MultiScan MS 20

Determination of Heavy Fuel Oil Stability and Compatibility with MS 20 According to ASTM D7061

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Understanding Interfaces

Understanding of the stability of heavy oils is an important issue in petroleum industry (Fig.1). The destabilization of asphaltenes (macrocyclic organic compounds that are found in crude oil that can precipitate when pressure, temperature, composition of shear rate changes) in heavy oil will lead to a series of problems, such as heat exchanger fouling, stable oil-water emulsion, major damage in the petroleum processing, etc. Besides, the flocculation and deposition of asphaltenes can be caused by incompatible heavy oil blends. Hence, it is of great significance to predict stability of asphaltene in heavy oils. MultiScan (MS 20) (Fig. 2) from DataPhysics Instruments is a compact and versatile measuring device for the optical stability and aging analysis of a variety of multi-phase dispersions. The asphaltene stability study of two heavy fuel oil samples with MS 20 according to standardized ASTM D7061 will be presented throughout this application note.

Fig. 1. One of the heavy fuel oil vials at the beginning and the end of the experiment.

Keywords: MultiScan 20 (MS 20) ▪ Stability Analysis ▪ Separability Number ▪ Heavy Oil ▪ ASTM D7061

Technique and Method

Due to the polarity and polcyclic aromatic chemical structures of asphaltenes, they are insoluble in paraffinic hydrocarbons, like n-heptane, but soluble in aromatic solvent, like toluene. The flocculation and aggregation of asphaltene molecules are prone to occur even in low concentrations. Therefore, the stability and compatibility of heavy oil can be evaluated based on transmittance change of light when adding n-heptane.

MS 20 from DataPhysics Instruments is a measuring device for the automatic optical stability and aging analysis of liquid dispersions and the comprehensive characterisation of time- and temperature-dependent destabilisation mechanisms. It consists of a base unit and up to six connected ScanTowers with temperature-controlled sample chambers (Fig. 2).

Fig. 2. DataPhysics Instruments stability analysis system MultiScan MS 20 with six independent Scan Towers.

The ScanTowers of the MS 20 can be individually controlled and operated at different temperatures (4 °C to 80 °C).

Experiment

A small vial filled with the desired dispersion is placed in one of the “Scan Towers” of the MS 20. The scanning system composed of a transmission and backscattering LED together with a detector moves along the vial and scans at regular time intervals.

The obtained transmission and backscattering intensity are represented in an intensity-position diagram. Changes in the detected measuring signal can provide explanations on the stability properties of the sample. Fig. 1 shows the heavy fuel oil vials at the beginning and the end of the experiment.

According to standardized ASTM D7061, the oil stability reserve test was conducted:

- Two oil samples (sample 1 and sample 2) were diluted with toluene (in which asphaltenes are soluble)
- n-heptane is added to induce asphaltene flocculation
- Samples were placed in MS 20 tower and changes of the samples can be monitored precisely by scanning the vial vertically
- The measured zone was between 0 mm (bottom of the vial) and 57 mm (fill level of the vial). One scan was run every 60 s for 15 min
- Separability number was obtained by MSC software.

Results

According to ASTM D7061, the separability number (stability number) describes how easily the asphaltenes floculate upon addition of heptane. When separability number value is between 0 and 5, the oil is very stable and has less risk for flocculation. If its value is between 5 and 10, or even higher than 10, the stability reserve of the oil is low or very low.

Fig. 3 and Fig. 4 show the plot of the transmission intensities against the position. The colourcoding of the curves indicates the time at which they were recorded, from red (start of the experiment, t = 0 s) to purple (end of experiment, t = 15 min). Every curve represents one individual measurement. The transmission diagram shows that the transmittance through the sample increases, because asphaltenes precipitated out of solution.

