White Paper

EFFECTIVE VISCOSITY MANAGEMENT IN ASPHALT AND LUBRICATION OIL REFINERIES

INTRODUCTION

There are more than 700 refineries worldwide with a capacity for 82 million barrels of oil per day[1] operating in virtually every country on earth. 137 of these operate in the US with an estimated capacity of 17 million barrels of crude oil per day. Demand for energy continues to rise along with pressures on producers to streamline and speed production, increase yield and operate more efficiently.
A barrel of crude yields 50% gasoline, 15% fuel oil, 12% jet fuel, and so on through diesel, asphalt, lubrication oil and other refined products, but 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 significant improvements in production quality, cost and output. These are discussed below for asphalt and lubrication oil refining.

ASPHALT

Asphalt is critical for road paving. Roads are subject to radically different environments throughout the world, and throughout the year. Asphalt must be suitable for those local conditions. All customers have asphalt pavement specs that are 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. 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. Variations in refinery process conditions can also have an impact.

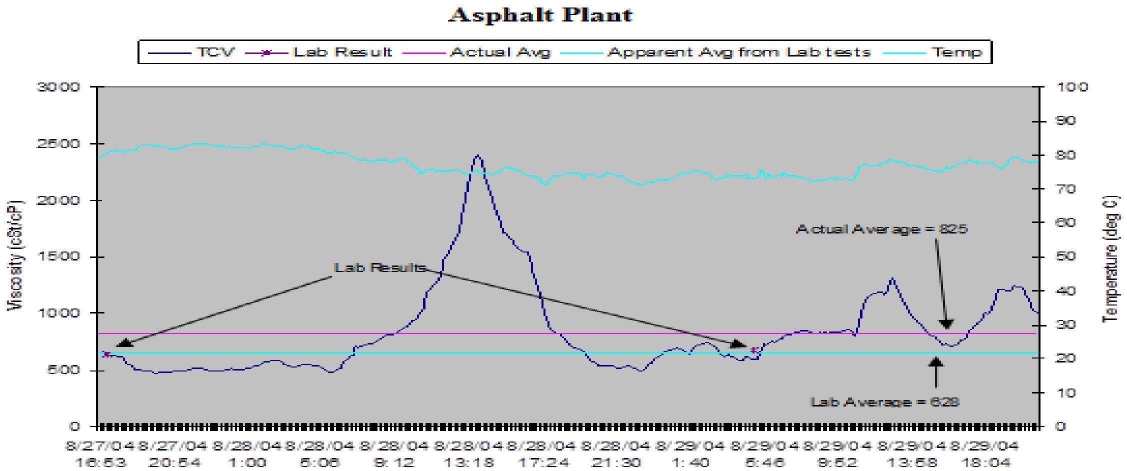

Figure 1

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. This can require significant post-process blending to meet customer specifications (see example below- Figure 1).

Refineries utilize in-line measurements to enhance production consistency. Three technologies are commonly used for in-line viscosity measurements: capillary, vibrational and oscillating piston. All require conditioning of the fluid being tested so that it is as consistent as the lab samples are in terms of temperature, flow, and particles. The oscillating-piston technology is preferred for its accuracy, reliability and ease of installation. Capillary systems require high precision pumps for accuracy, but require frequent and costly maintenance and recalibration. Vibrational-based viscometers can cause resonance frequencies in fluids which cause inaccurate measurements, and are subject to process equipment vibrations which also can cause incorrect data.

A typical asphalt process flow diagram with an oscillating piston viscometer is installed in the main asphalt line or in a bypass to the asphalt line. A diagram is outlined below figure 2. 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.

