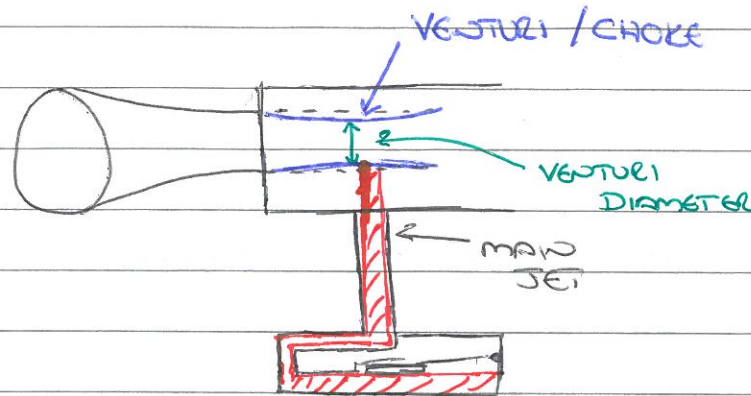


COMPETITION ENGINE PERFORMANCE

18/11/15

CARBURETOR

THE AIR TRAVELS THROUGH THE NARROWER VENTURI OR 'CHOKE'.

THE VENTURI INCREASES THE AIR SPEED WHICH IN TURN DROPS THE AIR PRESSURE. FROM BERNOULLI, FASTER AIR, LOWER THE PRESSURE.

THE LOWER AIR PRESSURE SUCKS THE FUEL FROM THE FLOAT CHAMBER. THE AMOUNT OF FUEL IS CONTROLLED BY THE DIAMETER OF THE MAIN JET FOR ANY GIVEN AIR SPEED.

THE HIGHER THE RPM THE HIGHER THE AIRSPEED, THUS THE LOWER THE AIR PRESSURE AND THE MORE FUEL CAN BE SUCKED IN.

TO CALCULATE VENTURI SIZE NEEDED -

TAKE A FORD 1600 X FLOW ENGINE.

40mm VALVE DIA

2 VALVES / CYL.

HEAD WAS A BEST FLOW COEFFICIENT AT
FULL LIFT ≈ 0.5 (STANDARD)

FROM AN AIR FLOW POINT OF VIEW THE EFFECTIVE WORKING AREA

$$= 0.5 \times \frac{\pi D^2}{4}$$

$$= 0.5 \times \frac{\pi \times 40^2}{4} \text{ mm}^2$$

$\therefore$ BEST EFFECTIVE WORKING AREA AT FULL LIFT
 $= 628 \text{ mm}^2$

THE AIM IS TO GET THE EFFECTIVE VENTURI AREA SLIGHTLY BIGGER THAN THE HEAD BEST EFFECTIVE WORKING AREA AT FULL VALVE LIFT.

C_d FOR VENTURI ≈ 0.85

$$\text{EFFECTIVE WORKING AREA OF VENTURI} = 0.85 \times \frac{\pi D^2}{4} \text{ mm}^2$$

STANDARD CROSS FLOW HAS 30mm VENTURI

$$\therefore \text{EFFECTIVE WORKING AREA} = 0.85 \times \frac{\pi \times 30^2}{4}$$
$$= 600.8 \text{ mm}^2$$

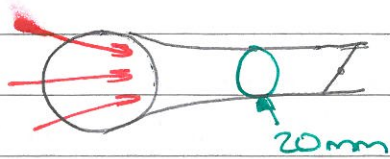
SO THIS WOULD BE A ^{SMALL} RESTRICTION FOR THE HEAD.

RACE CROSS FLOW HAS 34mm VENTURI

$$\therefore \text{EFFECTIVE WORKING AREA} = 0.85 \times \frac{\pi \times 34^2}{4}$$
$$= 771.7 \text{ mm}^2$$

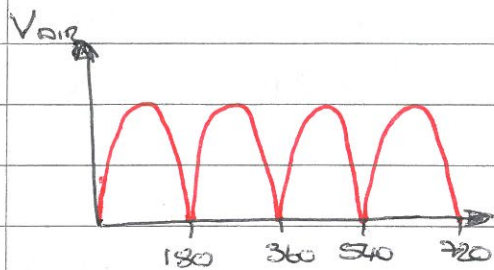
SO FROM A FLOW POINT OF VIEW IT IS NO RESTRICTION COMPARED TO THE HEAD.

RESTRICTORS - FORMULA STUDENT CBL600R (115BP)
LIMITED TO ≈ 80 MPS WITH A 20mm RESTRICTOR.



