**////Title: Optimising Lubricant Oils to Boost Engine Efficiency**

**////Standfirst:**

The engine of a typical passenger vehicle is made up of hundreds of mechanical parts. These parts require lubrication to prevent them from overheating and to keep them working efficiently. Ken Hope and his team at Chevron Phillips Chemical, headquartered in Texas, have analysed the extent to which different types of lubricant oils reduce friction. They then used this data to estimate how an optimised oil mixture can achieve an overall improvement in engine efficiency.

**////Main text:**

Originally patented by Karl Benz, the first cars powered by an internal combustion engine were manufactured in 1886. Since then, such engines have rapidly evolved. However, one thing that still remains is the fact that they are based on a complex system of moving parts, including pistons and bearings.

Whenever such metal parts rub against each other, heat is produced. This heat produced is actually wasted energy, lowering the efficiency of the engine. Even after more than a century of improvements made on the internal combustion engine, the average car can have an efficiency of as little as 35%. As such, up to 65% of the fuel pumped into a car is lost to friction and other processes instead of propelling the vehicle, meaning that up to two-thirds of a car’s emissions are unnecessary.

Chevron Phillips Chemical researches and develops synthetic base oils, which are used in lubricants and engine oils for the automobile industry. In a unique study, Ken Hope and his colleagues measured the extent to which different lubricant formulations reduce friction between moving engine parts, thus improving vehicle efficiency.

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Engine oils must maintain their function over a wide range of temperatures. In the winter months, an engine will be very cold when started, but will quickly reach temperatures of around 100 degrees Celsius. Because of this, tests for lubricant base oils need to be carried out over a range of temperatures. This is also why there is such a range of lubricants available – to ensure high engine performance regardless of where in the world the car is being driven. Different chemical additives are also often added to the formulations to further improve the performance.

The American Petroleum Industry categorises base oils into five main groups. Groups one, two and three come from crude oil sources. The other two groups – four and five – are synthesised molecules that are not derived from crude oil. Group four base oils are polyalphaolefins [poly-alfah-oh-luh-fins], which are long, flexible molecules, while group five covers all other base oils, including silicones and polyester oils.

Previous studies have shown that the shapes of the molecules in a base oil can affect the amount of friction produced between two moving parts. Large, inflexible, bulky molecules, which are found in low concentrations in groups one, two and three, can actually increase friction. The polyalphaolefins in group four do not contain such molecules, and also offer many other benefits including good flow properties at low temperatures and biodegradability. They also have good oxidative stability, meaning that they don’t react with oxygen in the air. However, they are expensive to produce.

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In Hope’s study, his team tested three lubricant formulations where approximately three-quarters of the formulation was base oil. Formulation A contained a polyalphaolefin base oil, formulation B contained a group three base oil and formulation C contained a fifty-fifty mix of polyalphaolefin and a group three oil. They also added other oils and viscosity modifiers to ensure that the overall formulation was a good mimic of a typical winter lubricant formulation.

The team used a mini traction machine to measure the friction produced between a metal ball and a metal disc. In their measurements, the team kept the force applied and the rolling speed constant as they varied the ‘slide-to-roll ratio’. When this ratio is 0% it means that the contact between the ball and disc is a rolling motion, and when it is 100% the ball is no longer rolling but is sliding across the disc. In a second set of measurements, the researchers kept the slide-to-roll ratio and the force applied constant and increased the rolling speed.

In both sets of measurements, the team collected data at both 40 and 100 degrees Celsius. Their results showed that at both temperatures and using both types of measurement, formulation A performed the best and formulation B performed the worst. This was attributed to the base oils used in the formulations, because all other variables were kept constant. Ultimately, the study showed that the more expensive and more chemically pure polyalphaolefin oil performed the best.

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Hope and his colleagues then used the results from their experimental study to calculate the improvement to overall engine efficiency offered by their best performing lubricant formulation. Using the polyalphaolefin base oil, the energy wasted could potentially be reduced by 0.55% and using the mixture of base oils, by 0.26%.

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Overall, the team’s study shows that by using an optimised lubricant oil formulation in a typical car engine, less friction is produced. The decrease in friction achieved by using an optimised formulation means that less of the energy created by the combustion of the fuel is wasted. This means the car will perform more efficiently and have an overall higher fuel economy.

All over the world we are now trying to reduce our impact on the planet, and one way that we can do this is by burning less fuel and more energy efficient vehicles. A more efficient engine means that less fuel is required per journey. Hope and his colleagues at Chevron Phillips Chemical are committed to producing their products sustainably, leaving behind the lightest footprint, and enabling others to do so as well. ‘Energy efficiencies created thanks to our polyalphaolefin products are certainly a step in the right direction,’ says Hope.

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This SciPod is a summary of the paper ‘PAO Contributions to Energy Efficiency in 0W-20 Passenger Car Engine Oils’, in *Lubricants*. <https://doi.org/10.3390/lubricants6030073>

For further information, you can connect with Ken Hope at hopekd@cpchem.com