Viscosity Application Refineries
Role of Viscosity in Refineries – Overview

- **Viscosity** is a critical measurement for refineries
- Virtually all customers buy refinery products by their viscosity grades, based on internationally accepted ASTM
- D445 lab measurements, performed
  - periodically in-process
  - final quality verification
- Unfortunately, production varies substantially between lab measurements, achieving customer specifications requires post-refining blending

**In-line real time measurements substantially improve viscosity control, thereby reducing refinery costs and improving throughput**
Refineries Are Complex Operations

CVI portion: Atmospheric and Vacuum Distillation to Solvent de-asphalting and Lube feedstock

Our entry opportunities have been in Asphalt, HFO & Lube oils (yellow shaded)
Periodic Lab Measurements are Inadequate for Process Control

NOTE: Lab readings show process “in spec” …..But the resulting storage tank is not !!!!

Lab average data = 628 cSt. Actual average = 825 cSt. A 26% difference !!!!
Meeting Measurement Challenges

Viscosity drives in-line blending to hit quality targets efficiently
- Maximize production
- Minimize diluent
- Eliminate reprocessing

Monitor process with
- ASTM consistent instrumentation > correlation primary test method
- Provide fast and robust results
- Lower maintenance costs – self cleaning sensors

Oscillating Piston Method uses the same technology for lab & process – all ASTM consistent, producing accurate and repeatable results
Oscillating Piston Measurement Technique

- Constant piston motion keeps sample fresh and sensor clean.
- No seals, one moving part.
- Proprietary electronics measure absolute viscosity from piston cycle time. Complies with ASTM D7483.

Fluid enters measurement chamber.

Lead coil sets up magnetic field to drive the piston.

Trailing coil tracks piston electro-magnetically.

Coils switch when piston moves by detect point.

Temperature detector.

Sensor Shown in Process Line.
Installation Overview

• Installed in bypass lines with conditioning to meet lab results:
  - flow control
  - temperature control (insulated, heat traced, etc.)
  - particulate filtering (in some cases)

• Controlling temperature is essential for accurate viscosity information

• Temperature compensated viscosity (TCV) is used if process temperature is different from lab)
- Bypass line uses delta pressure valve to ensure flow
- Viscometer output controls set point of the diluents flow control
- Distance between control valve and sensor creates lag time and requires tuning on DCS
- All bypass lines are heat traced & insulated
CVI in Refinery Monitoring
Asphalt

Flexibility of implementing sensors

Sensor bypass line
Insulated & heat traced for temperature control – essential for accurate viscosity information

Sensor in bypass line with flushing ports
Asphalt Viscosity Data -

![Graph showing Asphalt Viscosity Data with Lab Values (P), Raw Data (mP), and Process Temperature trends over time.](image-url)
• Temperatures in production environments are often not controlled
• Temp swings can cause fluid to have different viscosity values
• ASTM D341 curves can be programmed into the VISCOpro
• TCV enables operators to despite temperature swings
CVI Process & Lab Data Tracks

Laboratory and Cambridge Inline Readings

(Both measurements are with constant temperature conditions)

High correlation to lab ASTM results
Asphalt Process Control

Result = Control band reduced from +/- 500 cP to +/- 40 cP
VISCOpro Tracking

Blending

Giveaway

No Control  Viscosity Control

Margin Improvement
Benefits

• Minimize the production of off specification material during “product run down”
• Minimize use of diluents in blending
• Avoid off specification events with information between laboratory tests
• ROI can easily be achieved in DAYS
Real Time Measurements
Compliment Laboratory

• Internationally accepted lab tests are required
• Real time data monitoring
  • Extends laboratory analysis
    • Lab is a snap shot
    • Real time monitoring is a continuous view
• Improves Quality Control
• Reduces testing demand on labs: labs can be used only for final QC

Results = improved process efficiency from tight viscosity control