226423.7821	234673.9578	243930.4853	264629.9593	280715.8264	292060.2870	298923.8221	302645.7610	312545.3342	319126.9329	319694.4919
	110		178741.7905	202497.2016	214827.6289	219662.9788	231252.2453	239442.5514	247167.3369	265267.3627	283116.7856	297022.1677	304292.4641	305116.3021	313894.8918	314112.6416	321310.6551
	120			208115.8808	216850.8989	228253.6046	240406.2588	246368.0746	253194.5080	270289.2233	289691.5122	303295.6202	308892.7364	310979.1701	318428.6007	315811.8436	323234.1214
	130			208485.7130	221402.3241	235802.1480	248051.1568	255898.6136	264799.9121	280715.8264	295424.4150	306374.3625	311544.5973	318952.3290	318341.3248	323890.2305	
	140			210171.6245	225925.0937	238814.3393	254123.5840	265904.9853	275452.6962	289820.6460	300654.1243	311196.6244	316814.5620	323321.5914	323715.2491	326385.2095	
	150				227047.3562	241706.0267	258268.0438	270630.1759	281915.9371	296201.5440	306200.7922	316291.3468	317032.6055	324459.0151	331515.1838		
	160				229793.8943	244224.4958	262591.7447	275409.9655	286680.7599	301606.4079	310761.7380	320698.9943	319257.8950	328137.7344			
	170				232086.1635	247461.8940	266457.7685	280544.4423	291974.1008	306417.7573	297454.2072	322884.2759	323496.5418				
	180					255940.8976	269394.5165	283030.9863	295208.5984	305072.9341	309240.3333	325684.5829					
	190						272975.8914	285606.5961	299399.5106	300870.5140	318472.2399						
	200						276478.5204	289562.3867	303078.9780	306547.9471	326253.8253						
	201		180152.0602	208485.7130	232419.8477	257760.0473	276393.0141	287669.5050	303338.9514	307763.4394	313981.9891	328751.4409	326998.4376	332876.3563	332568.9238	326954.6300	319476.1826

total CO energy Kj

load \ rpm	800	1000	1250	1500	1750	2000	2250	2500	3000	3500	4000	4500	5000	5500	6000	6500
2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000				
5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
10	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
20	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
30	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
40	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
50		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
60		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
70		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
80		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
90		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
100		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
110		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
120			0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
130			0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
140			0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
150				0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
160				0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000			
170				0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000				
180					0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000					
190						0.0000	0.0000	0.0000	0.0000	0.0000						
200						0.0000	0.0000	0.0000	0.0000	0.0000						
201		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

