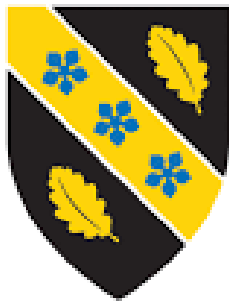


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The use of different tyre compounds in Formula One

Academic Skills (ACHA4005)

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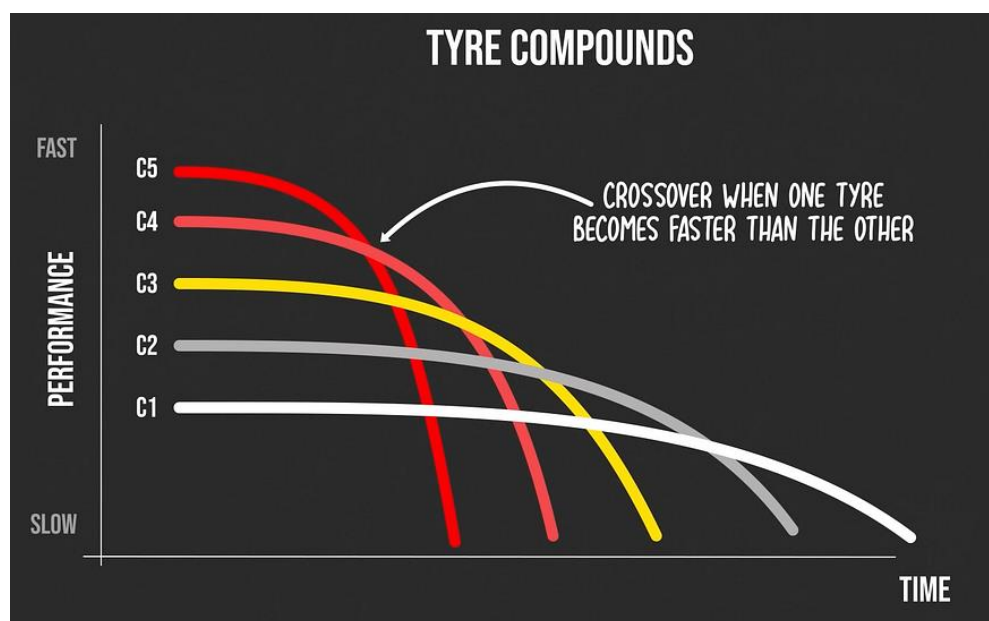
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Introduction

Many motorsports series have adapted the use of multiple tyre compounds in order to create an element of strategy and entertainment in the races. Formula One has taken this further than the likes of NASCAR and IndyCar, which use two compounds, and extended their range to five dry compounds and two wet compounds. Motorsports have always had a variation of tyres available since the start, although these have developed and changed over the years. There are different advantages to each tyre relative to the circumstances in which they are used, and this investigation will explore into which conditions qualify for the use of certain compounds.

Background

There are seven tyre compounds in Formula One, five dry compounds and 2 wet compounds. The five compounds are also known as C1-C5. C5 tyres are the softest of the compounds, meaning they have better grip, which results in faster lap times, but wear out quicker. In a Formula One race weekend, each team are given three of these tyre compounds to use throughout practice, qualifying, and the race, along with intermediate and full wet tyres. The tyres are known as softs, mediums, and hards for the sake of simplicity. In Monaco, the C5 tyres are the soft tyres, the C4 medium, and the C3 hard. Whereas in Spain, the C3 tyres are the soft tyres, C2 medium and C1 hard. Despite the C3 being hard tyres in Monaco and soft in Spain, they are ultimately the same tyre. These tyre rules have only been in place since 2019, before this the tyres were all referred to on their 'softness' ranging from hypersofts, 3 grades above normal softs to superhards in 2018 (previous years only ultrasoft to hard) and not every grand prix weekend would have the 3 soft medium and hard compounds



Graphic depicting tyre performance (lap time) over time

Different compounds are used depending on the track characteristics. On any given weekend, drivers can choose from soft, medium and hard compounds for dry weather conditions. These 'slicks' are marked red (soft), yellow (medium) and white (hard). There's also a full wet compound (marked blue) for racing in serious rain, along with an intermediate (marked green) for a damp, in-between track surface. (Asher, 2022)

Despite the existence of a full wet tyre, it is rarely used as when the track conditions are bad enough to warrant using it, the race director usually takes the decision to red flag the session, to stop it until the weather has eased off and the cars can go out on track safer. The full wet tyre can move up to 85 litres of water a second when driving at speeds of up to 300km/h (F1 in schools and Pirelli, 2022)

Discussion

One of the key differences between the five tyres is how it gains and holds temperature. The softer the tyre, the lower temperature they require to reach their optimum operating window. The harder tyres need more heat required to work at optimal grip levels. Softer tyres also are easier to warm up as the tyre heats up quicker.

