The Advantage of Real Atmospheric Distillation using D7345 Test Method

Presented by
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Distillation - a Critical Measurement

- Crude feedstock has a complex mixture of hydrocarbons
  - Separate the hydrocarbons through evaporation and condensation
  - Boiling range gives information on composition, properties of fuels
# Distillation Method Comparison

| ASTM D86          | • Historical test method  
<table>
<thead>
<tr>
<th></th>
<th>• Determines the boiling range of the product by performing a simple batch distillation</th>
</tr>
</thead>
</table>
| ASTM D7345        | • Alternative distillation method  
|                   | • Uses MicroDistillation  
|                   | • Provides fast results using small sample volume |
ASTM D7345 - Microdistillation

- Real online distillation analysis
- Demonstrates temperature limitations at 400 °C, 752 °F
Case Studies
Case Study #1: Analyzer Performance

Customer Challenges:

- Large capacity (350,000 bpd)
- Diverse output including:
  - diesel fuel
  - gasoline
  - LPG
  - naphtha
  - kerosene
MicroDist in Distillation Tower
Case Study #1: Analyzer Performance

Microdistillation Solution

- 720 hr Evaluated based on:
  - Operability
  - Robustness
  - Response time
  - Precision
  - Accuracy
  - Ease of Maintenance

- Tested through the distillation range at 5%, 10%, 85%, & 90%
Case Study #1: Analyzer Performance

MicroDist Results

- Repeatability that is superior to ASTM D86 lab standard
- Solutions for several process applications
- Fast analysis cycle of 7 - 10 minutes
- User friendly equipment interface
- Easy installation

“This analyzer surpassed by far our expectations....confronting with other technologies that have been used for 14 years, as online chromatography and infrared techniques... we recommend the analyzer implementation in direct distillation plants for monitoring and controlling of tower fraction cuts, in cracking plants, hydrotreating unit ... all this because PAC’s MicroDist is a real distillation.”

~ Plant Supervisor
Case Study #2: Diesel Optimization

Microdistillation Solution

• Fast analysis that is ideal for on-line control
• Optimizes cutpoint while permitting diesel specs to be met
Case Study #2: Cutpoint Optimization

Distillation Cut Points

**Crude Charge**
100,000 BPD
21.4 API

**Temperature, Deg F**

- **Light naphtha**: 10,000 BPD
- **Heavy naphtha**: 5,530 BPD
- **Kerosene**: 10,890 BPD
- **Mid-distillate**: 9,950 BPD
- **AGO**: 11,260 BPD
- **LVGO**: 2,000 BPD
- **HVGO**: 21,470 BPD
- **Vacuum residue**: 31,400 BPD

**Cut optimization zones**

- $3.30 / gal
- $3.15 / gal
- $3.35 / gal

- 260 F
- 375 F
- 515 F
- 650 F
- 760 F
- 1020 F
Diesel Blending Specification
T 85% 360 °C

OPTIMIZATION

<table>
<thead>
<tr>
<th>Date</th>
<th>T85 - Analisador</th>
<th>T85 - Laboratório</th>
</tr>
</thead>
<tbody>
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<td>361.2</td>
</tr>
</tbody>
</table>

- T85 - Analisador
- T85 - Laboratório
Case Study #2: Cutpoint Optimization

MicroDist Results

- Tight correlation to ASTM D86 lab standard
- Determine accurate diesel cutpoints to maximize margin
- Complete distillation in under 10 minutes

*With microdistillation, optimizing the diesel cut point can result in an additional 0.5% to 1% in production for every 1°C closer to setpoint*
Case Study #3: Gasoline Blender Application

Customer Challenges:

• Blending as economically as possible to
  – Reduce the octane usage
  – Meet required specification.
Case Study #3: Gasoline Blender Application

Excellent Correlation to Lab Results

- 93% regression analysis of the lab and process values at the 50% recovery point
- Allows for good process control for the gasoline production
Case Study #3: Atmospheric Distillation & Boiling Point Analysis in a Gasoline Blender

Achieved a Return on Investment in 36 days with the MicroDist by PAC

<table>
<thead>
<tr>
<th>Investment</th>
<th>$350,000</th>
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</thead>
<tbody>
<tr>
<td>Boiling Point Analyzer and Sample</td>
<td></td>
</tr>
<tr>
<td>System with Installation costs, including shelter, total per system</td>
<td></td>
</tr>
<tr>
<td>Economics</td>
<td></td>
</tr>
<tr>
<td>Incremental analyzer earnings $/year</td>
<td>$300,000/month x 12</td>
</tr>
<tr>
<td>400,000 barrel/day refinery (1 °F closer results to 50% recovery point)</td>
<td>$3,600,000</td>
</tr>
<tr>
<td>Analyzer maintenance $/year</td>
<td>$14,160</td>
</tr>
<tr>
<td>Net analyzer earnings $/year</td>
<td>$3,505,840</td>
</tr>
<tr>
<td>Before tax payout, years</td>
<td>0.10 (pay off in 36 days or about 5 weeks)</td>
</tr>
</tbody>
</table>

This table demonstrates a profitability calculation in the gasoline blender for a boiling point analyzer. A return on investment can be obtained in a little over a month.
MicroDist by PAC
Technology & Features
ASTM D7345 - Microdistillation

Determines the complete distillation curve using data from a single phase transition – evaporation.

- Based on thermodynamic dependencies
- Measures liquid and vapor variations while monitoring the pressure inside a MicroDistillation flask
- Measured vapor pressure characterizes the product flow rate through the hydrodynamic process in the capillary
MicroDist Technology

Analytical Principle: Changes in Temperature and Pressure During an Average 7-minute Distillation Time for Jet Fuel

Pressure and Temperature in the MicroDist Flask
Benefits and Applications

- Correlation to primary test method D86
- Robust technology
- Fast response time

Key Applications include:
- Cutpoint Optimization
- Cetane Index
- Driveability Index
- Density
Questions?