total H2O energy Kj

load \ rpm	800	1000	1250	1500	1750	2000	2250	2500	3000	3500	4000	4500	5000	5500	6000	6500
2	64898.9951	85463.2640	113902.2029	116964.0769	135417.8200	163638.0297	161976.8560	173731.6588	201755.1348	213267.3718	217005.5766	223136.8607				
5	68509.7340	88455.5708	118617.1530	133116.6819	148643.7058	165797.9529	170487.0300	174303.1520	193911.5543	203770.0649	216894.3774	224105.7401	234887.3922	235789.9342	236730.7444	248110.8229
10	89760.0812	103684.2547	126962.2667	135349.0485	145442.0257	150981.8603	158451.2470	164416.5069	185182.3893	200620.9562	217821.3418	228923.8356	239745.8673	242465.3628	246327.4833	255229.4415
20	95262.1291	110482.8151	126042.6078	142354.6111	151995.5898	160494.6393	168672.8910	177630.9113	193002.9341	207773.3769	220903.8247	234774.6183	245190.4120	252065.2754	255382.1149	264265.8740
30	112123.7958	122712.3028	137414.3524	148504.2874	156236.2841	162118.1296	174124.5280	183055.5985	199962.9010	214043.6877	226157.7384	237107.2574	248452.5816	257980.1363	263305.8694	271197.0435
40	119123.8074	131848.3001	145615.7642	156130.9290	162506.7309	169099.4701	180860.9670	189303.1985	208030.9272	221350.1145	232671.2950	242238.5258	253055.6779	259970.1321	267265.2623	274907.3358
50		137724.5329	153640.6973	165408.1308	172625.2486	180321.9675	189049.7339	198392.3702	214561.5045	227128.9280	239708.1357	247693.2349	256909.7744	261962.9564	271197.0435	278859.8713
60		144192.0132	162436.0653	173767.3683	181759.8823	189846.5269	199597.4738	209209.0004	222280.3948	232671.2950	245645.1253	253131.8923	261617.8424	268382.0278	276184.9330	284185.3506
70		151610.9515	171341.8072	183019.5860	192131.3328	198027.4319	208030.9272	215042.5297	226792.6632	238501.2936	250771.2123	258247.8553	265918.6020	272085.1046	280218.5808	289529.8284
80		157958.6200	178204.4514	187204.7698	197297.8968	203806.7317	213415.2036	220606.3864	234774.6183	244470.7635	256069.3534	263075.5651	268767.3211	278433.1062	283873.8501	294618.6730
90		165337.2696	185651.5470	190933.9606	200438.1262	211052.0374	218823.2411	224180.3000	237634.5570	249554.3891	258706.9217	268073.8676	272162.3530	279985.5706	290037.9505	302835.2745
100		167642.6966	190607.6218	195803.7756	203660.0715	213673.9521	221908.2000	227764.3365	241444.9001	256031.1646	264304.2877	273089.6552	277424.8794	286796.7082	295756.1818	303426.6466
110		177881.7982	195694.5249	204833.8590	206743.7263	218043.9163	226381.7934	231770.9125	247124.0040	262154.7230	274249.6152	279869.0792	281461.9205	291015.5854	299370.3705	309550.4511
120			199999.4500	206339.4620	212159.2021	225709.7467	231808.4159	237333.2170	252408.0262	269499.6631	281423.0504	286289.6723	289686.1556	299999.7830	304886.3126	318043.8259
130			200803.8145	209393.1781	219677.3471	231995.9494	239330.8792	247313.7210	262998.8053	276456.0818	286913.7407	292463.6351	301416.8880	306623.8852	320313.5682	
140			204430.2392	213969.7316	223733.0062	242238.5258	250923.3915	259587.2207	274210.9350	285626.8828	294736.3074	301377.5066	311174.2338	317367.4929	328062.0647	
150				216153.3051	227689.5662	250999.4875	259970.1321	269422.5569	283367.8000	293913.0551	303584.3832	307019.0533	319715.9636	333354.7820		
160				220680.7393	230758.7306	259166.1390	268613.1914	278898.6743	293521.1850	301850.1480	311887.6324	313712.1964	330064.9330			
170				224031.1845	234887.3922	264995.9123	275991.2860	287225.8717	301219.9911	292620.2632	318362.1969	321908.2402				
180					251075.5876	270772.5112	281306.4461	294069.8311	304254.9401	309233.8070	325701.7473					
190						276959.7768	286172.6883	300235.8780	304294.3935	321708.8219						
200						282628.4963	292972.7348	306979.5321	310183.9270	330105.0147						
201		177917.6439	203110.2567	224292.1482	254161.1997	282511.7976	292502.7907	307532.9186	312046.2083	320313.5682	330586.0686	327541.7092	338543.1528	338704.2832	332752.5037	318879.6818

total O2 energy Kj

load \ rpm	800	1000	1250	1500	1750	2000	2250	2500	3000	3500	4000	4500	5000	5500	6000	6500
2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000				
5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
10	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
20	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
30	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
40	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
50		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
60		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
70		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
80		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
90		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
100		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
110		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
120			0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
130			0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
140			0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
150				0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
160				0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000			
170				0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000				
180					0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000					
190						0.0000	0.0000	0.0000	0.0000	0.0000						
200						0.0000	0.0000	0.0000	0.0000	0.0000						
201		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