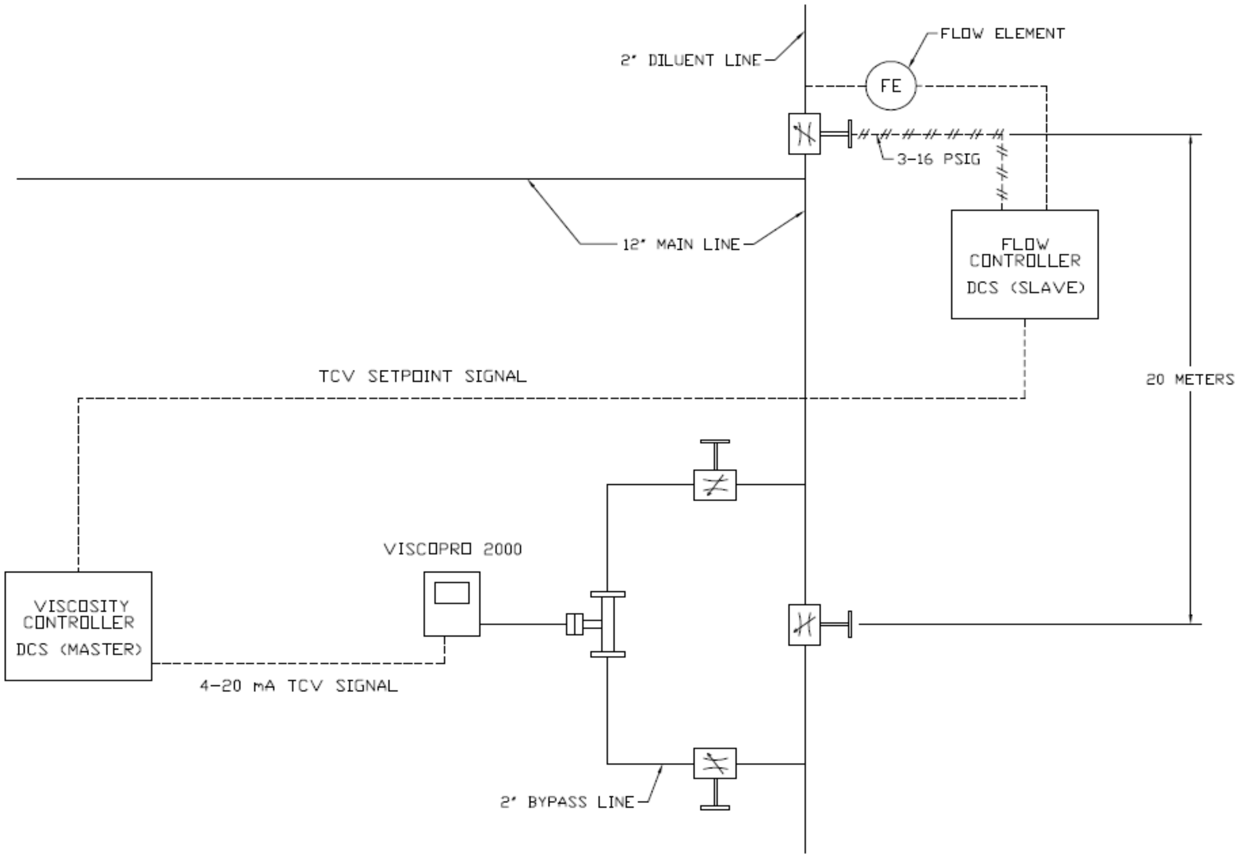

Figure 2

LUBRICATION OIL

All lubrication oils are graded and sold based on their viscosity characteristics. Viscosity is the measure of a fluid's resistance to flow, so the ideal lubricant is frequently one that keeps moving parts separated at the lowest viscosity possible. The industry typically uses VI, or viscosity index to characterize lubricants. The VI is a ratio that compares the viscosity of oil at two different temperatures, and is a governing specification for any lubricating oil.

Highly precise viscosity measurements are required for lubricant production. Obvious cost advantages exist from producing lubricants with the specified characteristics the first time rather than trying to blend them in later. Meeting laboratory results in line typically requires process instruments to be installed in a by-pass line that is conditioned for constant temperature, flow, and with particulate filtering. CVI's in-process viscometers provide great accuracy and matches the lab results for most of these lube oils. (See figure 3, on in-line versus laboratory measurements below.)

