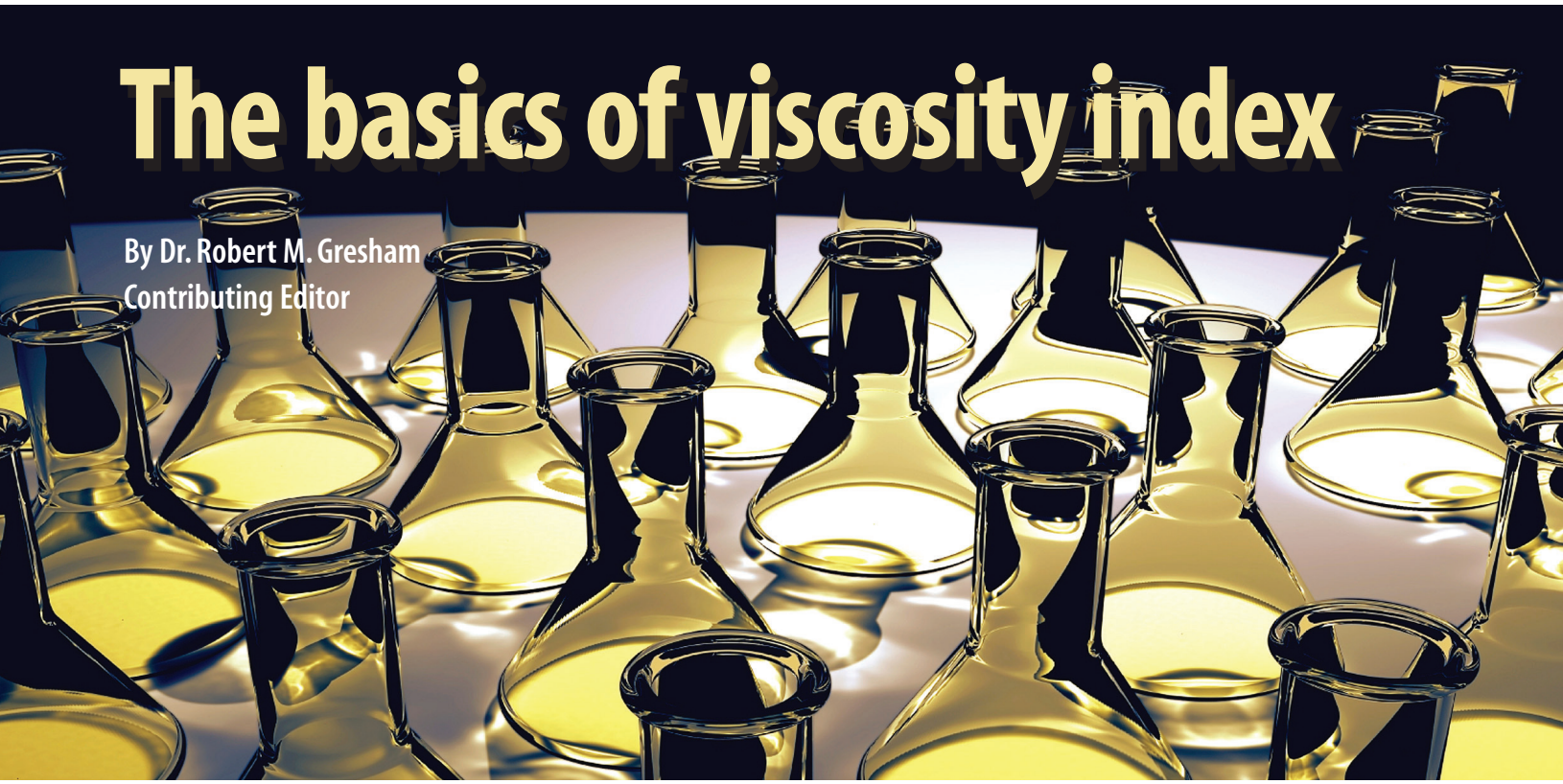
The basics of viscosity index



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There are many factors to calculating the viscosity of a lubricant. But understanding its temperature in cold and hot environments is the first step.

In the July TLT we reviewed the measurement and classification of viscosity. As we have said many times, viscosity is the most important property of a lubricant. And so it is important to understand the concepts fully. In this article, we'll take a look at viscosity index (VI).

