Fuel Economy Engine Oils: Scientific Rationale and Controversies

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Since a significant part of energy losses in the internal combustion engine comes from viscous dissipation, the trend has shifted toward low-viscosity oils from SAE 40 and 50 in the 1960s-1980s to current SAE 20 and 30 viscosity grades. This transition has been facilitated by availability of high-quality hydroprocessed and synthetic base oils. Due to their greatly reduced volatility and good low-temperature performance, modern base oils of API Group II-IV allow the formulation of thinner engine oils of 0W-30, 0W-20 or even lighter grades to achieve better fuel economy. Use of low viscosity engine oils significantly reduces energy losses in the main bearing and piston/bore systems, while losses in valvetrain increase due to boundary friction. This makes a strong argument for deploying friction modifiers (see Fig. 1).

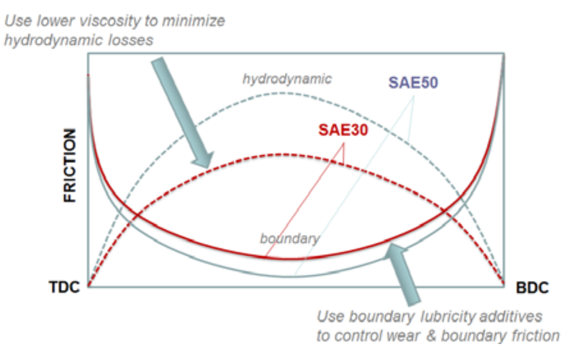

Figure 1 */ Standard practice: Reducing engine friction by using a lower viscosity oil in combination with boundary lubricity additives.*

However, development of a balanced formulation is not as straightforward as it appears, and numerous pitfalls may be encountered. One potential hurdle is that certain additives require high treat levels for fully revealing their tribological effect, and such high levels are not acceptable due to potential negative impact on emission control equipment. Finally, there is always a cost factor.

Another serious problem is that the definition of "fuel-economy engine oil" is rather vague, as it depends on choice of reference oil. Usually, the assessment of fuel economy is based on the Sequence VIB (ASTM D 6837) engine test using a 1993 4.6L Ford V8 gasoline engine and a 5W-30 reference oil (see Fig. 2). It is not unexpected that the results of this test turn to be largely misleading when extrapolated to modern heavily boosted low-displacement engines.

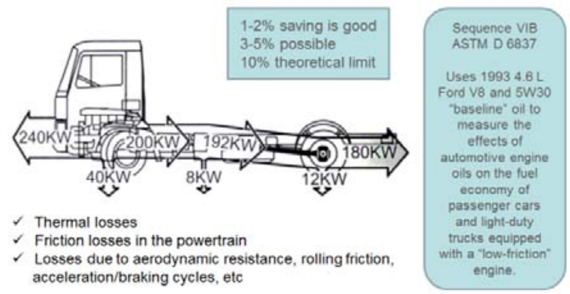

Figure 2 */ Energy losses in cars and typical fuel economy figures achievable in Sequence VIB due to oil upgrade.*

Furthermore, the "fuel economy" performance of the same oil may change dramatically depending on the driving cycle, and the result will be different for different engines. For instance, a low viscosity oil may boost fuel economy at cruising speeds (high speed / low load limit) and degrade fuel economy during city driving (low speed / high load), especially for cars with a start-stop system (see Fig. 3). In some extreme cases, oils claiming "fuel economy" according to Sequence VIB may prove inferior to non-FE products!

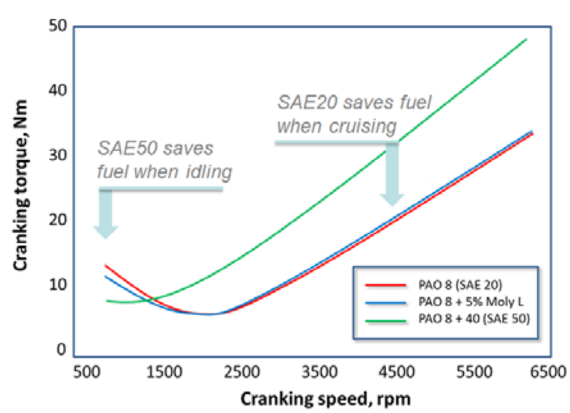

Figure 3 */ Friction torque measurements carried out for a common i4 production engine using model lubricants to mimic 0W-20 and 5W-50 motor oils.*

All the aforesaid circumstances are to be taken into account when trying to harmonize normative performance claims with customer expectations.