THE IMPORTANCE OF VISCOSITY INDEX

Our modern society would not be running smoothly without lubricants. Proper lubrication is needed to keep car engines, wind turbines, and conveyor belts up and running. In this article we discuss the importance of the viscosity index for lubricants.

Lubricants fulfill several purposes. First and foremost they form a protective film between two moving parts to prevent them from wear and tear, while at the same time allowing the parts to move without requiring too much energy. Additionally, lubricants are also needed to transmit forces and transfer heat. In order to fit the wide variety of applications, lubricants are available in many different formulations.

When it comes to characterising lubricants and assessing their quality, the most important parameter is the viscosity index (VI). This dimensionless number describes the behavior of a lubricant's viscosity with changing temperature.

- An oil with a high viscosity index will show only small changes in viscosity when the temperature changes
- An oil with a low viscosity index will have significantly different viscosities at different temperatures

Why is it important to know the viscosity index? This is due to the fact that not every lubricant oil can be utilised for every purpose. For instance, while 10W-40 grade engine oil might be perfectly fine for the typical Central European climate, using this type of oil in colder regions might result in a lack of lubrication and eventually lead to engine damage. Employing 5W or 0W engine oil instead would be the better choice.

However, the importance of the viscosity index is not just limited to engine oils. In fact, VI is applicable for lubricants across all sectors of modern life, be it in food manufacturing or bottling plants, inside transformers or hydraulic machinery.

Experience twin power: SVM 4001 Smart Viscometer

The highly precise SVM 4001 viscometer is based on a rotational measuring principle and features two integrated viscosity and density measuring cells. Each viscosity measuring cell contains a tube which rotates at a constant speed and is filled with sample. The measuring rotor with a built-in magnet floats freely in the sample. While the sample's shear forces drive the rotor, the magnetic effects (Eddy currents) retard its rotation. Shortly after the measurement starts, the rotor reaches equilibrium speed. The difference between the speed of the outer tube and the measurement rotor is a measure for the sample's dynamic viscosity (Fig. 1).

The integrated density cell means that density is measured simultaneously. From these two parameters, the instrument calculates the kinematic viscosity. The high-performance measurement cell covers the entire viscosity, density, and temperature range without the need to change the capillary and requires as little as 2.5 mL of solvent, while giving users more parameters than any other kinematic viscometer on the market.

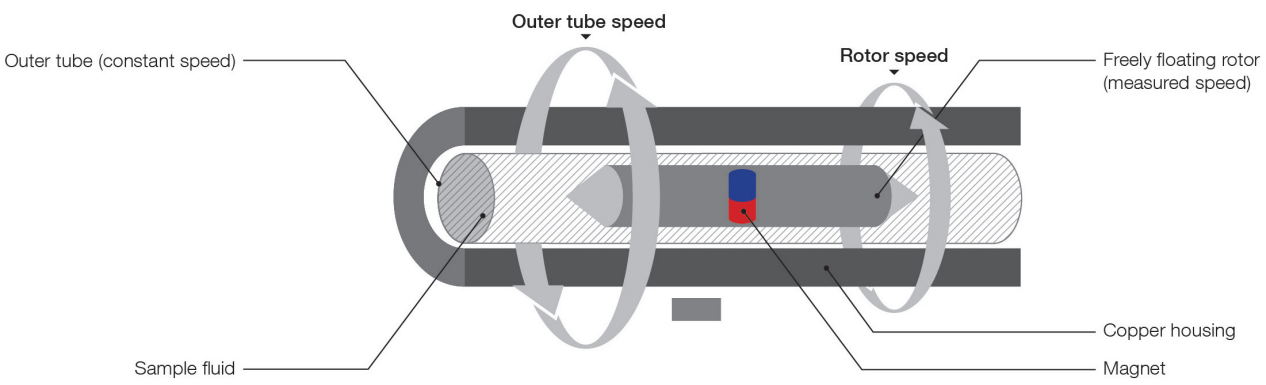

Figure 1: Measuring principle of the SVM Smart Viscometer

Simultaneous determination at two temperatures

To determine the viscosity index according to the current ASTM Standard Practice D2270, it is required to measure the viscosity of the lubricant oil at 40 °C and at 100 °C. This was traditionally done by measuring the same sample with two different capillaries at those two temperatures in two different baths sequentially. It needed lots of efforts and took time.