total N2 energy Kj

load \ rpm	800	1000	1250	1500	1750	2000	2250	2500	3000	3500	4000	4500	5000	5500	6000	6500
2	292607.5678	383472.5772	507281.4202	520492.8904	599663.8262	719325.6248	712326.3084	761740.6911	878518.5668	926096.6179	941498.7938	966712.0180				
5	308649.1705	396597.0448	527616.5186	589832.7829	655948.9515	728418.3903	748127.4057	764136.4180	845973.6179	886861.9793	941040.9587	970690.7693	1014866.7414	1018556.5845	1022401.5521	1068804.6443
10	402311.2808	463030.5663	563482.4099	599370.1837	642357.3398	665861.4324	697453.3068	722603.8715	809627.5329	873819.1265	944856.8941	990454.5031	1034714.8888	1045809.1379	1061545.7264	1097733.8634
20	426363.3208	492501.1151	559537.6177	629230.5898	670155.6152	706076.4660	740507.2467	778074.4417	842196.6292	903418.5321	957536.2524	1014405.6025	1056914.9246	1084884.1900	1098353.5032	1134351.6801
30	499597.7317	545236.6156	608184.2235	655357.5406	688096.7655	712921.7713	763387.6834	800751.4607	871091.4839	929297.0770	979112.4937	1023939.9332	1070195.2051	1108892.6835	1130467.0127	1162360.4763
40	529798.5822	584408.9952	643095.4308	687651.4762	714559.5088	742299.6248	791583.6517	826802.4200	904482.7662	959370.7381	1005801.4128	1044884.1756	1088907.7748	1116958.7953	1146480.3972	1177326.4286
50		609507.1786	677119.8926	726777.9993	757100.8248	789330.7015	825746.8945	864578.6222	931431.2930	983096.0937	1034560.8835	1067105.3122	1104551.8091	1125030.7222	1162360.4763	1193248.8372
60		637045.0706	714261.7149	761890.4049	795339.8233	829064.6678	869576.4654	909349.3212	963193.6558	1005801.4128	1058767.0065	1089217.3424	1123633.2428	1150993.0851	1182475.4268	1214668.7100
70		668526.5242	751715.6691	800601.0936	838572.1612	863064.6454	904482.7662	933413.4774	981716.9797	1029633.8974	1079624.8074	1109978.1667	1141036.4244	1165944.3084	1198717.3850	1236127.0669
80		695373.1746	780474.5875	818060.2939	860037.4203	887013.7450	926706.1491	956313.4476	1014405.6025	1053983.1137	1101142.3118	1129534.8911	1152549.5971	1191530.6747	1213416.8525	1256524.2288
90		726479.7801	811584.4437	833590.8275	873061.3695	916958.1799	948979.7438	970996.8917	1026094.0445	1074677.1124	1111839.2410	1149748.0278	1166255.9985	1197779.7397	1238165.2458	1289387.5976
100		736177.1949	832232.7468	853834.6500	886406.6966	927772.9194	961664.3149	985701.5937	1041647.4391	1100987.3596	1134507.0946	1169996.9344	1187470.5611	1225158.1598	1261079.0077	1291749.5493
110		779124.4260	853380.9495	891264.1585	899162.7630	945772.9359	980031.6483	1002116.0791	1064788.4707	1125807.1747	1174674.8016	1197310.9450	1203719.4157	1242085.7831	1275539.7873	1316182.2925
120			871242.9991	897491.3654	921526.3363	977274.4328	1002269.6086	1024863.0698	1086276.8024	1155507.5520	1203563.0703	1223122.1760	1236754.1623	1278056.4280	1297577.5943	1349992.1108
130			874576.9439	910109.9402	952493.1412	1003037.2899	1033020.9540	1065560.6961	1129224.2011	1183567.9303	1225628.0512	1247890.4978	1283720.7287	1304511.7489	1359012.3989	
140			889594.1290	928992.2267	969160.2956	1044884.1756	1080243.4270	1115407.1677	1174518.8424	1220460.2563	1256995.3345	1283563.3523	1322653.0053	1347303.0541	1389759.3277	
150				937989.2631	985395.0299	1080552.7500	1116958.7953	1155196.1524	1211382.8643	1253697.9740	1292379.4781	1306088.2232	1356638.0365	1410720.4194		
160				956619.1349	997971.6437	1113700.6258	1151926.9669	1193405.0462	1252128.1140	1285451.9998	1325494.8388	1332760.1569	1397695.3014			
170				970384.6561	1014866.7414	1137304.9189	1181695.1296	1226881.1847	1282933.8665	1248518.2001	1351257.7410	1365346.1299				
180					1080862.0817	1160646.8629	1203094.0463	1254325.9743	1295057.0275	1314920.0962	1380400.9229					
190						1185597.1361	1222652.3825	1279000.2995	1295214.5482	1364554.2468						
200						1208410.7367	1249930.6482	1305930.5669	1318707.0593	1397854.0686						
201		779274.4338	884130.6073	971456.0927	1093397.3578	1207941.5212	1248047.4204	1308137.9327	1326126.4427	1359012.3989	1399759.4218	1387696.7433	1431236.4280	1431873.0744	1408336.8390	1353314.6516

