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Application Note

BENKE VISC-4 Viscosity Process Analyzer

Reduce production costs in lube oil manufacturing with advanced on-line viscosity measurements

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APPLICATION NOTE

In today's highly competitive environment, oil refiners demand instrumentation that aids in the optimization of refining processes. When looking at lube oil processing units, one of the key process parameter and differentiator between the various lube oil grades is the viscosity. With more accurate measurement, base oils and final lube oil can be blended closer to the required specification thus helping to reduce unnecessary product giveaway as well as lowering production costs and improving product quality.

Leveraging Bartec's decades of experience in physical property analysis and an installed base of well above 2,000 units, the BENKE VISC-4 Viscosity Process Analyzer is the first choice to keep pace with the growing demands of 21st-century refineries. With its industry-leading viscosity measurement, the oil-less oven design for thermal stabilization and full compliance to ASTM D445, it is the perfect choice for any lube oil manufacturing and blending companies.

D445 compliant advanced viscosity measurement technology

The BENKE VISC-4 is based on the capillary viscometer principle that measures continuously and directly kinematic viscosity. As the sample passes through a capillary at a specific flow rate and temperature, the pressure drop across the capillary is measured and used to calculate the kinematic viscosity. Since the kinematic viscosity of liquids decreases with increasing temperature for most products, the temperature accuracy and stability is of the utmost importance for a good and reliable measurement. This is particularly true for base oils as the viscosity rate of change per temperature unit is significantly greater than for other products.

Thanks to Bartec's unique thermal insulation of the capillary with a Dewar vessel, the BENKE VISC-4 shows an unrivaled temperature stability of ±0.02 Kelvin as defined in the ASTM D445 without the need for high-maintenance oil bath. The use of four temperature sensors inside the measuring chamber assures highest confidence in the isothermal condition and therefore in the collected data quality. In addition, thanks to the integrated mass flow and density measurement, the dynamic viscosity can be calculated directly from the measured kinematic viscosity.

Increase profit thanks to industry-leading measurement performance

With markets becoming more price-competitive, refiners are looking for ways to improve efficiency of their lube oil processes. One way to achieve this is by using accurate and reliable online viscosity measurement that reduce giveaway and increases the yield of products of higher economic value. There are many different types of on-line/inline viscometers available on the market that seem to fit this requirement. However, it can be shown that ASTM D445 compliant systems with high temperature stability, allow more precise control of lube oil processes, which can then lead to increased revenue. In addition, the data can be directly compared with laboratory results without any need for conversion.

As an example, an error of 1% on product viscosity that causes a blend adjustment can easily result in increasing production cost of €0.01/$0.01 a gallon. For large lubricant manufacturers, this can amount to €900,000/$900,000 in lost revenue per year. The excellent and reliable performance of the BENKE VISC-4 allows plant operators to optimize the production of higher value products, while the payback time for the BENKE VISC-4 investment is in the region of only a few months.

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Outstanding robustness and system uptime

Like all Bartec process analyzers, the BENKE VISC-4 is designed to provide unmatched reliability and longevity. This is achieved by using only the highest quality components combined with high quality manufacturing under strict quality control. Thanks to the measurement principle without moving parts and the unique thermal insulation without the need for a high-maintenance oil bath, the analyzer provides industry leading robustness and system uptime. The analyzer is always on and ready to run, as it does not require any cleaning tasks or calibration thanks to the adaptive thermal controls outstanding reliability even under changing conditions.

Exceeding the repeatability of ASTM D445

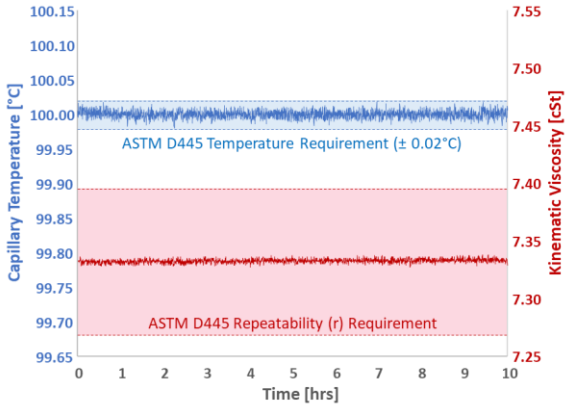

Fig. 2: Kinematic viscosity readings and capillary temperature of an engine oil sample (5W20) with the BENKE VISC-4 at 100°C. The ASTM D445 repeatability (r) and temperature range of ±0.02° C are highlighted.

