EFFECTIVE VISCOSITY MANAGEMENT IN ASPHALT REFINERIES

INTRODUCTION

There are more than 700 refineries worldwide, operating in virtually every country, with a capacity to produce 82 million barrels of oil per day[1]. Of these, 137 operate in the US with an estimated capacity of 17 million barrels of crude oil per day. With the demand for energy continually rising, there is immense pressure on producers to streamline and speed up production, increase yield, and operate more efficiently.

A barrel of crude typically yields 50% gasoline, 15% fuel oil, 12% jet fuel, and so on through diesel, asphalt, lubrication oil, and other refined products. However, actual output varies dramatically by refinery. Viscosity is one on the most critical measures of product quality for virtually every refinery product. New developments in viscosity measurement are enabling refineries to realize significant improvements in production quality, cost, and output. These new developments and their respective benefits are discussed below for an asphalt refining application.

IN-LINE VISCOSITY ANALYSIS OF ASPHALT

Asphalt is critical for road paving. Roads are subject to radically different environments throughout the world and throughout the year, so the asphalt must be suitable for those local conditions. All customers have asphalt pavement specs suitable for their region.
The raw material for making asphalt is basically what is left in the bottom of the barrel of crude oil when all higher value materials have been extracted and refined. Therefore, that material can be very non-homogenous, and can vary radically in make-up from barrel to barrel depending on the source of the crude as well as variations in the refinery process conditions.

Customer specs are based on international standard test methods that utilize standard laboratory test equipment. These lab tests are done periodically throughout production, and the process is adjusted based on the test results. The material is then tested in the storage tank and re-blended to meet the exact customer specifications. Unfortunately, the asphalt characteristics can vary significantly between lab tests (see Figure 1). With fluctuations in raw material and process manufacturing, periodic laboratory testing doesn't truly represent the asphalt being produced. This means refineries spend a significant amount of time and money on post-process blending to meet their minimum targets.

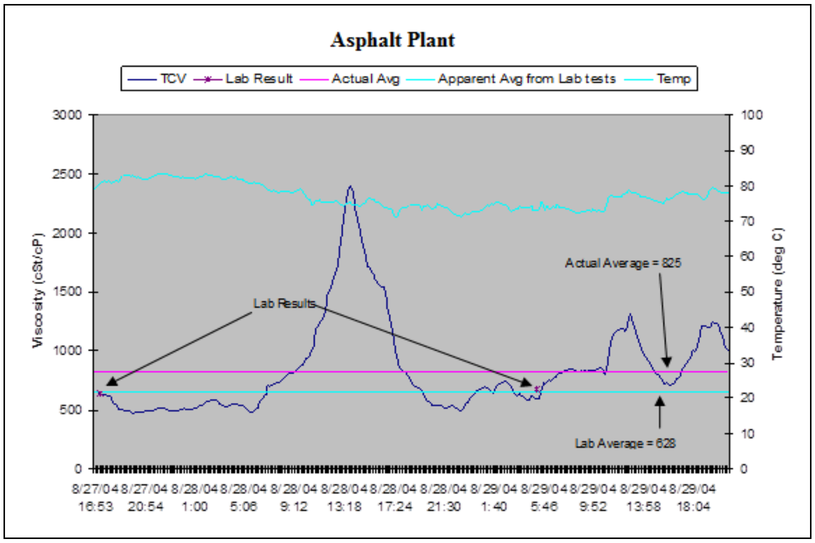

Figure 1

With accurate in-line viscosity analysis, operators are able to properly control the process and enhance production consistency. Three technologies are commonly used for in-line viscosity measurements: capillary, vibrational and oscillating piston. The oscillating-piston is preferred for its accuracy, reliability, ease of installation, small sample size, and low maintenance requirements. Capillary systems require high precision pumps for accuracy, as well as frequent and costly maintenance and recalibration. Vibrational-based viscometers can cause resonance frequencies in fluids and are subject to process equipment vibrations which can result in incorrect data.