With the patented technology of SVM 4001, determination of viscosity index is easier and faster than ever. Thanks to its double-cell design, the instrument enables simultaneous measurement of kinematic viscosity on the sample at 40 °C and 100 °C.

It automatically calculates the viscosity index fully compliant with ASTM D2270 and displays the results on the screen within a few minutes. No external PC or software is required to perform the calculations.

The fast measurement means that SVM 4001 can be employed in areas where speed is essential, such as filling lines. Here, a quick check of the viscosity and the viscosity index can tell whether the lines are clear of the old product/batch and the new product/batch is ready to be loaded into the tank trucks.

Quick results for lube blending

Lubricants are carefully blended and formulated to suit a specific application. Therefore, a multitude of additives is available, ranging from antioxidants to corrosion inhibitors and viscosity index improvers. Depending on the type of machine, oils can contain up to 30 %vol additives, which significantly alters the lubricating behavior of the oil. One fast way to check whether the lubricant blend has the desired performance and properties for a given application is to determine the viscosity and the viscosity index, respectively.

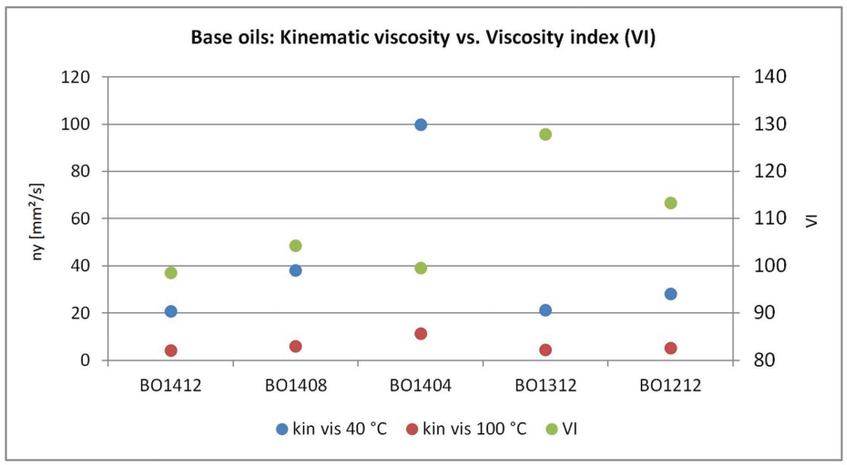

Figure 2: Kinematic viscosities and VIs of various base oils

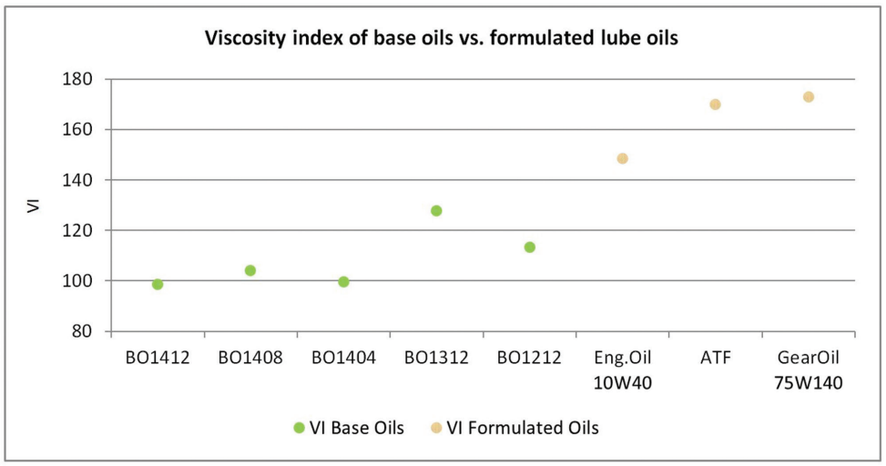

Figure 3: VI comparison of base oils and formulated oils

Figure 2 shows a plot of the kinematic viscosities and viscosity indices of several base oils. Both parameters can be determined with SVM 4001 from a single syringe. Depending on the type of base stock, the oils already show pronounced differences in the viscosity index.

The influence of additives (especially so-called "viscosity index improvers") on the viscosity is illustrated clearly in Fig. 3, which compares the base oils with the corresponding formulated lubricants.

Wide measuring range

With an increasing variety of lubricant formulations comes an increase in the viscosity range. This can be a problem for traditional viscosity measurement methods as the capillaries are usually covering a rather narrow viscosity range. Thus, it is necessary to have a sufficient number of capillaries available in order to make sure that the full range of samples can be covered.

SVM 4001 on the other hand covers the entire viscosity range (0.2 mm²/s to 30 000 mm²/s) with one measuring cell so there is no need to exchange or find the correct capillary by trial and error. In addition, thanks to its integrated Peltier temperature control system, there is no need for a bath or external cooling to cover the temperature range between +15 °C and +100 °C, the Smart Viscometer does it all in stand-alone mode. This allows measurement of a wide range of lubricants with the least time and effort. Of course, you can also measure other petroleum products such as additives, diesel, or fuel oils, too.

