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## BEng Motorsport Engineering

|                           |                                       |
|---------------------------|---------------------------------------|
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## **Introduction**

The assignment is all about sustainability and understanding how the automotive, motorsport or motorcycle industry effect the environment and how the industries are changing to improve the environment. In the assignment there are four different tasks, the first is about current times and how the environment is impacted by the industries in current times this includes pollution and source depletion. The next task speaks about legislation that have been implemented to bring change but also include other types of fuels that could and are being used in the industry, for the third task it involves how there are issues and technology restraints which can hold back the industries from progressing this could be such as issues with the grid to cost problems. The final task is about future goals and targets for the development of the industry to help improve the impact on the environment this involves future technologies and advances that could be brought in and implemented.

## **Task 1: Environmental Impact**

Fuel is an important part of motorsport and the automotive industry and this brings reasons into how different fuels are used but also impact the environment. Due to standard fuel like petroleum and diesel being produced from fossils, this means petroleum and diesel are fossil fuels and are finite and will eventually run out. This causes impact to the environment as when these fuels are used, they produce harmful gases but also by their production they harm the environment as it is extracted from the ground. This usually involves drilling deep into the surface of the earth and extruding the crude oil. Crude oil is refined to create petroleum as well as other substances, but this can cause issues such as if an accident happens during the drilling process the crude oil could end up spilling. This can be seen in modern day examples such as when in 2012 crude oil spilled into the ocean which caused harm to the animals but also the environment. With fossil fuels being finite and stated previously that they could run out, with the rate that they are being consumed all fossil fuels could be depleted by 2060 and oil could be gone by 2052 (Howarth, 2019),

To improve emissions and reduce air pollution cars have catalytic converters added to their exhaust system, cars produce harmful gases some of these gases are carbon monoxide, nitrogen oxide as well as soot. The catalytic converter with the harmful gases goes through an oxidation process which also reduces the chemical reaction from the gasses coming out of the engine after combustion. During combustion, an engine will never be able to have complete combustion due to an engine not being a hundred percent efficient so harmful gasses and other products will always be produced. A catalytic converter can also be known as an after-treatment technique but there are also in-cylinder techniques, the in-cylinder technique involves optimising the air-to-fuel ratio, optimising the ignition for combustion but also precise fuel metering (Ashok, 2022). To help improve and reduce emissions and carbon dioxide task 2 will show alternative fuels and ways to change.

## Task 2: Sustainable Practices and Legislations

To help with the automotive and motorsport industry legislations and different solutions have been implemented to help increase the sustainability of fuels, one legislation brought into the United Kingdom was that no new petrol and diesel cars can be sold after 2035 this was brought in to reduce the number of combustion engine vehicles and increase the number of electric cars on the road to help reduce pollution. In the UK euro rating is used to classify vehicles into different classes in Figure 1 and Figure 2 shows two different standards one being euro 5 and the other being euro 6. Euro 5 was introduced in 2009 till 2015 when euro 6 was introduced, the new standard was introduced to reduce emissions this was set for petrol and diesel vehicles. The chart shows the maximum amount of gas and particles the vehicle can emit from its exhaust. When comparing the two standards the main change was for diesel vehicles with the amount of nitrogen oxide output being decreased by 0.10 g/km and the hydrocarbon plus nitrogen oxide decreasing by 0.06 g/km.

| Euro 5 Emissions Limits (Petrol) |                              |                                    | Euro 5 Emissions Limits (Diesel) |                              |                                          |
|----------------------------------|------------------------------|------------------------------------|----------------------------------|------------------------------|------------------------------------------|
| V5 Reference - Exhaust Emissions |                              | Maximum by Emissions Type          | V5 Reference - Exhaust Emissions |                              | Maximum by Emissions Type                |
| V.1                              | CO (g/km or g/kWh)           | 1.0 g/km                           | V.1                              | CO (g/km or g/kWh)           | 0.50 g/km                                |
| V.2                              | HC (g/km or g/kWh)           | 0.10 g/km                          | V.2                              | HC (g/km or g/kWh)           |                                          |
| V.3                              | NOx (g/km or g/kWh)          | 0.06 g/km                          | V.3                              | NOx (g/km or g/kWh)          | 0.18 g/km                                |
| V.4                              | HC+NOx (g/km)                |                                    | V.4                              | HC+NOx (g/km)                | 0.23 g/km                                |
| V.5                              | Particulates (g/km or g/kWh) | 0.005 g/km (Direct Injection Only) | V.5                              | Particulates (g/km or g/kWh) | 0.005 g/km and $6.0 \times 10^{-11}$ /km |