VI is a means of expressing the lubricant's variation in viscosity with respect to temperature (*see Figure* 1). In general, this means the viscosity increases with cold and decreases with heat. Each machine is designed with an optimum lubricant viscosity range to insure sufficient film thickness to reduce friction and prevent wear. Clearly, the less a lubricant varies with temperature, the more a lubricant can be used in cold as well as hotter environments.

This cuts two ways. When a lubricant is too cold (not up to operating temperature), either because of the environment, as in winter, or just because we are just starting up a machine, the viscosity is too high, the lubricant doesn't flow well and wear can ensue. Equally, if the lubricant is too hot because of the environment or because we are overworking a machine, the viscosity is too low, and we don't have sufficient film thickness to prevent wear.

So if this is important, how do we determine the VI of a lubricant? VI is calculated from the measured viscos-

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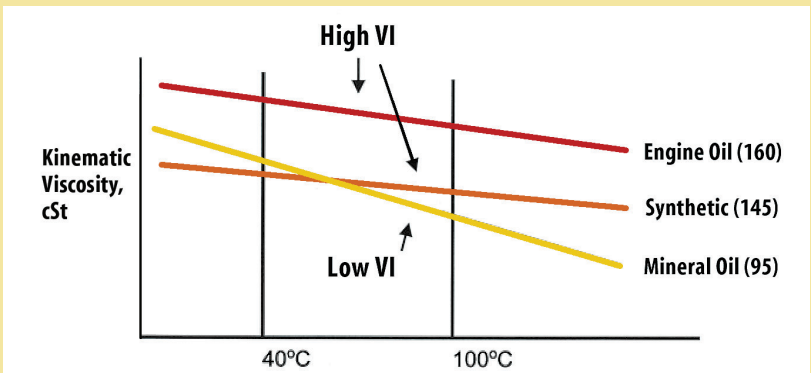
Figure 1. Viscosity vs. Temperature



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ity at 40 C and 100 C using ASTM Method D 2270. Unfortunately, the method is a wee bit awkward and arcane, yet widely used. Its utility is in characterizing base oils or finished lubricants and cannot be used as blending guidance (i.e., blending two oils 50-50, which have VIs of 80 and 100 don't necessarily provide oil with a VI of 90).

The idea of the method is to measure the viscosity of a test oil at 100 C (called Y). Then, consulting a huge chart in the ASTM method and using the measured viscosity of the test oil, the tester looks up values for two parameters called L and H. L is the 40 C viscosity of some mythical oil having the same viscosity of our test oil at 100 C, defined as having a VI of 0. H is also the 40 C viscosity of another mythical oil having the same viscosity of our test oil at 100 C but defined as having a VI of 100. High VI is defined as having less variation with respect to temperature; thus L is larger than H. The VI of the test oil is defined by the relationship of its 40 C viscosity (called U) to the parameters L and H. Thus, the VI of the test oil becomes the percent of the way U is from L to H, as shown in the formula below:

VI = 100 X (L – U) / (L – H)

This is pretty exciting stuff, right? Perhaps the example below will help. For an oil of 10.0 centistokes (cSt) viscosity at 100 C, the table in ASTM D 2270 provides L = 147.7 and H = 82.87. If the test oil has a 40 C viscosity of 110 cSt, it would have a VI of 58 using the formula above:

VI = 100 X (147.7 – 110) / (147.7 – 82.87) = 58

If this isn't painful, awkward and arcane enough, if the VI is over 100, as many mineral oils and synthetics now are, we have to go to a completely different calculation. As of now, when dealing with VIs of 100 or more, U, the viscosity of the test oil at 40 C, is less than H. For these oils, VI is defined by a new parameter, N, calculated from Y and H rather than H and L as before. Thus, a new formula is shown below:

VI = 100 + 140 X ((antilog N) – 1), where
N = (log H – log U) / log Y)

We're having fun now! So what's a poor soul to do?

Probably the easiest and fastest thing to do is to call your supplier. Second, grind it out with ASTM D 2270, ugh. Finally, you might find a computer program that will calculate it all for you.

The point of all this is that viscosity index is an important parameter in characterizing base oils and lubricants. **<<**

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