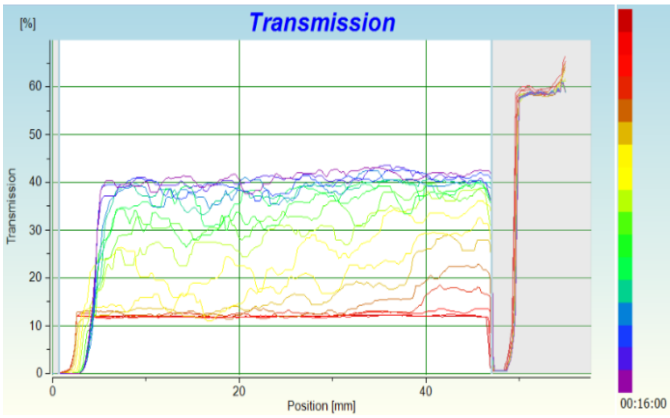

Fig. 3. Transmission intensity vs. position diagrams of sample 1

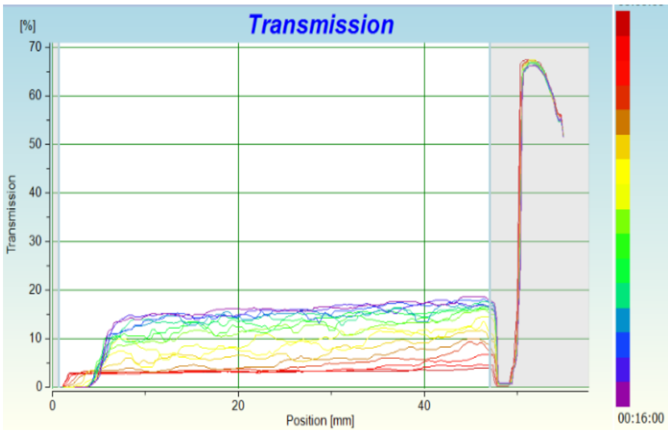

Fig. 4. Transmission intensity vs. position diagrams of sample 2

The changes of transmission intensity were evaluated via using the Value Analysis Method of the MSC software. The obtained diagram (Fig. 5 and Fig. 6) plots the mean intensity of the experiment against time. The standard deviation of the total average transmission is the separability number of sample 1 and sample 2 which are 10.4 and 4.22, respectively, indicating that the oil stability reserve of the sample 1 is very low and sample 2 has a high stability reserve.

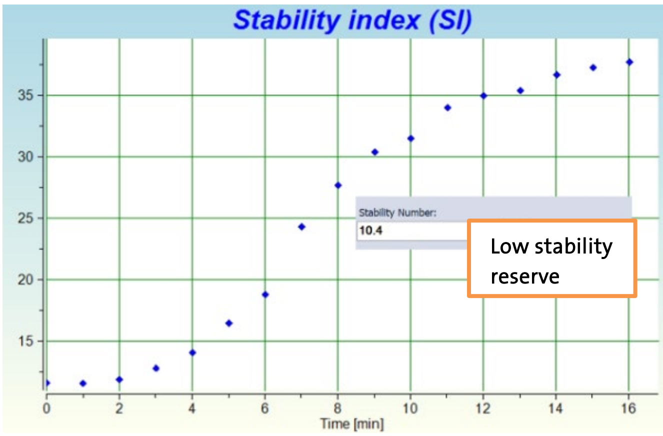

Fig. 5. The change of transmission stability index of sample 1 vs. time

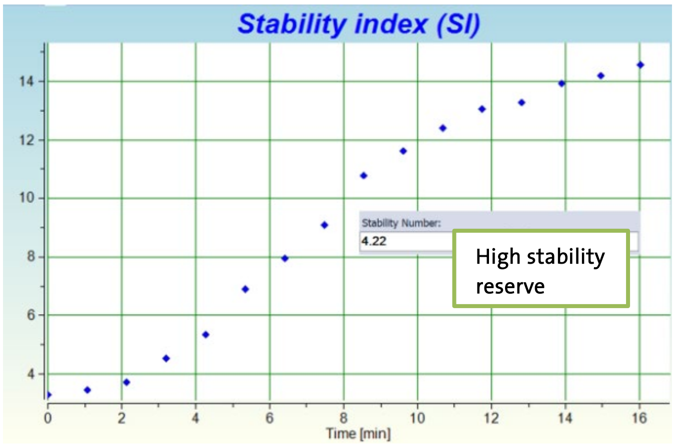

Fig. 6. The change of transmission stability index of sample 2 vs. time

Summary

Using the MS 20 stability analysis system and its corresponding MSC software, it was possible to study the oil stability reserve of different heavy fuel oil.

This technique, provides an easy and reliable way to quantify the stability heavy oil within a short time precisely. It is very important for the petroleum industry to understand well the stability and compatibility of heavy oils.

Literature

*[1] **R. A. Kishore Nadkarni**. ASTM Stock No. MNL44–2nd, Guide to ASTM Test Methods for the Analysis of Petroleum Products and Lubricants 2nd Edition*

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