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The use of the composite material, Carbon fibre, in
motorsport.

Academic Skills ACHA4005

Keira Phillips

2321194

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1 Introduction

This report will be utilised to explore the advantages and disadvantages of the use of carbon fibre in the motorsport industry, with the intent to research how this revolutionary material can still be improved.

1.1 Justification

Carbon fibre is a world known material renowned for its incredible durability and unbelievably light-weight qualities. As a result of this it is used in countless industries from aircraft, medical, robotics, other consumer products and in the automotive industry, from racing vehicles, now to some street vehicles. When carbon fibre was used by McLaren in 1981 it completely changed the industry and its future. Because of this, it is both valuable and important to recognise and understand the significance of this material but to also take into consideration all its qualities, positive and negative, and how this may have an affect on its use in the future.

1.2 Aims

Aim 1: To research the background of Carbon fibre including its first use in motorsport and how it is produced.

Aim 2: To investigate how carbon fibre is used in motorsport and its advantages in the industry.

Aim 3: To investigate the disadvantages of the use and production of carbon fibre and how this can potentially be battled in the future.

1.3 Objectives

Objective 1.1 – Research the origin of carbon fibre.

Objective 1.2 – Research when it was first used in the motorsport industry.

Objective 1.3 – Delve into what carbon fibre is.

Objective 2.1 – Research what it is used for in the motorsport industry.

Objective 2.2 – Research the advantages of carbon fibre.

Objective 2.3 – Analyse the effects these advantages have on racing vehicles.

Objective 3.1 – More in-depth analysis of what carbon fibre consists of and how it is produced.

Objective 3.2 – Research the advantages or disadvantages of the production of carbon fibre.

Objective 3.3 – Research how the production of carbon fibre could be improved in the future.

2 Background

Alborough, J (2022) explains that Carbon fibre was first invented back in 1860 by a man named Sir Joseph Wilson Swan who was the early developer of the first incandescent light bulb. He used carbon fibre in the bulb's filament because of its high heat resistance and conductive qualities, and the process in which he used to produce carbon fibre is still used by polymer chemists today. However, the carbon fibre in these bulbs was eventually replaced by tungsten and thus became obsolete until the 1950s when Union Carbide started experimenting with the material.

From here Carbon fibre only increased in popularity and through the years it was altered and moulded to become more useful until its first use in the motorsport industry by McLaren in 1981 in Formula 1. Today it replaces components such as body panels, suspension arms, subframes, wheels and more, as mentioned by the author on LORECENRAL (2019).

Furthermore, Gemma, H (2019) educates that Carbon fibre is a composite material meaning that it is made of two very different materials, one being a polymer matrix and the other, a reinforcing agent such as a fibre. She then explains that fibres are considered to be the strongest of all available structural materials because of their ability to carry load along their length, which provides strength and stiffness. LORECENRAL (2019) explains how these fibres are braided together to create strong and light threads that are intertwined with hundreds of others that are each smaller than a strand of human hair. However, these fibres are very weak when they are subjected to compression and bending loads. Because of this they are embedded in a polymer matrix such as a resin. Resins bind the fibres together and support them, which allows them to absorb higher compressive loads and share the stresses between the fibres, increasing the overall integrity of the structure. The common resins used to produce Carbon fibre include thermosetting resins and thermoplastic resins.

3 Discussion

The use of Carbon fibre allows the motorsport industry to pursue maximum efficiency. According to an anonymous author on motorsportengineer.net (n.d.) there is a multitude of benefits to using carbon fibre in the racing industry. Carbon fibre has an incredible strength-to-weight ratio that goes unmatched by the more common materials used in the industry such as Steel and Aluminium. This combination of properties is what makes carbon fibre so sought after as it allows the production of lightweight vehicles whilst preserving their structural stability. The strength of carbon fibre plays a vital role in ensuring the safety of the driver in such a challenging and dangerous environment. Furthermore, these qualities offer several other privileges, such as an improved power-to-weight ratio which improves the overall performance of these vehicles and allows for full-blown acceleration. As a result of these properties, fuel efficiency is also increased, which would allow for cars to cover longer distances on a single tank of fuel which is especially beneficial in race cars.

