Viscosity Measurement by Houillon Method

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Introduction - *What is viscosity?*

The viscosity of a lubricating oil can be considered as its most important physical property. It must be monitored and controlled carefully because of its impact on the oil and the oil's impact on equipment life and reliability. Basically, the viscosity can be defined as the property of a liquid characterizing its internal friction or resistivity to flow. Physics defines several types of viscosity and separate two families between Newtonian and non Newtonian fluids. There are mainly two related measures of fluid viscosity :

- **dynamic** (**or absolute**) viscosity
- **kinematic** viscosity.

The knowledge of viscosity is needed to adjust and define the required temperatures for storage, pumping or injection of fluids and is also critical to check if an oil can provide adequate lubrication.

ASTM D445 requires the oil sample be injected in a capillary viscometer tube, which is then immersed in a heating bath at the prescribed test temperature. The time taken for an oil to flow from one capillary section to another is used to determine its kinematic viscosity

NVH 450 Automatic Houillon Viscometer by Normalab Analis

From the above mentioned definition, the HOUILLON method can be defined as a kinematic method, using a capillary tube and being close to the traditional D445.

The term « Houillon » refers to a special type of capillary tube used to measure viscosity. The method was initially developed in France for use in lubricant blending facilities and research laboratories willing to get results during the blending process quicker than with existing tubes.

What are the benefits of Houillon method?

Comparing to the whole range of tubes described in the ASTM D445 & 446, the Houillon capillary is not a U tube but a straight one (see fig.1).

This makes the particularity of its related heating bath design, as the low part of the tube is not immersed.

By using the Houillon type of capillary tubes, the NVH 450 determines viscosity of a wide range of oils including lubricating oils, coloured oils, used oils, fuels, and similar materials over a wide viscosity range. For several reasons, the ASTM is presently working on the standardization of the Houillon method (draft in progress).

Simple Measurement Principle

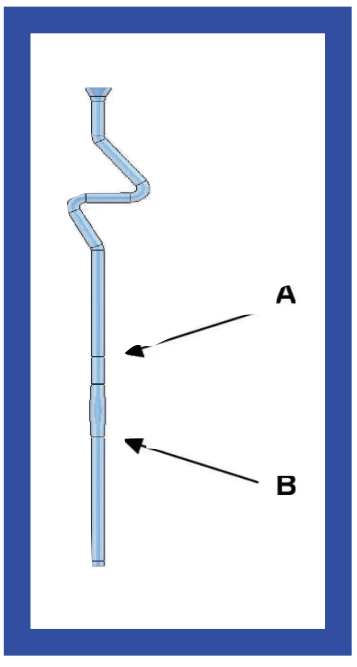

Fig. 1

We measure the viscosity of an oil according to a time and a tube constant. The time is measured between two points (A & B). Then the viscosity is obtained by applying by the following calculation:

V = C x T

With **V** as the kinematic viscosity in cSt or mmÇ/s, **C** the constant of the tube and **T** the pouring time in seconds to flow from **A** to **B**.

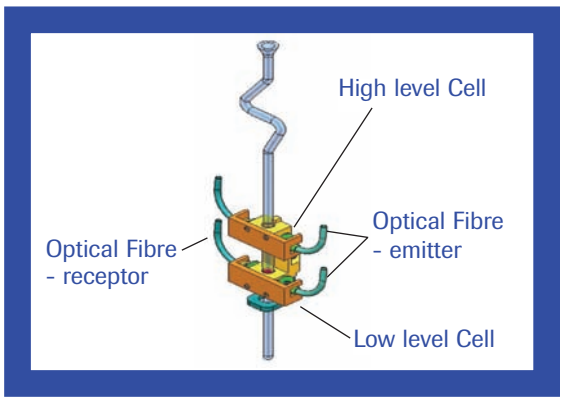

Fig 2

In Automatic mode, the sample detection begins when the edge of the sample reaches the first cell - high level- and stops when it passes the second cell -low level- (see fig. 2). The NVH 450 records the flow time and calculates automatically the viscosity of the sample. Result can be printed out or stored in the archives menu.

Clear and Dark Oils with the Same Tube

The measurement is related to the viscosity of the sample and not to its colour. Operator can easily switch from one product to another and cover a wide range of analysis with a basic equipment and a limited number of tubes. Sample reaches quickly the temperature due to its volume and special tube design. NORMALAB ANALIS produces petroleum glassware and viscometer tubes for more than 40 years.

Quick and Economical:

Table 1

Tube Series	Approximate constant	Minimum viscosity in cSt	Maximum viscosity in cSt	Volume to be injected in µL
50	0.016	0.8	3.2	130
75	0.032	1.6	6.4	135
100	0.06	3	12	135
150	0.14	7	28	135
200	0.4	20	80	180
300	1	50	200	220
350	2	100	400	280
400	4.8	240	960	350
450	10	500	2000	400

Low Sample Consumption

Sample size is related to the expected viscosity range of the sample to be analyzed. With the Houillon method, the sample is injected by the means of a micropipette. See table 1 with expected volume according to the tube constant and sample viscosity. An average analysis time of 60 seconds is reached due to a maximum sample size of 0,4 ml.