Figure 1: Euro 5 (Shropshire Council, 2023)

| Euro 6 Emissions Limits (Petrol) |                              |                                                                                          | Euro 6 Emissions Limits (Diesel) |                              |                                                                                          |
|----------------------------------|------------------------------|------------------------------------------------------------------------------------------|----------------------------------|------------------------------|------------------------------------------------------------------------------------------|
| V5 Reference - Exhaust Emissions |                              | Maximum by Emissions Type                                                                | V5 Reference - Exhaust Emissions |                              | Maximum by Emissions Type                                                                |
| V.1                              | CO (g/km or g/kWh)           | 1.0 g/km                                                                                 | V.1                              | CO (g/km or g/kWh)           | 0.50 g/km                                                                                |
| V.2                              | HC (g/km or g/kWh)           | 0.10 g/km                                                                                | V.2                              | HC (g/km or g/kWh)           |                                                                                          |
| V.3                              | NOx (g/km or g/kWh)          | 0.06 g/km                                                                                | V.3                              | NOx (g/km or g/kWh)          | 0.08 g/km                                                                                |
| V.4                              | HC+NOx (g/km)                |                                                                                          | V.4                              | HC+NOx (g/km)                | 0.17 g/km                                                                                |
| V.5                              | Particulates (g/km or g/kWh) | 0.005 g/km (Direct Injection Only) and $6.0 \times 10^{-11}$ /km (Direct Injection Only) | V.5                              | Particulates (g/km or g/kWh) | 0.005 g/km (Direct Injection Only) and $6.0 \times 10^{-11}$ /km (Direct Injection Only) |

Figure 2: Euro 6 (Shropshire Council, 2023)

There are many different types of alternative fuel sources that could be used to in order to improve pollution and sources that could be sustainable, some types of sources include hydrogen, biodiesel and there is also the option of alcohols (Methanol, Ethanol and Butanol).

## **2.2: Hydrogen**

As brands are trying to go carbon neutral hydrogen has been a good source that has been looked into and has been around for a reasonable amount of time with the regulation of no new diesel and petrol cars being sold after 2035, it could be as early as 2025 that long range and large hydrogen powered vehicle could become competitive (Hydrogen Council, 2024) and smaller vehicles by 2030. For hydrogen to become competitive though it means that the network around it also has to, with the production of hydrogen being 90 million tonnes that number is expected to increase to over 200 million tonnes by 2030 and this is due to countries wanting to be net zero by 2050 and 15 different countries launching major goals for hydrogen.

## **2.3: Biodiesel**

Biodiesel is an alternative to normal diesel this change in the fuel doesn't involve any changes to a standard internal combustion engine but there are many processes to making the biodiesel. One method is dilution this process involves vegetable oil being mixed with diesel to reduce the viscosity of the vegetable so it mimics regular diesel better but this process is only used on vegetable oil as stated by (Avinash K Agarwal,Hardikk Valera, 2022). Another method of making biodiesel is called microemulsion this is a method that is used for two substances which are incapable of being mixed so in this method crude oil would be mixed with methanol, butanol or ethanol to reduce its viscosity. The downside of doing this is that when used in an engine it creates a lot of carbon buildup in the injector as well as the combustion chamber, when the fuel is also at a lower temperature it becomes less stable and causes the two fuels mixed to separate. As seen in Figure1 it shows how biodiesels are standardised this is done after the production has been completed as there could be other substances like alkaline and catalysts that could all cause different harm to the engine components such as abrasion if there is alkaline left in the diesel or solid ash particles if there is catalyst left. To make sure there is nothing left the fuels must go through a number of steps these are starting with titration, transesterification, separation, washing, drying and the final step is filtration to have usable biodiesel.

| Parameter                                         | Austria   | Czech (CSN) | France (JO) | Germany (DIN) | Italy (UNI) | USA (ASTM) |
|---------------------------------------------------|-----------|-------------|-------------|---------------|-------------|------------|
| Density at 15 °C (g/cm <sup>3</sup> )             | 0.85–0.89 | 0.87–0.89   | 0.87–0.89   | 0.87–0.89     | 0.86–0.90   | –          |
| Kinematic viscosity at 40 °C (mm <sup>2</sup> /s) | –         | –           | –           | –             | –           | 1.9–6      |
| Ignition point (°C)                               | 100       | 110         | 100         | 110           | 100         | 130        |
| Cold filter plugging point (°C)                   | 0/–5      | –5          | –           | 0/–10/–20     | –           | –          |
| Pour point (°C)                                   | –         | –           | –10         | –             | 0/–5        | –          |
| Cetane number                                     | ≥49       | ≥48         | ≥49         | ≥49           | –           | ≥47        |
| Neutralization number (mgKOH/g)                   | ≤0.8      | ≤0.5        | ≤0.5        | ≤0.5          | ≤0.5        | ≤0.8       |
| Carbon residue (%)                                | 0.05      | 0.05        | –           | 0.05          | –           | 0.05       |
| Ester content in massive (%)                      | –         | –           | ≥96.5       | –             | ≤0.98       | –          |
| Total glycerol mass (%)                           | ≤0.24     | ≤0.24       | 0.25        | ≤0.25         | –           | ≤0.24      |
| Iodine number in massive (%)                      | ≤120      | –           | ≤115        | ≤115          | –           | –          |

