

Viscosity Index Improvers

Description

Both the modern, high compression, gasoline engine and the lengthening of time between oil changes have made it mandatory for lubricating oil manufacturers to use many different additives in the base oil stock. One essential additive is a viscosity index improver. These compounds make it possible to furnish the multigrade oils commonly used in most engines today. These multigrade oils have a viscosity at low temperatures equivalent to the first or low viscosity number but on heating do not drop in viscosity as rapidly as a straight mineral oil and have a viscosity of the higher grade at the elevated temperature.

The improvement in the slope of the viscosity temperature curve is accomplished by the addition of organic polymers such as poly (alkyl methacrylates) or polyisobutylene.

Objective

Many of the organic polymers used as viscosity index improvers are shear sensitive compounds. This means that under high shear there will be a change in the average molecular weight of the polymer and a reduction in viscosity. The molecular weight change is most likely brought about by breakage of chemical bonds in the polymer chain. This, of course, will defeat the purpose of adding them to the oil; hence, it is essential that they be sold in as stable a condition as possible. Unfortunately, in the manufacture of these compounds the mixture coming from the reactor may contain a wide variation of molecular weights with a corresponding variation in its resistance to shear. To overcome this, these products are passed through the homogenizer. The homogenizer transfers intense energy to the product, and this corresponds to a high shear environment. This process, then, exerts more energy on the polymer than it would be subjected to in lubricating an engine. Hence, there will be a remarkable improvement in polymer stability with respect to viscosity change.

A term which describes this stability is the "Shear Stability Index" (SSI) (described in the brochure on Acryloid 700 Series by Rohm and Haas Company, Philadelphia, Pennsylvania):

$$\frac{\mu_i - \mu_f}{\mu_i - \mu_o}$$

where

μ_i = initial oil viscosity in cSt/100°C.

μ_f = final oil viscosity after subjection to high shear conditions in cSt/100°C. and

μ_o = viscosity of base oil blend with all additives except the VI improver in cSt/100°C.

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This constant can be used to predict the viscosity of an oil after it has been used in an engine.

Equipment and Processing

The product, which usually consists of the polymer dissolved in an oil, is heated from a minimum of 100°F. (38°C.) to as high as 300°F. (150°C.) to make it pumpable. A common temperature used is 100°C. The exact temperature depends upon the particular polymer being used. The polymer solution is pumped to the homogenizer which has special wearing parts. The solution is processed in one or more passes at high homogenizing pressure. The pressure and number of passes used depends on the particular polymer and the desired viscosity reduction. The finished product would be added to the oil to obtain the required viscosity.

Testing

The principal test is a viscosity check immediately after homogenization and, again, after 24 hours of hold time to determine any viscosity regain, if this should occur. The viscosity is usually checked with the samples hot (100°C.); the temperature of the samples should be held constant, because any variation in temperature will have a significant effect on the viscosity.

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