

DATE & TIME: 13/05/2022 at 12:00

MODULE: AUTOMOTIVE MATERIALS AND SUSTAINABILITY (ACHA6012)

STUDENT NAME: SAMUEL JAMES DIGBY

STUDENT NUMBER: 1901067

QUESTION: 1a Section A

LPG and ethanol fuel can be used to reduce the CO<sub>2</sub> emissions of engines. LPG produces less carbon when compared to petrol (approximately by 33%). Ethanol can be used as an additive to petrol to make blends such as E10 or separately. When used as a blend like E85, the reduction in carbon emissions are approximately around 70%.

Both fuels reduce the carbon produced by the engine.

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### QUESTION 1b Section A

In terms of end user impact, LPG costs less as a fuel to buy when compared to iso octane. However, for LPG to work a major overhaul of the fuel injection system is needed as the LPG requires a converter and mixer system that converts the liquid fuel into vapour and the mixer mixes this vapour into the intake air. LPG systems also need an additional tank typically located in the boot if retro fitted. LPG systems also require separate fuel gauges and can cause additional wear to ignition and valve components.

Ethanol can be used on most vehicles constructed from around 2010 onwards without changes to the fuel system, such as different piping. However, the end user will experience a reduction in miles per gallon when using stronger ethanol blends due to ethanol having a lower calorific value than petrol.

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QUESTION: 1C Section A

In order to make LPG more viable, an increase in pumps would be required across the country. This would make LPG more viable to consumers. In terms of the vehicle however, a improved system that does not take up boot space and that is integrated better to the drivers control display would be necessary in order to make the system less complex to the every day user.

Ethanol would need to be sourced from waste product of corn or cane in order to make it environmentally better than petrol. This and making higher blends of the fuel such as E85 and E100 more readily available at the pump would potentially increase the usage of these fuels. However, adapting existing vehicles that can measure the ethanol content of fuel and so it can adjust the fuel air ratio would be needed to ward off the negative aspects of ethanol such as the reduced mileage.

Over all the general adaptation of these fuels would have to be improved upon in order to make them viable in terms of

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QUESTION. 1 C Section A

Sourcing the fuel in an environmentally way and providing the fuel in a manner that does not cause a major problem for customer who may want to use these fuels.

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QUESTION ~~Questi~~ 2 a

The valency of an atom is defined by the amount of ~~the~~ hydrogen atoms can bond with itself. The valency varies with which group of the atom is in.

Ionic bonding is when atoms transfer electrons from their outer shell to another atom.

Covalent bonding is when the atoms share electrons on the outer shell in order to have a full outer shell. Note that unlike ionic bonding, electrons in covalent bonds do not permanently transfer.

Metallic bonding occurs in metals and this type of bonding has delocalised electrons that are located around positive ions. The bond itself is the force of attraction between these ions and electrons.

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QUESTION: 2b

$$R = ?$$

$$a = 0.362 \text{ nm}$$

$$a = 2\sqrt{2 \times R}$$

$$a^2 = 2 \times (2 \times R)$$

$$\frac{a^2}{2 \times 2} = R \quad \frac{(0.362^2) \times 2}{2} = 0.131044$$
$$= \underline{0.131 \text{ nm}}$$

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QUESTION 2C

A point defect is defined by the absence or the addition of an atom that causes a non parallel structure to be formed and destroys the crystalline structure.

A line defect is when the atoms are not aligned with the rest of the lattice structure causing a layer to slip. These slips break the existing bonds and create new bonds when the slip is completed. The effect of this is that the crystalline structure has been deformed which is permanent. This deformation is known as plastic deformation.

An area defect is when a grain boundary is formed between the crystals. This grain boundary causes the bonding structure to change which also leads to the orientation of the crystals to be altered. These grain boundaries cause the crystalline structure to change at these areas.

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QUESTION 2d

The controlling factor during the second stage of creep is dislocation movement. This is when atoms move and triple points are formed within the grain boundary. These triple points are the weakest point of the grain boundary and dislocation movements occur at these points.

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QUESTION 3a

Casting is when a liquid metal is poured into a mould. The metal is left to solidify and the desired shape is made. This process is best put to use in high volume production due to its cost effectiveness. However, this process is limited to metal and not as accurate as other procedures due to inaccuracies in the moulds occurring over time.

Injection moulding is when a material is injected into a mould. The material is heated and pressurised before it is injected into the mold where it would cool. This method works with polymers and metals, though differences occur in heat application. A limitation of this is accuracies in the mould and cost of the mould has this process is used for more complex shapes.

Forging is used when heat is applied to a material and a shear pressure is then applied. This process is a costly process and only works with metals.

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### QUESTION 3b

The first stage that determines RPN is the likelihood of failure (D). This stage evaluates the likelihood of failure and designates a number with 1 being not likely to 10 being very high ~~occurrence~~ likely.

Stage 2 is the Severity number (S). This evaluates the potential damage a failure can do. Lower numbers are not severe and high numbers are very severe and the numbers range from 1-10.

Stage 3 evaluates the probability of occurrence of the failure. Again ranked between 1-10 with 10 being unavoidable. This number is designated P.

Once these numbers are collected the equation below is used to get the RPN.

$$D \times S \times P = RPN.$$

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QUESTION 3C i

$$D = 10\text{mm} = 0.01\text{m}$$

$$h = 1.0\text{mm} = 0.001\text{m}$$

$$r = 0.5\text{mm}$$

$$f = 55\text{N/m}$$

$$h/r = 2$$

$$C_1 = 0.455 + 3.354\sqrt{2} - 0.769 \times 2 = 3.66$$

$$C_2 = 0.891 - 12.721\sqrt{2} + 4.593 \times 2 = -7.913$$

$$C_3 = 0.286 + 15.481\sqrt{2} - 6.392 \times 2 = 9.395$$

$$C_4 = -0.632 - 6.115\sqrt{2} + 2.568 \times 2 = -4.144$$

$$K_t = C_1 + C_2 \left( \frac{2 \times 1}{10} \right) + C_3 \left( \frac{2 \times 1}{10} \right)^2 + C_4 \left( \frac{2 \times 1}{10} \right)^3$$

$$K_t = \underline{\underline{2.42}}$$

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QUESTION. 3d

$$a = 3.0 \text{ mm} = 0.003 \text{ m}$$

$$\sigma = 625 \times 10^6 \text{ Pa}$$

$$E = 200 \times 10^9 \text{ Pa}$$

$$K_c = \sqrt{G_c E} \quad K = \sigma \sqrt{\pi a} = 60.675 \times 10^6$$

$$K_c^2 = G_c E$$

$$\frac{K_c^2}{E} = G_c \quad G_c = \frac{60.675^2 \times 10^6}{200 \times 10^9} = \underline{\underline{18.413 \times 10^3 \text{ Pa}}}$$