turbine output gas enthalpy CO2 Kj/Kg

load	rpm	800	1000	1250	1500	1750	2000	2250	2500	3000	3500	4000	4500	5000	5500	6000	6500
	2	10.2919	12.8313	22.2866	29.0979	39.5879	52.3272	60.9882	74.9769	111.9702	144.7265	193.8826	233.9312				
	5	9.1634	13.8481	23.3675	32.5354	49.2004	59.1128	71.0805	83.6281	119.0704	157.0197	214.7552	266.0901	321.3232	397.9440	454.2740	567.4527
	10	12.6321	18.4233	29.8225	43.2848	60.0005	72.3590	85.8139	101.0818	147.4098	190.4559	262.7356	323.6742	398.7882	474.2274	563.2784	675.2843
	20	20.8529	31.2710	48.8755	69.3261	92.2637	111.7538	133.9929	162.2660	215.2545	291.2666	368.6073	461.3243	555.1834	661.6489	767.3257	904.6121
	30	40.5773	50.1308	76.6707	107.3544	138.8546	161.2443	196.3730	232.8607	310.4864	406.7482	497.7687	606.9902	729.5423	871.4371	1002.8879	1171.4954
	40	54.4522	71.2483	106.7558	151.7297	184.7537	216.6243	260.2746	309.0286	410.5115	521.9235	639.1064	765.3500	915.8648	1072.7849	1241.7989	1429.8703
	50		100.9015	146.4102	198.7036	241.0371	282.0364	330.4034	394.9557	512.6053	635.4488	784.6662	928.3300	1099.1973	1271.3073	1491.8666	1707.8867
	60		130.9430	186.3668	248.5199	301.8007	349.2235	413.2679	497.0076	625.3420	759.9896	943.0470	1104.2147	1317.9069	1531.9301	1770.8655	2030.8929
	70		166.3266	232.9615	303.0380	371.6635	427.0437	497.9312	582.0820	730.6745	894.7096	1110.3465	1297.8710	1539.9536	1782.3527	2049.6944	2374.1158
	80		200.6692	267.2814	350.3613	421.4984	491.6789	571.6921	670.3732	856.4968	1039.7990	1282.3436	1507.9287	1767.6443	2071.6891	2331.6015	2693.2296
	90		240.3219	318.7111	403.4831	483.0585	561.1956	657.9375	766.8695	981.8173	1200.0551	1452.6729	1725.4336	1981.2603	2297.5081	2615.3283	3023.0497
	100		280.7066	383.1694	461.9625	553.4965	647.8236	740.5267	862.0571	1113.7430	1382.4280	1673.5663	1935.5317	2204.4801	2551.3683	2879.6773	3178.1851
	110		340.8507	467.6420	557.3583	634.8870	734.5471	841.6239	960.6056	1218.7562	1526.3730	1872.3741	2158.1520	2414.2327	2777.2069	3061.0713	3471.9401
	120			534.3809	619.9074	722.4068	842.1732	950.1424	1074.2304	1349.0999	1710.4876	2106.8515	2383.6223	2677.6602	3060.4527	3333.0212	3814.8360
	130			585.1354	719.2501	842.1739	941.9054	1076.2847	1230.6760	1533.7026	1894.5116	2288.6590	2591.8780	2991.2856	3296.2697	3780.1814	
	140			652.3348	815.3699	957.2475	1055.5835	1220.1161	1405.3826	1726.9486	2098.6284	2498.9737	2849.6810	3282.8368	3653.3739	4163.4513	
	150				890.2148	1054.6104	1148.4857	1338.3038	1547.5031	1917.9050	2314.5803	2762.9367	3055.2917	3558.7972	4148.1988		
	160				975.8262	1146.3287	1244.9402	1455.1783	1680.0687	2127.4771	2526.6656	3020.5837	3308.9751	3944.2611			
	170				1039.6332	1250.7996	1349.6826	1594.8172	1842.2755	2326.4343	2612.4329	3254.7408	3607.9974				
	180					1294.9010	1458.7526	1718.4305	1988.7629	2441.0072	2837.4948	3529.4936					
	190						1582.5967	1844.9393	2159.1071	2590.9339	3069.2762						
	200						1691.8949	2002.4043	2324.1317	2790.6507	3419.6612						
	201		349.2948	655.2822	1042.0157	1346.8857	1692.4274	1990.9127	2339.7123	2793.1669	3052.8207	3726.3063	3801.8110	4267.8679	4434.3678	4431.1434	3960.2844