All these technologies typically require conditioning of the fluid being tested in terms of temperature, flow, and particles so that it is as consistent as the lab samples. However, through a technique called Temperature Compensated Viscosity (TCV), process instruments can provide real-time process viscosity information at the laboratory reference temperature without sample conditioning. By utilizing the TCV technique, process viscosity analyzers eliminate the effects that the process temperature can have on the product and achieve a correlation between on-line and lab results. This technique uses a mathematical relationship based on the ASTM standard D341 that is accurate for liquid hydrocarbons and most other Newtonian fluids. This method is a procedure for determining the viscosity-temperature relationship of a petroleum oil and providing viscosity data at a reference temperature that is different than the actual process temperature (See Figure 2).

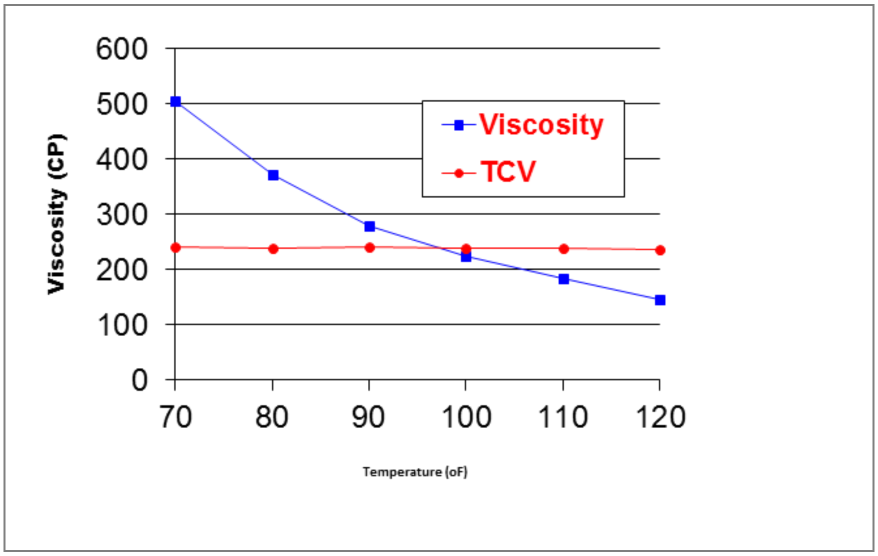

Figure 2

In a typical asphalt process, an oscillating piston viscometer is installed in the main asphalt line or in a bypass to the asphalt line. This allows real-time viscosity measurement, and a savings in installation, maintenance, material, processing time, and labor. A typical asphalt process diagram is outlined below (See figure 3). This viscometer is located in a 2" bypass line of a 12 inch mainline, and is used to maintain the diluent addition to achieve the ideal customer specification the first time.

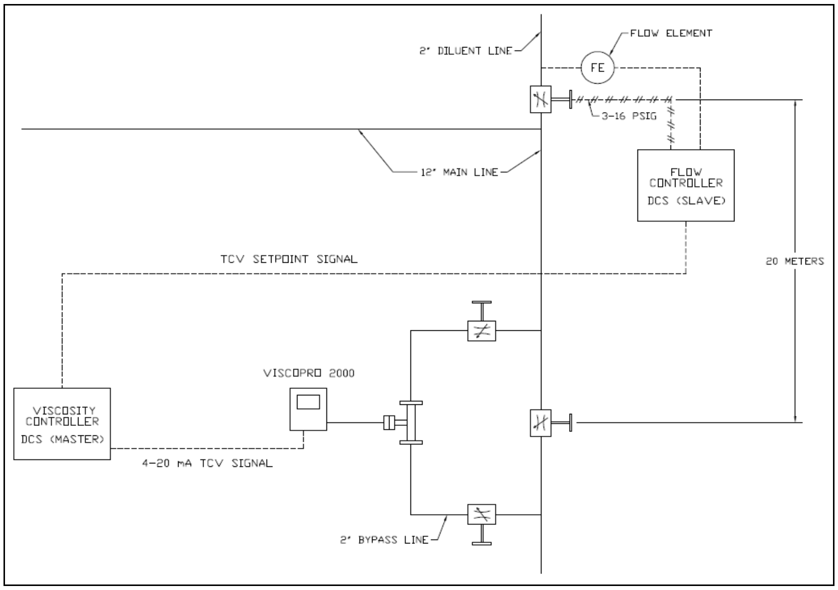

Figure 3

Case Study

A Brazilian refinery produces five unique grades of asphalt, each with a different viscosity that needs to meet a targeted specification. One of the refinery's biggest challenges was caused by the significant variation of the viscosity and density of asphalt during processing.