Figure 3: Biodiesel Standards (Avinash K Agarwal,Hardikk Valera, 2022)

## 2.4: Alcohols

Alcohols are largely produced already, and these are from waste products or agricultural products (Avinash K Agarwal,Hardikk Valera, 2022), the alcohols are already widely used in internal combustion engines in Brazil alcohols are also obtained from vegetable waste artificially this creates ethanol the other process is chemically from coal which produces methanol. The alcohols are mixed in with petroleum, usually this is because after 10 to 15 percent of alcohol to petroleum would lead to the engine needing changes. But up to the 10 to 15 percent range it gives increased benefits. This is due to the alcohol having a higher octane rating it means it is more resistant to knock another benefit to it is that the alcohol has higher latent heat of evaporation compared to petroleum which means there is a higher volumetric efficiency (Avinash K Agarwal,Hardikk Valera, 2022).

## 2.5: Hybrids

A hybrid vehicle will have two different power sources the conventional sources are having a petrol power source and coupling it with an electric power source this is done to improve the efficiency compared to a standard combustion engine-powered car, this is done by having the ability of the electric power source running alongside but also it being able to run purely on electric power in an urban environment meaning the combustion engine won't use any fuel. With the electric powertrain the battery could be charged through the combustion engine but it also has the function to also charge the battery from the braking system this means that overall the car is being more efficient (Mehrdad Ehsani, Yimin Gao, Sebastien E. Gay, Ali Emadi, 2004).

### **Task 3: Sustainability and Technological Challenges**

With the increase of electric vehicles and biofuels they all have their issues and barriers, one issue with electric vehicles is that the range they can do on one charge can't cover enough distance let alone not having enough charging station to charge them at the same time or quick enough. With electric vehicles their issues are also that the grid won't be able to produce enough electricity which then could cause power outages. With electric cars there is also the issue of digging up the ground to get lithium to produce the batteries which leads to huge damage to the environment and the animals in the area.

Issues with biofuel can be how the space used to grow the plants that are turned into the fuel could be used to grow other products such as food instead, with biofuels or biodiesel at the moment is that in the production stage of the fuel, the raw material is expensive with the raw material price accounting to over 70 percent of the cost. With new and sustainable sources, it is usually the cost that causes a lot of the issues this can be especially seen with electric vehicles, as stated before it also isn't the infrastructure with the charging station but with the cost of having a charger installed in a living environment. With cost being a reoccurring theme with electric cars the cost of new can be more expensive compared to its fossil fuel counterpart. One example that could be used is comparing a petrol BMW 5 series to a full electric BMW 5 series, with the full electric one costing over 16,000 pounds more than its petrol version (BMW, 2024), this isn't the only comparison another comparison could be looking at the Toyota Proace City van with the price for the electric version being just under 31,000 pounds with the diesel version being just under 23,000 pounds which shows a difference of 7000 pounds (Toyota, 2024). This difference wasn't so bad in the beginning when electric cars first came out as the government here in the UK gave out grants. So for buying a electric car they would give back up to 35 percent of the value of the car back to the consumer as stated by (Evans Halshaw, 2023) which closed the gap between the price difference but this was stopped back in 2022 (Evans Halshaw, 2023).

## **Task 4: Future Outlook**

In the future I think the industry will go to biofuels or hydrogen powered vehicles not only because the industry is leaning to hydrogen now, but it also seems like a good and efficient type of fuel with reduced emissions and less pollution caused by it. With hydrogen becoming more main stream and searched into more manufactures are investing into searching into them, one company that had looked into it in the past was BMW on there 7 Series back in the early 2000s. This was a dual mode drive technology which means it could run on conventional petrol with the combustion engine but it could be switched to running on hydrogen. When running on the hydrogen the characteristics of the car didn't change meaning there was no performance down side let alone comfortable changes. The car had two separate tanks one to store petrol and the other to hold the hydrogen, the tank for the hydrogen was made using stainless steel plates two-millimetre-thick and featuring a 30-millimetre-thick vacuum super-insulation layer between the inner and outer tank (BMW, 2006). With this it meant the tank was safe and strong to be able to use for daily use, now they have started looking at producing and have already started testing there new concept for the X5 this concept involves using a hydrogen fuel cell that would turn hydrogen into electrical power to power electrical motors through its fuel cells instead of powering the motors from a battery cell. This concept would only create water vapour from its reaction and would make the car completely locally emission-free which means it would decrease the air pollution in cities (BMW, 2024).

## **Conclusion**

Overall, the assignment shows how the environment has been impacted by one of the three industries over the years and how there has been a change to improve the environment by using different fuels and power sources to try become net zero to reduce the air pollution as well as our carbon footprint. With all this in mind future development and ideas have also been spoken about which could help bring change.

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