turbine output gas enthalpy CO Kj/Kg

load	rpm	800	1000	1250	1500	1750	2000	2250	2500	3000	3500	4000	4500	5000	5500	6000	6500
	2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000				
	5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	10	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	20	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	30	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	40	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	50		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	60		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	70		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	80		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	90		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	100		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	110		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	120			0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	130			0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
	140			0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
	150				0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
	160				0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000			
	170				0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000				
	180					0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000					
	190						0.0000	0.0000	0.0000	0.0000	0.0000						
	200						0.0000	0.0000	0.0000	0.0000	0.0000						
	201		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

turbine output gas enthalpy H2O Kj/Kg

	rpm	800	1000	1250	1500	1750	2000	2250	2500	3000	3500	4000	4500	5000	5500	6000	6500
load	2	12.4728	20.3309	32.3020	40.4805	54.8019	79.1343	85.7971	105.7320	152.2621	190.2745	244.3856	288.4218				
	5	15.1471	22.8741	38.5969	52.1547	71.9412	89.8936	103.7573	117.7227	158.4621	201.3821	266.7970	322.4146	392.9776	453.5272	515.6292	620.0832
	10	24.3334	32.4418	50.8345	64.9252	83.6860	98.1972	114.2582	131.5974	186.8461	238.3941	319.7549	384.6994	468.0663	542.1374	633.9084	750.6338
	20	35.7605	49.3289	72.5237	96.7566	122.3090	147.2037	172.2967	202.8878	264.7005	343.0696	427.3971	528.6097	631.9400	740.0479	846.6516	990.7906
	30	61.7119	72.6208	101.9335	131.2175	161.5459	188.5890	229.4227	267.1468	351.8878	451.5820	550.7294	666.4011	798.8333	944.6507	1080.1712	1258.6297
	40	76.0345	95.0750	131.7368	169.9144	201.9273	237.6640	287.3287	335.4956	444.9912	562.0218	685.9259	820.2045	979.3057	1139.4003	1314.8198	1514.3528
	50		118.2494	164.6236	213.7383	254.7571	300.0670	353.9513	417.7864	542.1869	673.4018	828.6785	979.2591	1158.2014	1333.8622	1560.7602	1787.7532
	60		145.4875	202.5375	260.1080	311.5478	365.0096	436.1517	519.0998	652.5145	795.6268	984.4996	1152.8378	1373.5959	1589.3248	1829.2936	2099.6413
	70		177.0176	246.5046	313.6355	381.3357	440.1469	521.4588	604.4711	756.5662	929.9687	1151.4905	1346.1169	1591.4605	1830.4100	2099.2312	2431.4851
	80		215.3420	292.7843	364.5374	437.6776	508.3226	597.3125	696.5474	884.1649	1074.6209	1324.2587	1554.4066	1812.6046	2109.1308	2380.1048	2754.5695