FIRING ORDER OF 1342

$\therefore$ 180° FIRING INTERVAL.



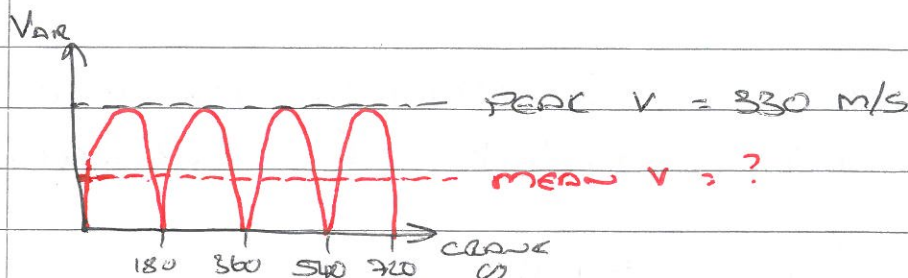
EACH CYLINDER DRAWS IN AIR
OVER 180° CRANK ROTATION
(INLET DURATION OF CAM). IMAGINE
IT IS OVER 180° (EFFECTIVE
DRAW DUE TO LAG ETC)

ASSUME THAT AIR VELOCITY IS AT A PEAK
JUST AFTER PEAK PISTON VELOCITY, THEREFORE
AIR VELOCITY FLUCTUATES.

THE HIGHEST AIR SPEED THROUGH A RESTRICTOR IS
 ≈ 330 m/s @ 20°C (SPEED OF SOUND).

AS PNEUM IS RELATIVELY SMALL FOR GOOD THROTTLE
RESPONSE THE AIR THROUGH THE RESTRICTOR IS
PULSING LIKE THE PORT.

CHOKING VELOCITY IS WHEN PEAK V IS 330 m/s.



MEAN OF A SINE WAVE $= \frac{2}{\pi} = 0.6$

IF PEAK V IS 330 m/s THEN MEAN V $= \frac{2}{\pi} \times 330$
 $= 210$ m/s

BECAUSE AIR IS PULSING THROUGH THE RESTRICTOR, THE MEAN VELOCITY AT CHOKING IS 210 m/s.

BECAUSE OF BOUNDARY EFFECTS, EFFECTIVE AREA OF RESTRICTOR $= 0.85 \times \frac{\pi}{4} \times 20^2 \text{ mm}^2 = 267 \text{ mm}^2$

WITH A MEAN VELOCITY OF 210 m/s, VOLUME OF AIR $= (0.85 \times \frac{\pi}{4} \times 0.02^2) \times 210 = 0.056 \text{ m}^3/\text{s}$

MAX POTENTIAL POWER -

$$\text{MASS OF AIR/SEC} = \underset{\substack{\uparrow \\ \text{m}^3/\text{s}}}{0.056} \times \underset{\substack{\downarrow \\ \rho = 1.2 \text{ kg/m}^3}}{1.2} = 0.067 \text{ kg/s}$$

$$\text{AT STOICHIOMETRIC, MASS OF FUEL/SEC} = \frac{0.067}{14.7} = 0.0046 \text{ kg/s}$$

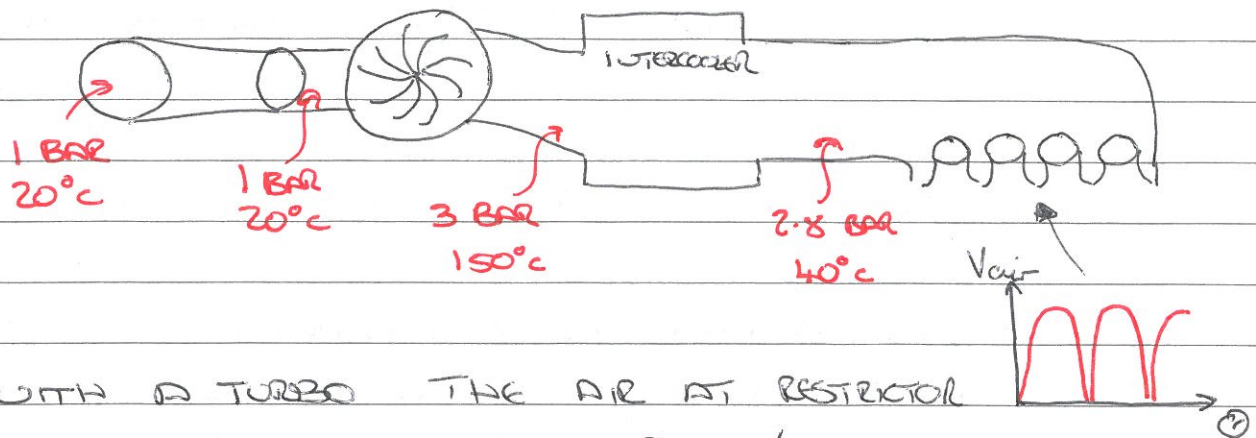
$$\text{CALORIFIC VALUE} \approx 44 \times 10^6 \text{ J/kg}$$

