LUBE

TECHNI-GRAM

FROM:

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VISCOSITY INDEX IMPROVERS (MODIFIERS)

The viscosity of a liquid is a measure of its “thickness” or its resistance to flow. A high-viscosity oil is less fluid than one of low viscosity. The viscosity of a typical petroleum oil tends to increase or “thicken up” and flow sluggishly as temperatures drop; conversely, the oil tends to thin out and flow more readily at higher temperatures. Where wide differences in the ambient temperature exists, there is often an advantage in an oil whose viscosity remains as close as possible to the optimum value, in spite of the temperature change.

The rate at which viscosity changes with temperature is known as “viscosity index” (V.I.). The higher the V.I. of a liquid, the more constant its viscosity. Lubricants separated from crude oil by simple distillation may vary widely in viscosity index, depending on the source of the crude. Paraffinic crude oils rate highest in natural V.I.

The V.I. of an oil can be raised, however, by the incorporation of a V.I. improver or viscosity modifier. Viscosity index improvers are mainly long-chain polymers of very high molecular weight, such as polyisobutylene or polymethacrylate. These materials function by increasing the viscosity proportionately more at high temperatures than at low temperatures. Their behavior in an oil suggests that they distend or stretch themselves at higher temperatures, thereby impeding flow and giving the oil more viscous characteristics. In doing so, they compensate, in a large measure, for the tendency of the oil to thin out when heated.

It is postulated that in cold oil, the molecules of the polymer adopt a coiled form and are held in colloidal suspension so that their effect on viscosity is minimized. In hot oil, the molecules are more soluble so tend to straighten out, and the interaction between these long molecules and the oil produces a proportionately greater thickening effect as illustrated in Figure 1.

Viscosity modifiers are a key ingredient in modern lubricants. These polymers modify the flow characteristics of lubricants and are required for most multi-grade fluids, allowing them to be used over an extended temperature range and eliminating the need for seasonal oil changes.

Viscosity modifiers were initially used in lubricants in the 1930’s, and their use continues to escalate. Over the years, lubricant needs have changed significantly, as have viscosity index improver technology and application. A prime example of the importance of V.I. improvers is the internal combustion engine. In an internal combustion engine, the oil must be fluid at even below-zero starting temperatures, yet have sufficient "body" when temperatures rise to 180°F or more during operation. The stability of V.I. improvers has resulted in virtually every major engine manufacturer recommending the use of multi-graded oils. Automotive gear lubricants, as well as industrial gear lubricants and hydraulic oils also have seen a surge in multi-grade recommendations due to the stringent shear stability requirements today's quality V.I. improvers are able to meet.

It is extremely important to keep in mind that all V.I. improvers cannot be expected to make consistently stable high V.I. lubricants from all base stocks. It is easy to see that a V.I. improver must be selected with discrimination and that its usefulness is contingent on the suitability of the base stock to which it is applied. With the proper V.I. improver (modifier) correctly applied to a matching base stock, users of multi-grade lubricants could anticipate the following benefits:

- Increased thermal stability
- Improved shear stability
- Better low-temperature fluidity
- Sustained wear resistance
- Lower oil consumption
- Improved fuel/energy economy
- Extended service intervals

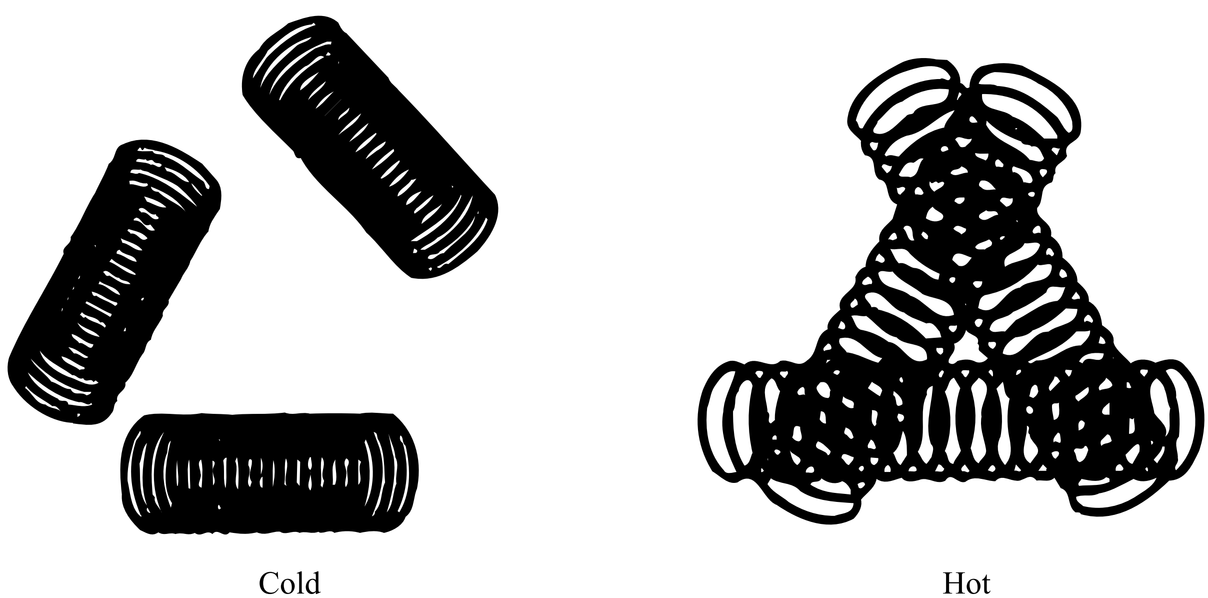

Figure 1: Viscosity improvers react to temperature in a manner similar to springs … the molecules in the VI improver shrink when cold and expand or thicken when hot. These changes in the physical characteristics of the VI improver help compensate for what would otherwise be changes in the base oil stock. The result is improved temperature stability of the oil over a wide temperature range.