The temperature can change quickly so if the softer tyres over heat they can be cooled down easier, whereas the harder tyres face rapid degradation and wear as quickly as the soft tyres normally do, with less performance. When the tyres are cold, they lose grip which causes more wheelspin and more brake lockups. (Opong, 2023) The colder temperatures can harden the rubber on the tyre's surface and make them generally slower throughout a lap, with increased braking distances and slower increases in acceleration.

Despite the lower temperature making the rubber harder, the higher temperature can destroy the tyres. Due to this, teams aim to have their tyres in their narrow optimal operating window, through measures such as changes in tyre pressure, tyre blankets and systems such as Mercedes' DAS system on their 2020 W11. This system would increase toe on the front, which would straighten the wheels and produce less drag, causing higher top speed and generating tyre temperature. (Hatton, 2020)

Tyre Blankets are used to heat the tyres to 70 °C. This is so drivers have better grip when they are leaving the pit lane and to avoid unnecessary spins due to cold tyres. Due to the tyres already being heated, overheating can be caused by the track being so hot that tyre blankets essentially weren't necessary. When a track's surface is hot, it can cause the tyres to over heat as generally the hotter the day, the less grip there is on a race track. (Burgess II, 2023)

Due to over heating, prolonged stress on the tyres and high tyre pressures, Formula One tyres are prone to punctures. Current tyre suppliers Pirelli have released many statements about controversies with their tyres failing over the years, the most recent event being at the 2023 Qatar Grand Prix. The FIA were forced to introduce a mandatory three stop rule, which has never been used before purely to stop any dramatic incidents because of punctures. As previously mentioned, the hard tyres are designed to go longer and to not puncture as easily, but in Silverstone in 2020 four drivers all had tyre failures on the hards in the last 5 laps, two of which were the Mercedes drivers of Valtteri Bottas and Lewis Hamilton, who despite his puncture managed to win the race on three wheels.

The next year in Azerbaijan, Max Verstappen's rear right hard tyre blew up whilst going over 300km/h down the main straight, taking him out of the race and causing a red flag. Not only did this

incident almost decide the outcome of the championship, but the impact itself was close to severely hurting him. Thankfully he walked away unharmed.

The most infamous case of a race weekend being plagued with tyre failures is the 2005 United States Grand Prix in Indianapolis, which doesn't hold any of the three US Grand Prix's today. This was during the period where Formula One had a 'tyre war', where there would be multiple tyre manufacturers competing to be the tyre supplier to each of the Formula One teams. Of the 10 teams, 7 of them ran with Michelin tyres that season and only 3 with Bridgestone. Throughout the Friday sessions, Ricardo Zonta and Ralf Schumacher both suffered tyre failures, causing Zonta to spin and Schumacher to crash. On the Saturday, Michelin announced their tyres had an issue which Charlie Whiting described as 'flexing of the sidewalls'. Michelin told all of their customer teams to be cautious in Saturday's FP3 session.

Come Sunday, all the Michelin running teams were forced to pull out of the grand prix, causing only six cars to start the race, which then went on to be won by Michael Schumacher. (Cooper, 2023)

Conclusion

Overall, this report looks at the use of different tyre compounds in formula one as part of a wider race strategy. The tyres are not as simple as they seem when it comes to strategising a race as whilst the tracks may be memorised by the drivers, the unpredictability of the weather can cause huge impacts on tyres. The rules to tyres change frequently over the last few years, and the rules will continue to change as time goes on, and the tyres will evolve to suit the next generation of cars like the current tyres suit this generation. The tyre choice is an important part of race strategy as whilst most things are decided upon before the race, the choice of tyres can be split second decisions which can win races and even championships (with assistance from the fia)

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