	90		263.8938	358.2495	426.6181	510.5691	591.5228	690.0625	795.7525	1009.0186	1234.6119	1490.1923	1766.5649	2026.4401	2338.2076	2691.3482	3136.5927
	100		312.1690	429.0905	501.2118	589.1822	687.7630	787.7741	905.5412	1143.1850	1418.4727	1703.8335	1989.2875	2273.3668	2633.8245	3002.3874	3393.5189
	110		381.6120	508.4235	597.8588	672.2401	779.1663	895.1808	1013.3640	1277.3222	1590.0298	1944.9226	2233.0491	2505.4509	2896.6282	3282.0816	3762.9727
	120			577.7328	663.5909	755.4028	889.5256	1005.7407	1132.8026	1417.3302	1790.1726	2199.2772	2485.3522	2806.1083	3243.7477	3619.9295	4222.7772
	130			634.0224	765.2666	882.6567	991.0577	1132.4277	1293.0837	1616.5180	1994.4794	2411.1962	2737.2768	3180.1837	3571.8089	4205.7422	
	140			713.8289	868.7505	1008.8960	1131.9920	1295.2940	1489.9901	1838.1773	2242.9520	2662.6432	3049.6814	3554.4363	4029.4514	4707.9469	
	150				953.4387	1117.6356	1255.6838	1446.2870	1663.7895	2064.1573	2499.4091	2983.4281	3328.6382	3945.1201	4692.6196		
	160				1054.2678	1218.5143	1382.2869	1596.6746	1838.7702	2329.2511	2760.9856	3304.7906	3657.9332	4463.3546			
	170				1128.9947	1335.6468	1510.0626	1765.0505	2038.8549	2572.8423	2891.2254	3610.3019	4039.0682				
	180					1429.0712	1649.4911	1921.4549	2228.7277	2738.7699	3192.1143	3970.8895					
	190						1806.4052	2079.6706	2435.7808	2947.9708	3488.0274						
	200						1945.7206	2279.2363	2648.2980	3176.7196	3892.5313						
	201		388.0829	718.1852	1131.2735	1494.0906	1946.1311	2277.4084	2668.5688	3186.0405	3503.6799	4215.4889	4284.1432	4883.0882	5080.6966	5073.4358	4447.0014

turbine output gas enthalpy O2 Kj/Kg

	rpm	800	1000	1250	1500	1750	2000	2250	2500	3000	3500	4000	4500	5000	5500	6000	6500
load	2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000				
	5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	10	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	20	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	30	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	40	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	50		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	60		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	70		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	80		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	90		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	100		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	110		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	120			0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	130			0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
	140			0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
	150				0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
	160				0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000			
	170				0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000				
	180					0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000					
	190						0.0000	0.0000	0.0000	0.0000	0.0000						
	200						0.0000	0.0000	0.0000	0.0000	0.0000						
	201		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