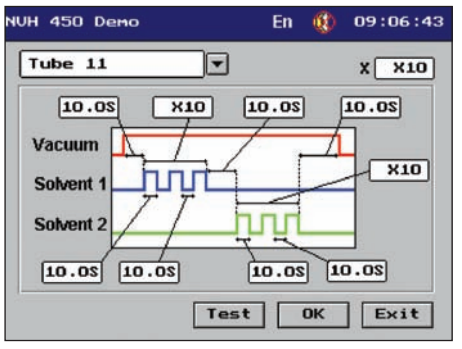

Fig 3: Cleaning cycles settings

While ASTM D445 is an accurate, reliable method of determining the viscosity of an oil, the tendency is today to reduce the sample analysis time. The Houillon method can be presented as an alternative for faster analysis, still providing similar accuracy to the manual method described in ASTM D445.

Time saved from one hand can be then used for a second analysis that allows crosschecking results and ensuring a perfect measurement. 4 tests can be performed at the same time in the bath.

Low Solvent Consumption

1 or 2 solvents can be chosen depending on the viscosity of the samples. Programmable cleaning and drying cycles are related to one or several tubes. The NVH 450 integrates in standard a double solvent system offering an efficient tube cleaning and drying with the lowest solvent consumption possible. Further to this, the safety is maximized as the solvent is pumped through a sealed system: No risk of solvent ejection

Quick Bath Heating and Cooling

Having a small liquid bath volume, the heating and cooling of the medium is being done in highly acceptable times.

Reliable

Comparable to the results obtained by using the D445
No distinction between used oils and others.

Viscosity Index Calculation

The Viscosity index (VI) is a numbering scale indicating the changes in oil viscosity with changes in temperature. The VI of a sample is usually calculated from results obtained at 40°C and 100°C through an algorithm defined in the ASTM D2270 standard method. It is critical information, as indication of operation conditions of engine oils. .

To measure viscosity at two temperatures and calculate the VI staying cost effective, laboratories need a quick and accurate equipment. The NVH 450 allows VI calculation of an oil by recall of both results at 40°C and 100°C from the stored data (200 results) or through the connexion of 2 NVH working at the different temperature and linked through the network (LIMS for example) without need of external computer.

Calibration Procedure

The instrument utilizes multiple sample measurement (from 5 to 10) on each tube before a calibration is

Viscoscity Measurement

recorded. The confidence factor must be low enough to get a calibration validated. Calibration is done with the tube placed in the bath. No need for factory calibration.

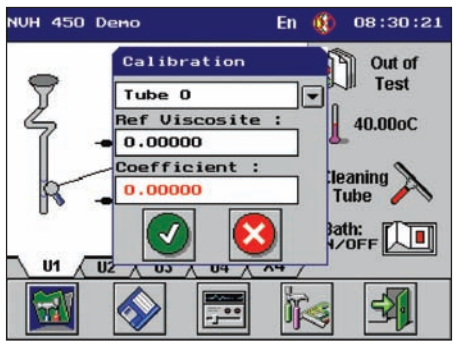

Fig 4: Calibration menu - start up

Summary : Main Advantages of the Method

- Low sample volume : from 100 to 400 µl
- Short test duration : from 50 to 200 seconds
- Detection of clear and dark products with the same tube
- Low solvent consumption
- Accurate and reliable results
- Traditional as using capillary tube
- VI Calculation

Summary: Latest Software Technology Allows

- Easy launch of test & comfort of use
- Quick training of the operators
- Accurate detection
- Flexible calibration procedure
- Flexible cleaning system
- Intuitive network mode when 2 equipments are connected

Conclusion

The New automatic Houillon viscometer NVH 450 combines the advantages of a quick and economical standard method for viscosity measurement with the latest improvements in technology to reach comfort of use and accuracy. 4 tests can be launched simultaneously and apart from sample introduction, all the operations are driven by the internal CPU.

2 NVH 450 can be connected, and allow quick VI determination having 2 different temperatures.

Tube calibration and installation is comfortable, due to a special bath design and to the test procedure being computerized through user-friendly software managed by the operator via colour touch screen. The solvent tanks and washing circuit are included in the equipment.(under the bath) for a maximum operator's safety. It also offers the choice between 12 cleaning cycles related to the tube characteristics.

Using the Houillon method, oil analysis labs now can have the rapid throughput of the highest quality automatic viscometer with comparable repeatability and reproducibility of the ASTM D445 procedure.

Features of New Normalab Analysis Houillon Viscometer NVH 450

- Plug and play equipment : no external connexion for use above ambient
- Small foot print (wxdxh in mm : 540x340x760)
- 4 tubes in the same bath
- Measuring range from 0,2 to 5000 Cst
- Full automation of the method and computer interface through a user friendly software accessible by colour touch screen
- Temperature range from 20°C to 120°C (optional chiller can be connected to work below ambient)
- Temperature stability +/- 0,015°C (2 heating elements associated)
- Excellent Correlation with ASTM D445
- Automatic calculation of viscosity index (VI)
- Flow measurement by optical fibre
- Positioning and re-positioning of the tubes without new calibration
- Automatic tube cleaning with 2 solvents in standard
- Choice between 12 automatic cleaning cycles depending on tube characteristics
- Alarm to prevent from both solvent overflow AND avoid suction in empty bottles
- Easy bath maintenance and quick drainage by the means of a tap

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