Economic and efficient

Some lubricants are blended in smaller quantities for very specific purposes (e.g. some food-grade lubricants) or contain expensive components. For such cases, it is highly beneficial to use small sample volume when it comes to viscosity or VI measurement. Due to its small cell, the minimum sample volume required by SVM 4001 is just 2.5 mL. This also helps to minimize the consumption of solvent, resulting in significant reduction of solvent purchase and disposal costs.

Used oil measurements with viscosity temperature extrapolation

When it comes to monitoring the condition of lubricants for machinery health, viscosity is considered to be one of the most important parameters. The viscosity is routinely checked as part of oil condition monitoring (OCM) tests, where changes in viscosity can indicate several problems:

- Decreasing viscosity can be caused by contamination of the oil with water, fuel, or coolants.
- Increasing viscosity can be caused by the presence of particles, such as soot or metal debris.
- Changes in viscosity may also point towards aging or degredation of the oil.

As a lack of lubrication can lead to damaged machinery and to undesired and costly downtime, having a reliable, fast, and robust method of measuring used oil viscosity is of the utmost importance.

With SVM 4001, used oil samples of varying viscosities can be measured simultaneously at two different temperatures, without the need to change capillaries for different types of in-service oils. Proper oil condition monitoring can also help make the most use of the lubricant, which is especially beneficial for expensive blends.

Some used oil samples are challenging to measure at high temperatures: Volatile components tend to form gas bubbles, which adversely affect the measurements. To mitigate this problem, SVM 4001 enables viscosity-temperature extrapolations according to ASTM D341. Integrated in the instrument, this allows for the measurements to be carried out at lower temperatures, where no gas is produced (e.g. 80 °C instead of 100 °C), still providing the calculation of the viscosity index in full compliance with ASTM D2270.

Conclusion

One injection is enough for SVM 4001 to measure kinematic viscosity and density simultaneously at two different temperatures and to automatically calculate the viscosity index fully compliant to ASTM D2270. In addition, the wide measurement range means a high degree of flexibility compared to traditional methods, enabling the testing of a wide variety of samples, from base oils and lube blends to used oils – all with one instrument. Combined with its built-in intelligent software and its economic efficiency, SVM 4001 serves as a precise, reliable, and flexible solution for the measurement of lubricants, and in-service oils.

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