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Carbon Fibre In Motorsport

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1.Introduction

The purpose of this report is to investigate why carbon fibre is so widely used in motorsport. Specifically, looking into the introduction and the advancements made by analyzing the properties of carbon fibre. The research shows that carbon fibre is a very strong and lightweight material. However, it does have some limitations to its use due to its brittleness and high cost of production reducing the application of it in certain circumstances.

2.What is Carbon Fibre

Carbon fibre (CF) composite is a polymer material made of long chains of carbon atoms that are bonded together. These chains of fibres are joined together into tow – long thin strips – that are woven together into a fabric using one of three weave types: Satin, Twill, and Plain.

Satin weave stands out from the other weave types due to its draping quality. Therefore, manufacturers have an easier time forming these weaves over complex contours. However, the Satin weaves flexibility makes it less stable than the other types of CF weaves.

Twill weaves are the most common type of CF weave. They serve as an excellent balance between Satin and Plain weaves as it can form over complex contours like Satin weaves whilst keeping weave and fibre orientation like Plain weaves. However, it must be handled very delicately when forming as distortions to the weave can be created, making weak points in the form.

Plain weaves are made in an under – over pattern. The spaces between the interlaces reinforce the stability levels in the CF fabrics. Additionally, these weaves will maintain their weave and fibre orientation under various circumstances. However, Plain weaves only work best when used as flat sheets or tubes.

3.The properties of Carbon Fibre

3.1.Positive properties

There are many applications for composite materials motorsport with the most commonly used being carbon fibre. Due to its incredible strength to weight ratio, 2457 kN.m/kg, CF can absorb high loads. Carbon fibre was first introduced into motorsport in 1981. In 1974 Roger Sloman, who was working for McLaren F1 at the time, first suggested using carbon fibre to make an F1 car chassis. After seven years the McLaren MP4/1C was produced with a carbon fibre molded monocoque. Since then, advances in the understanding of how carbon fibre behaves under different circumstances have brought the number of parts in a Formula One car made with carbon fibre up to 85% but only accounts for 20% of its overall weight. It is used in all aspects of the cars from engine intake systems to the floor and bodywork to suspension components.

Carbon fibre is corrosion resistant and chemically stable meaning that it can be exposed to all weather conditions and chemicals. This is good as racing takes place in wet conditions as well as chemicals spilled flicked up from tires while racing will not affect the strength of the parts made with carbon fibre. However, epoxy which is used to set the carbon fibre is sensitive to sunlight. Therefore, a UV resistant finish must be used on exposed parts.

Carbon fibre is classified as non-combustible and has no listed flash point. If it is exposed to high heat in the presence of a fuel burning, it can oxidize but as soon as the flame and fuel is removed it will not continue burning. Thus, making it a good for protection drivers of cars in formula series as they have a carbon fibre monocoque.

3.2.Negative properties

Carbon fibre is very brittle. The fibres are joined together in layers with strong covalent bonds, however, these layers are susceptible to cracks. When the fibres are bent, they fail at exceptionally low strains. In other words, carbon fibres cannot be bent very much at all. Therefore, it must be reinforced with other materials to make parts stiffer to stop them from catastrophic failure. This can be done by doubling the

thickness of laminate or creating a sandwich structure with two plies of carbon fibre sheet, one on each side of a lightweight core material which avoids doubling the weight of the materials used. The common core material for this is Nomex or Kevlar honeycomb structures.

Carbon fibre is electrically conductive, this can be helpful or a problem. Hybrid engines first came into motorsport in 1998 with the Panoz Q9 Hybrid racing the 24 hours of Le Mans and since the multiple racing series such as formula 1, super GT and World Endurance Championship all use Hybrid powertrains and all electric races have started in the last 15 years. With this the electrical conductivity of carbon fibre needs to be taken into consideration. It restricts its use for certain parts such as battery boxes and requires carbon fibre parts to be insulated in areas where there is a risk of electricity coming in contact with them.

It is awfully expensive to make carbon fibre parts. Over the past 10 years as carbon fibre has become more readily available, the cost of production has come down. In 2010 it cost between £8.36 - £12.45 per 454g and in 2020 has come down to £5.85 - £7.52 per 454g to make a carbon fibre mold. This restricts the accessibility to lower budget and amateur racing classes. Even with the exceptional benefits that carbon fibre has and the reduction in cost, the cost is not always justifiable so alternatives such as fibre glass are used costing £167 -£2.51 per 454g.

3.3.How it can be used based on its properties

Carbon fibre is also used in applications other than the car in safety products such as driver crash helmets. Crash helmets protect the drivers head from impact that could lead to life changing damage. The job of a crash helmet is to absorb and dissipate the energy exerted during impact to stop it passing through to the driver's brain. The foam used on the inside of the helmet absorbs the shock as it compresses, however if the force is exerted on only place, a large amount of the force will continue through to the driver. Therefore, an outer shell is needed to spread the force around the helmet. Carbon fibre is perfect for this as it is very strong and resistant to flexing, resulting in most of the energy being spread over a larger surface area this allows the foam core to absorb more of this energy, reducing the amount transferred to the brain in turn reducing the likelihood of brain injury.

4.Conclusion

This report shows that carbon fibre can be used in many applications in the motorsport industry from the race cars to protective equipment. The advancements in the understanding of the characteristics and its behavior in certain conditions has allowed it to be the most highly used material in the largest motorsport racing series across the world. However, its use is limited to this small segment of motorsport due to its high cost of production, leaving low budget racers to resort to alternatives who are therefore unable to benefit from the weight savings that this high strength material has.

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