The refinery installed a Cambridge Viscosity VISCOpro 2000 in-line viscometer, which uses oscillating piston technology and the TCV technique, to automatically measure the kinematic viscosity of the in-process asphalt production. Figure 3 displays process data for the two days prior to implementing in-line viscosity control and the three days afterwards. The “before” portion of Figure 3 shows significant, continuous viscosity fluctuations prior to in-line control. The "after" portion of the diagram displays process data when in-line control was implemented with the Cambridge viscometer. This “after” section shows much tighter viscosity control in the process and continuing close correlation between the results of the periodic laboratory tests with associated in-line results. With this solution, the refinery achieved continuous sample measurement with no missed data points and spot-on correlation with lab results. It should be noted that in this test the control parameters for the Cambridge viscometer were not optimized for the characteristics of the specific plant process environment. Despite that, the plant realized the following benefits:

- Product variation was reduced by 90%
- Significant monetary savings were realized by reducing diluents use
- Targeted product specs were met with minimal post-process blending

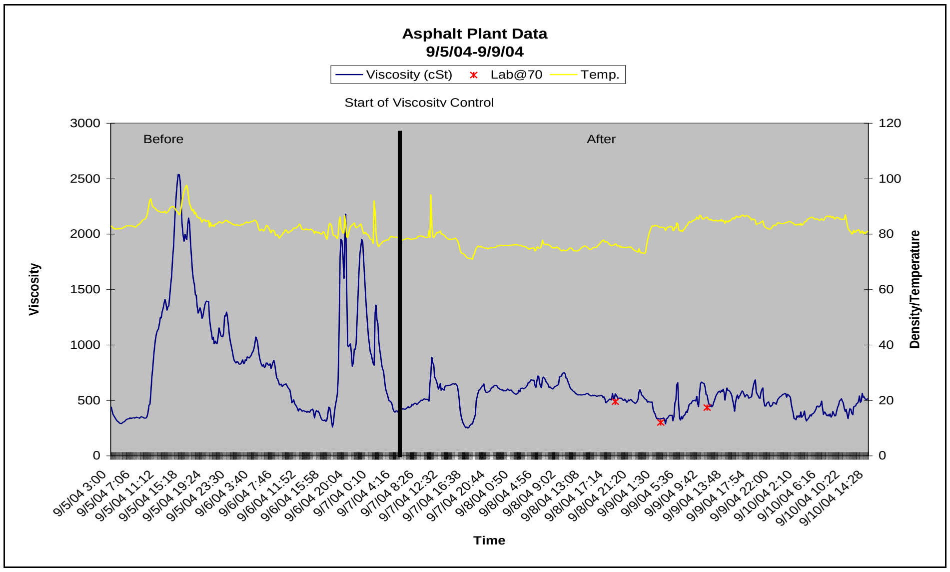

Figure 4

RETURN ON INVESTMENT

At some refineries, it takes 4-12 hours to realize and correct off-spec production. This can cost a refiner up to $150,000 per off-spec occurrence for a low value material, such as asphalt. On-line, real-time viscosity measurement can help eliminate this cost.

CONCLUSION

Heavy competition in the refinery marketplace today drives refiners to produce more with fewer resources to maintain narrow margins. Highly accurate, real-time viscosity measurements aid refineries in reducing operational costs and increasing production of materials, such as asphalt. Oscillating piston is the preferred technology of in-line viscometers due to its inherent accuracy and reliability advantages over competing approaches. The VISCOpro 2000 combines oscillating piston technology with the TCV technique to provide accurate online asphalt viscosity measurements without a sample conditioning system. In addition to asphalt applications, the VISCOpro 2000 can accurately measure other heavier products, such as roofing materials. With a high temperature option, it can measure viscosity up to 375°C.

ABOUT CAMBRIDGE VISCOSITY BY PAC

With more than 10,000 installations worldwide, Cambridge Viscosity is the proven leader in viscosity management technology. With over 25 years of experience, Cambridge Viscosity understands and meets the needs of laboratory researchers and process engineers in a wide range of industries whose jobs depend on the quality, accuracy, and reliability of viscosity measurement equipment. Cambridge Viscosity is part of the PAC team. Visit http://paclp.com/Process_Analytics/Brand/Cambridge%20Viscosity.

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