Carbon fibre helps race vehicles to obtain the best possible speed and acceleration, this is because it decreases the overall mass of the vehicle which allows for an increased power transmission efficiency and a higher maximum speed. The author also explains how due to the low weight of carbon fibre it lessens inertia which results in increased acceleration.

The handling and stability of vehicles is also improved as the rigidity of carbon fibre components significantly reduces flex and torsion, resulting in precise responsiveness on the track and the lightweight qualities allow for smoother manoeuvring.

Finally, carbon fibre is praised for its heat resistance and thermal control which is seen in its origin when it was first used in lightbulbs. Considering its significant use in the racing industry, it must be able to withstand the extreme temperatures that these vehicles produce, which thankfully, the composite's limited thermal conductivity allows it to do this. As a result of carbon fibre's ability to maintain a consistent temperature it reduces the risk of heat-induced performance degradation.

On the other hand, carbon fibre not only comes with a plethora of positives, but it also has a collection of negatives. The biggest disadvantage of using carbon fibre in motorsport and the automotive industry in general is in how it's produced. The carbon fibre commonly used in vehicle

production is produced using thermosetting resin. This is because thermosets have a high heat resistance and cannot be softened after their initial production, if they were to reach high enough temperatures they would disintegrate. This is due to the strong covalent cross-links between their polymer chains (shown in figure 1.1) that makes them very stable. However, this use of thermosetting resins is the main downfall of using and producing carbon fibre.

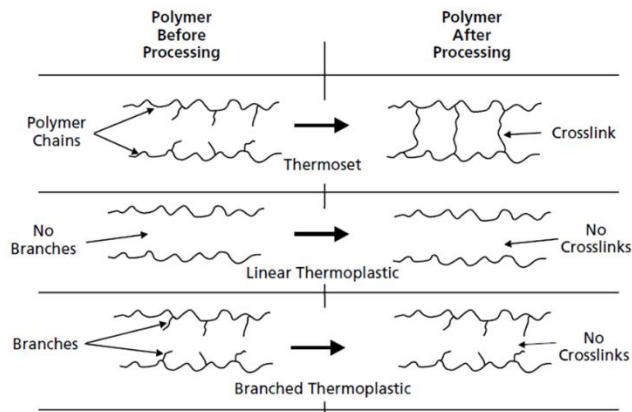


Figure 1.1 - Diagram of Thermoset polymers compared to Thermoplastic polymers (Morales Ibarra, Rodolfo. (2014)).

According to LORECENRAL (2019), thermosetting resin must under-go a complicated production process. This process involves the use of pressure and vacuum methods which, as reported by motorsportengineer.net (n.d.), involves extremely high temperatures at different stages of up to 3000°C which immediately draws attention to the negative effects this process must have on the environment. Expanding on this, carbon fibre made from this resin is hard to recycle. Moreover, due to this being such a long and complicated process this means that the rate of production does not match the current, growing, manufacturing demands, which is reflected in how expensive carbon fibre is.

Additive engineering, or rapid prototyping processes are currently being experimented with to attempt to battle the disadvantages of producing carbon fibre for the motorsport industry. Motorsportengineer.net (n.d.) explains that these processes consist of building complex shapes layer by layer by fusing powdered composites or filaments with thermoplastic resins. Firstly, thermoplastic resins are more environmentally friendly in how they are produced, and they are easier to recycle in comparison to carbon fibre made with thermosets. Secondly, these processes are much quicker than the process used with thermosets, this would allow the demands of carbon fibre to be met in the industry resulting in the decreased price of carbon fibre as it would be more obtainable.

Unfortunately, however, Carbon fibre made using thermoplastics is not currently an ideal choice for use in the racing industry. This is because thermoplastics are not as stable as thermosets as they do not have strong covalent cross-links between their polymer chains. As a result of this they cannot withstand intense heats, which they would be subject to in a racing vehicle, because they will melt. The author in LORECENRAL (2019) believes that, when the use of thermoplastics can be used it will be a breakthrough.

4 Conclusion

To conclude, carbon fibre is a revolutionary material in motorsport and is an unmatched material in the automotive industry. It has very few negatives in its attributes and in its use to create high performance vehicles, especially in the racing industry. However, there is still room for improvement in how carbon fibre is produced to adapt to a world that is aiming to be more environmentally friendly.

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