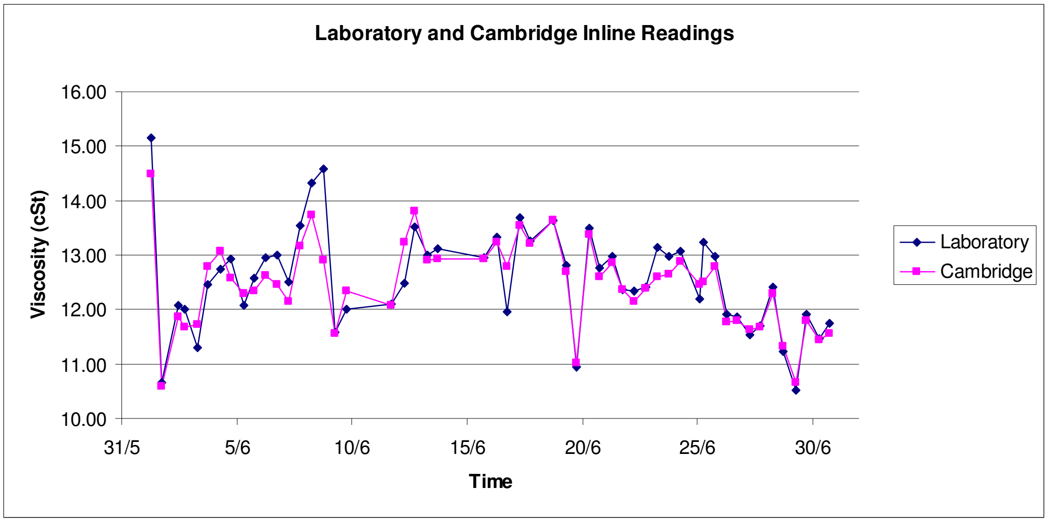

Figure 3

For higher accuracy, some refineries use dual viscometers at slightly different temperatures and average their results as the basis for each measurement. (An example of this is shown below in Figure 4). Achieving these results requires viscometers that are extremely accurate and extraordinarily reliable in the wide variety of environmental conditions to which refineries are subject.

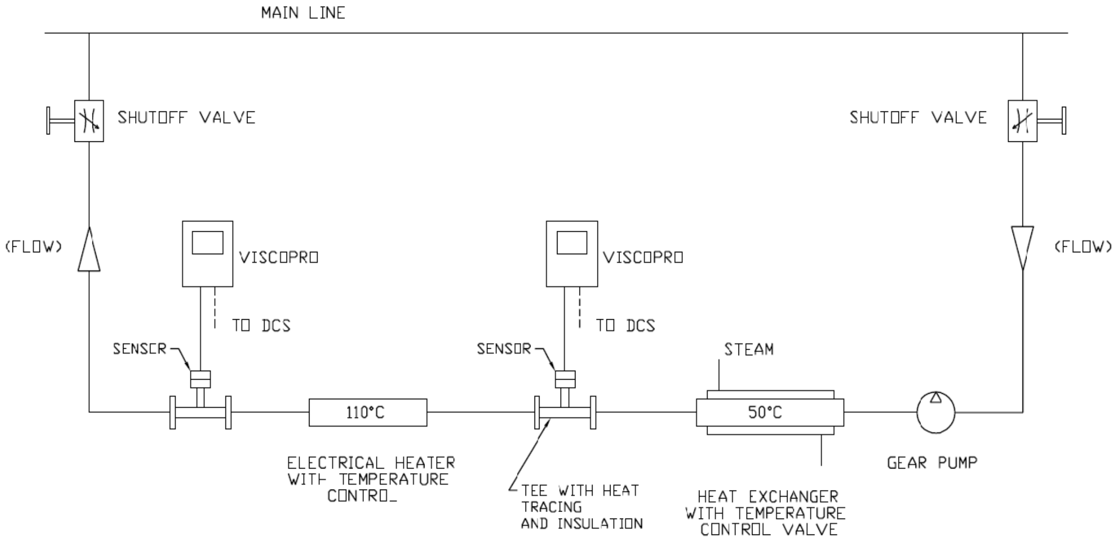

Figure 4

Oscillating piston technology is the preferred solution for a growing number of refiners over competing pressure and vibrational measurement approaches. Sensors utilizing oscillating piston technology outperform the others because of their high accuracy and repeatability, robust design, low maintenance requirements and vibration in-sensitivity, and inherent small size for ease of installation plus the associated reduction in sample conditioning costs. They typically have the lowest total cost of ownership as well.
The profitability of in-line control for lubricant production is significant. At some refineries, it takes 4-12 hours to realize and correct off-spec production. This can cost a refiner $150,000 per off-spec occurrence for a low value material (e.g., asphalt) and up to up to $500,000 for a high value material (e.g., lube oils). Installation of an in-line viscometer, on the other hand, costs on the order of $25,000 - $50,000 for total installed cost. In addition to this savings, one refinery reports that maintaining tighter control on their lube oil viscosity results in a 0.5% production improvement, or $600,000 in revenue per line per year.

COMBUSTION PRODUCTS

Precise control of the fuel viscosity is important as well. Viscosity controls the droplet size in fuel atomization, which is essential for efficient combustion. This includes fuels ranging from heavy fuel oil to diesel and gasoline plus jet fuels. Real time monitoring enables the meeting of tight regulatory standards and provides audit trail confirmation of the product quality.

CONCLUSION

In refinery applications where producing off-spec material can cost hundreds of thousands of dollars per day, refiners are increasingly relying on real time continuous in-line measurements to extend traditional off-line lab tests to assure product quality. The ROI for in-line viscosity control is measured in days for asphalts and lubrications oils. Oscillating piston is the preferred technology of in-line viscometers due to its inherent accuracy and reliability advantages over competing approaches. For refinery operations hard pressed to keep up with demand, this difference is critical.

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 www.paclp.com.