$$\begin{aligned} \therefore \text{MAX POTENTIAL POWER} &= 0.0046 \times (44 \times 10^6) \\ &= 201420 \text{ J/s} = \text{W} \\ &= 201.4 \text{ kW} \end{aligned}$$

ASSUME ENGINE IS 30% EFFICIENT AT MAX POWER
 $\therefore 0.3 \times 201.4 = 60.4 \text{ kW @ FLYWHEEL}$

$$\therefore \text{BHP} = \frac{60.4}{0.746} = 81 \text{ HP}$$

TURBO WEC WITH 33mm RESTRICTOR



WITH A TURBO THE AIR AT RESTRICTOR IS MOVING AT UP TO 330 m/s WITH NO PULSE.

i.e. MEAN VELOCITY ≈ 330 m/s FROM 2000 - 6000 RPM

MAX POTENTIAL POWER -

MEAN $V = 330$ m/s, EFFECTIVE RESTRICTOR AREA = $0.85 \times \frac{\pi}{4} \times 0.033^2$

$$VOL/SEC = 0.85 \times \frac{\pi}{4} \times 0.033^2 \times 330$$

$$= 0.24 \text{ m}^3/\text{s}$$

$$MASS \text{ OF AIR} = 0.24 \times 1.2 = 0.288 \text{ kg/s}$$

$$MASS \text{ OF FUEL} = \frac{0.288}{14.7} = 0.0196 \text{ kg/s FUEL}$$

$$MAX \text{ POTENTIAL POWER} = 0.0196 \times (44 \times 10^6) = 862 \times 10^3 \text{ W}$$

$$= 862 \text{ kW}$$

@ 100% EFFICIENCY

$$\therefore \text{AT } 25\% \text{ EFFICIENCY} = \frac{862}{4} = 215 \text{ kW}$$

$$= \frac{215}{0.746} = 308 \text{ HP}$$

$$\text{AT 30\% EFFICIENCY} = 862 \times 0.3$$

$$= 258.6 \text{ kW}$$

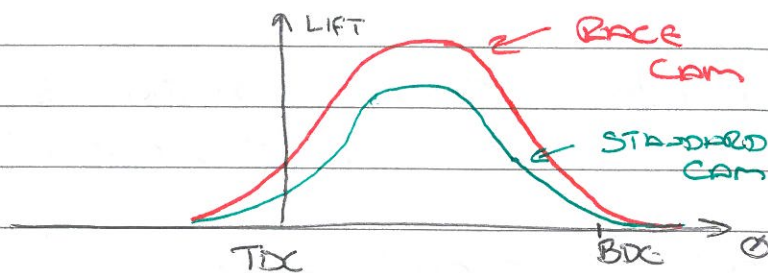
$$\text{HP} = \frac{258.6}{0.746} = 347 \text{ HP MAX POTENTIAL DUE TO RESTRICTOR.}$$

* SHOW HOW TO DO POLYNOMIAL IN EXCEL.

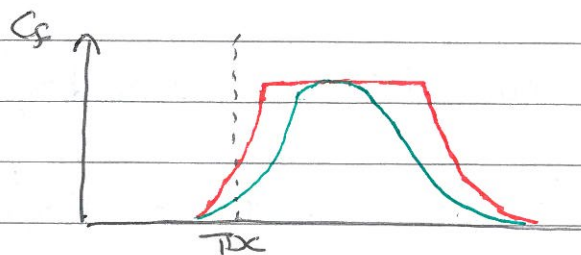
TO FULLY ASSESS ANY MODIFICATION MADE TO INTAKE IT IS NECESSARY TO PLOT FLOW COEFFICIENT AGAINST CRANK ANGLE.

FROM BEFORE YOU HAVE FLOW COEFFICIENT FOR EACH VALVE LIFT, BUT WE NEED TO SEE THE MEAN FLOW COEFFICIENT ACROSS THE CYCLE OF THE ENGINE.

LIKELY TO SEE -



GIVES THE EFFECT -



PEAK FLOW DOES NOT IMPROVE BUT THE DURATION OF THE PEAK DOES.