	turbine output gas enthalpy N2 Kj/Kg																
	rpm	800	1000	1250	1500	1750	2000	2250	2500	3000	3500	4000	4500	5000	5500	6000	6500
load	2	293.6744	476.3948	751.2785	940.7276	1267.3104	1816.6094	1970.3984	2420.9733	3462.3698	4314.8706	5537.0672	6525.4320				
	5	356.3665	535.5781	896.5588	1206.8276	1657.8939	2062.4610	2377.7074	2695.1397	3610.2218	4577.1162	6045.0037	7292.8621	8866.9136	10231.0119	11629.4627	13949.4778
	10	569.5568	756.5847	1178.2016	1501.4431	1930.1667	2261.5880	2626.4082	3020.3525	4266.0413	5422.4573	7243.3287	8692.0121	10549.5111	12211.4558	14266.1794	16859.6961
	20	835.8313	1148.3356	1681.3085	2233.4409	2816.1661	3381.9347	3950.1755	4641.0249	6031.9775	7789.9851	9674.7318	11927.5431	14225.5061	16633.5725	19015.6741	22209.7591
	30	1435.9749	1685.0509	2356.0012	3024.0313	3715.5135	4330.9379	5252.6308	6102.6715	8005.2324	10238.6838	12451.3022	15028.6739	17969.2928	21204.5886	24218.3913	28171.4508
	40	1765.9493	2200.7159	3038.2910	3908.0929	4636.7903	5448.2344	6567.2927	7652.1928	10103.6692	12720.8229	15484.6707	18475.7653	22006.3819	25564.9762	29454.0965	33868.2679
	50		2732.8884	3788.8443	4904.3636	5834.8683	6859.3660	8073.6471	9508.0008	12291.4568	15221.3485	18677.3264	22031.6026	26004.2849	29915.1236	34933.9268	39949.1839
	60		3356.6801	4650.8854	5955.7079	7119.2580	8324.2555	9923.0601	11783.0201	14765.8340	17961.1511	22159.6626	25905.4555	30808.5702	35594.8608	40900.7164	46865.8623
	70		4076.2418	5647.6881	7164.7196	8691.7058	10017.7681	11839.8914	13701.8941	17102.4983	20966.0096	25888.7375	30214.5307	35661.6969	40961.5870	46895.9676	54212.1659
	80		4950.6103	6696.4313	8318.8992	9963.3319	11553.3155	13544.8320	15768.4217	19950.2850	24194.5392	29738.1547	34852.9168	40592.1065	47134.9676	53129.5412	61350.7226
	90		6055.3225	8178.5450	9726.6735	11613.8003	13421.0600	15628.1395	17999.2227	22752.6557	27765.0575	33445.0316	39567.0015	45347.6676	52237.1811	59999.6929	69741.3746
	100		7158.8439	9783.8279	11413.7755	13391.5892	15594.9608	17828.1879	20465.5438	25755.7728	31854.1352	38193.1518	44507.4146	50816.2152	58757.0752	66854.4835	75444.9576
	110		8728.7636	11578.3127	13584.9701	15268.1271	17649.3380	20237.8662	22881.2590	28741.1549	35658.8184	43504.0099	49889.0993	55956.0255	64562.9613	73028.0853	83554.7252
	120			13142.9502	15073.1416	17134.8303	20113.1477	22708.9324	25545.6461	31853.9828	40083.4235	49118.4328	55450.7535	62562.6908	72165.8112	80454.5979	93604.7264
	130			14420.6882	17369.9854	19985.9023	22376.4385	25525.6160	29094.5706	36246.1854	44591.4868	53789.2191	60992.8146	70731.1178	79357.0620	93185.0146	
	140			16221.6949	19697.4577	22822.7154	25499.0287	29120.8591	33434.0394	41116.6727	50049.5178	59301.8647	67829.1366	78898.4332	89331.3969	104152.6899	
	150				21606.4850	25259.3870	28229.8627	32450.6587	37254.2236	46081.7613	55675.8346	66325.6552	73948.4590	87420.8954	103706.2583		
	160				23866.0697	27519.8477	31020.1394	35757.6829	41088.8736	51889.6781	61402.2035	73346.4640	81154.3343	98702.8884			
	170				25537.7528	30136.7410	33844.4963	39465.9503	45480.0169	57225.4210	64421.0464	80023.1373	89463.7718				
	180					32127.3587	36923.3302	42914.6362	49644.6324	60878.2476	70883.6670	87887.7422					
	190						40382.2927	46400.7192	54187.8120	65527.9059	77261.4879						
	200						43444.4639	50781.2536	58834.6093	70528.2769	86078.9920						
	201		8876.6934	16325.8707	25587.7487	33566.1125	43454.7001	50745.4781	59278.2931	70708.6705	77629.6903	93212.0698	94786.6742	107807.0764	112166.3118	112135.3978	98558.6050

Appendix 3

