LUBE-TECH

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SPECIFICATION AND LICENSING SYSTEMS FOR ENGINE OILS - ENGINE DEVELOPMENTS AND IMPLICATIONS FOR THE LUBRICANT

INTRODUCTION

We are all aware of the burdens being placed upon today's generation of engine oils by the requirements, often conflicting, of the OEMs, by legislation and also by the vehicle owners. Stress levels on the lubricant have accordingly increased with the successive introduction of more demanding performance specifications and general expectations from the lubricant. A simple calculation to express stress in a semi-quantifiable form is given by the equation:

$$\text{Stress} = \frac{\text{Engine Power x Oil Change Interval}}{\text{Oil Consumption x Sump Capacity}}$$

This simplified approach does not fully take into account increases in stress due to higher operating temperatures, higher shear rates, higher localised loadings, etc., but it can readily be calculated that stress levels on the lubricant have increased by a factor of 50 or more since the 2nd World War. In all likelihood, the increased stress levels on the lubricants are even higher than these calculations would indicate. Associated with the increased expectations of the lubricants are increasing development costs, and the increasingly rapid turnover in new specifications reduces the time available for the lubricant developers, or in this case mainly the additive suppliers, to recoup their investment.

Vehicle designers are being required to achieve higher and higher standards of fuel efficiency, reduce vehicle emissions and increase vehicle service mileage intervals. The main drivers may therefore be summarised under the following general headings.

- Resource Utilisation
- Environmental Protection
- Customer Satisfaction

These requirements, which are all to a certain extent interlinked, are being achieved by developments in lubricants technology, in addition to developments in engine technology, materials technology and fuel technology.

Lubricant performance increases are largely achieved by developments in additive technology.

1. RESOURCE UTILISATION

In 1975, the US introduced a Corporate Average Fuel Economy (CAFE) system for vehicles, the purpose of which was to progressively reverse spiralling levels of vehicle fuel consumption, which had been not helped by the low levels of duty payable on US fuel. A subsequent relaxation in oil prices coupled with a lack of demand for small cars was followed by a degree of relaxation in the CAFE requirements, which were then subsequently tightened up again. Although the main intention was to encourage the production and use of smaller and more fuel-efficient vehicles, it was also appreciated that the selection of a suitable lubricant could assist in achieving improvements in fuel economy.

The accepted engine test method for establishing lubricant-related fuel economy improvements compared with a reference oil (Sequence VIB) imposes limits for fuel utilisation efficiencies for the test lubricant and also evaluates its ability to maintain this performance over prolonged periods of use (equivalent to 4,000 miles). In Europe fuel economies are now generally expressed in terms of litres of fuel used per 100 km. and the target for many manufacturers of small 'eco' cars is 100 km per 3 litres of fuel, i.e. the '3-litre' car. An alternative way of expressing fuel economy is in terms of CO_2 g/km and the European body ACEA has already requested a 'voluntary' commitment from vehicle manufacturers to reduce CO2 emissions to a fleet average of 140g CO_2/km by 2008.

Lubricants can directly improve fuel utilisation in two ways:

- Lower viscosity lubricants will reduce churning/pumping losses in the engine; gains here are especially evident during the 'warming-up' phase.
- The incorporation of friction-reducing additives, usually based on molybdenum, will also decrease frictional losses in the engine.

The use of lower viscosity oils, whilst simple enough in theory, presents in practice a number of problems for the lubricant formulator. In general, although lower viscosity oils are well capable of providing an adequate lubricant function in a system designed for their use, they are more volatile. This volatility causes an increase in oil consumption by evaporative losses via positive crankcase ventilation systems, which in turn increases emission levels and also the need for more frequent topping-up. Increased migration rates past the piston oil-control ring into the combustion zone again leads to increases in emissions. Progressive loss of the lighter components will also result in oil thickening, with consequent adverse effect on fuel consumption. In engines not designed for low viscosity oils, certain parts of the engine subject to high loads are likely to wear at an increased rate due to breakdown of the lubricant film, with the consequent transition from hydrodynamic to mixed/boundary lubrication conditions.

Since conventional mineral oils cannot achieve the desired combination of low viscosity and low volatility, newer high-performance crankcase oils are now being formulated from synthetic fluids, such as polyalphaolefins (PAOs), or on a series of products known as 'unconventional base oils' or UCBOs. These latter products originate from crude oil, as do conventional mineral oils. However, their manufacture involves additional new refining techniques such as severe hydrocracking or wax isomerisation which re-arrange the molecular structure to such an extent that the finished product has properties more akin to those of a pure synthetic oil, although at about 50% of the cost. Interestingly, at a recent ruling in the US, such UCBOs are now allowed to be termed 'synthetic', although being originally derived from crude oil.

The use of friction modifiers to reduce internal friction in the engine is becoming increasingly widespread, as the newer specifications for crankcase oils emanating from both the API and ACEA call for demonstrable and sustainable improvements in fuel utilisation efficiency compared with reference oils.

However, one problem area has emerged where such oils have been used in high performance four-stroke motorcycles, since these vehicles use the crankcase oil to also lubricate other parts of the drivetrain,

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