Temperature control is the single most important parameter to obtain accurate and precise Kinematic Viscosity measurements. This is especially true for petroleum products as their viscosity rate of change per temperature unit is significantly greater than other products. Thus, a slight variation in temperature can have a very large effect on the viscosity of the sample. The BENKE VISC-4, with its adaptive thermal control exhibits industry-leading temperature accuracy and stability that easily exceeds the requirements of ASTM D 445 by up to a factor of two.

Because of the temperature stability, the repeatability (r) of the kinematic viscosity according to ASTM D445 is clearly exceeded by a factor of 10 and more.

Table 1: Kinematic viscosity readings with the BENKE VISC-4 with different grades of lube base oils over a 12hrs test run at 100°C. The repeatability according to the ASTM D445-19 is clearly exceeded by a factor of 10 and more

Lube Base Oil Grades	Average reading of BENKE VISC-4	Repeatability results of BENKE VISC-4	Repeatability according to ASTM D445	Factor better than the ASTM D445 requirement
Grade 100D, with wax	4.19 cSt	0.003 cSt	0.042 cSt	14.0
Grade 100N, wax free	4.23 cSt	0.003 cSt	0.043 cSt	14.3
Grade 150D, with wax	7.03 cSt	0.004 cSt	0.071 cSt	17.8
Grade 150D, wax free	6.61 cSt	0.004 cSt	0.067 cSt	16.8

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Viscosity measurement locations within the lube oil production process

A lube oil plant typically produces a range of Group III base oils using a feed from a hydrocracker unit and consists of a vacuum distillation unit, catalytic dewaxing unit and utilities. The unconverted oil feed from the hydrocracker unit is introduced to the vacuum tower, which separates the distillates and transfers them to intermediate tanks. The distillates from the intermediate tanks are introduced to the catalytic dewaxing unit and hydro-finishing unit, where improvements are made to the low temperature pour point as well as color and light stabilization. The final base oil is sent to the product tank, which provides intermediate storage before final lube oil blending of the various grades. The optimal viscosity measurement locations for a high-quality base oil and lube production are:

- In the hydrocracker residue stream (atmospheric bottoms) before it enters the vacuum distillation
- For the distillates of the vacuum distillation before they are transferred to the intermediate storage tanks
- After the catalytic dewaxing and hydro-finishing units before they are transferred to the base oil storage tanks
- For the lube oil blending process after the blending unit and the mixer

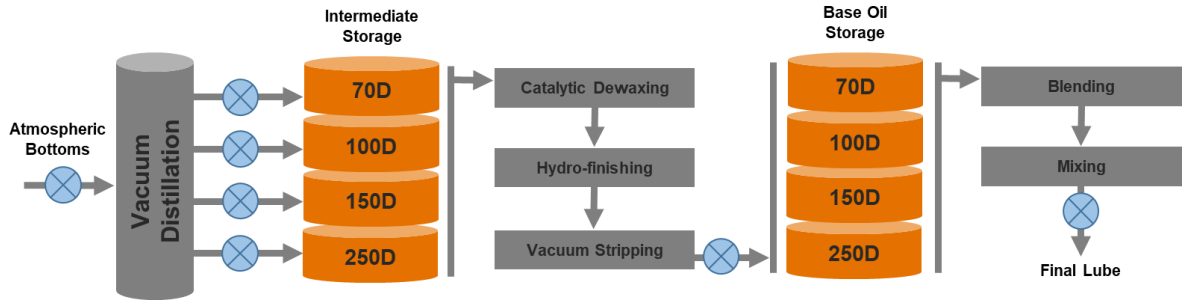

Fig 3. Optimal viscosity measurement locations (⊗) for an efficient and high-quality lube production

Get more data with a Viscosity Index Process Analyzer

In addition, Bartec also offers the BENKE Viscosity Index Process Analyzer VI-4 that consists of two BENKE VISC-4 units. One analyzer unit measures the kinematic viscosity at a temperature of 40°C and the other analyzer at a temperature of 100°C. These two values are used to calculate the Viscosity Index (VI) according to ASTM D2270. Due to the outstanding performance and temperature stability that clearly exceed the ASTM requirements the BENKE VI-4 is the best choice for highly accurate viscosity index measurements in lube oil production. The BENKE VI-4 is also suitable for handlling samples with a viscosity of up to 800 cSt at measurement temperatures of up to 100°C.

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