Correlating TBP to Simulated Distillations

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Maxxam Analytics

Overview
Maxxam Analytics – A Bureau Veritas Group Company

- 69,000 employees
- 140 countries
- 400,000 clients
- 1,400 offices and labs
- 8 global businesses
Maxxam Analytics – Part of the Bureau Veritas Group of Companies

- 2,600 employees
- >75% possess technical degrees
- 520 Technical Diplomas
- 756 Bachelor Degrees
- 192 Masters Degrees
- 30 PhDs

42 Locations in Canada
5 Laboratories in the US
59 Laboratories in North America
Maxxam is the market leader in Canada in all the markets we serve.
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TBP Curves and Simulated Distillations
Boiling Point Distribution

- Boiling profile is the most important property of a whole crude oil - provides vital information related to the yield of distillation cuts
- Commonly used distillation techniques in the petroleum labs for crude or petroleum products are:
  - Atmospheric distillation (ASTM D86)
  - Vacuum distillation (ASTM D1160)
  - Vacuum distillation (ASTM D5236)
  - Vacuum distillation (ASTM D2892)
  - Simulated distillations (ASTM D2887/D7900/D7169)
Ideal Boiling Profile by Simulated Distillation

D7169 Modified Simulated Distillation

- Boiling Point (°C)
- Weight % Distilled

- Naphtha
- Kerosene
- Distillate
- Gas Oil
Simulated Distillations

Simulated Distillations are high temperature gas chromatographs (HTGC) with various column lengths and internal standards (compounds) to measure response factors.

**ASTM D7169** – most commonly used by Maxxam for a wide variety of crude oils. Has a final boiling point of 720°C (1328°F). Weakness is with light hydrocarbons (IBP to 260°F)

**ASTM D7900** – replaces the D7169 front end for light end components. Very precise for C₄ to C₈. Merge process is not standardized and can be software determined. Not ideal for very light hydrocarbons (C₁ to C₄)

**ASTM D2887** – good method for lower final boiling point crude oils. Has a final boiling point of 538°C (1000°F)
Simulated Distillations

Pros

• Simulated Distillations are a great tool to “predict” the yields for various physical distillation cuts.
• It can help identify quantity issues for any physical distillation cuts ahead of time
• Can assist in identifying the need to run multiple physical distillations to obtain necessary volumes
• Provides overall boiling point distribution profile of the crude oil
• Can be plugged into modeling software for Flash Assays, update older assays and to substitute for TBP curves

Cons

• Simulated Distillations do not always match to the actual yields of the physical distillation curves.
Crude Assay Types

Crude Assay

Preliminary Assay (Inspection Assay)

Full Assay (Comprehensive Assay)

Conventional crudes

Heavy oils and bitumen
True Boiling Point Distillation (ASTM D2892)

ASTM D2892 “Standard Test Method for Distillation of Crude Petroleum (15-Theoretical Plate Column)”

- Designed for the distillation and fractionation of stabilized crude petroleum to a final cut temperature of 752 °F (400°C) (AET).
- Also suitable for petroleum mixture except liquefied petroleum gases, very light naphtha, and fractions having initial boiling points above 752 °F (400°C).
D2892 – Method Highlights

PROS
• 15/5 distillation (15 theoretical plate column, 5:1 reflux ratio)
• True boiling point distillation (TBP) - Lab Simulation of refinery distillation process
• Greater distillation efficiency for larger number of fractions of interest and can be combined to generate samples for analytical studies
• Operates under adjustable reflux ratio

CONS
• Long run – up to 24 hours
• Requires a larger volume of the sample
• Temperature limitation of max 752 °F (400°C)
• Heavier crudes are usually not suitable because of minimal yields and the increased thermal input required
Vacuum Potstill Distillation (D5236)

ASTM D5236 “Standard Test Method for Distillation of Heavy Hydrocarbon Mixtures (Vacuum Potstill Method)”

- Designed for distilling of heavy hydrocarbon mixtures having initial boiling points greater than 302 °F (150°C), such as:
  - heavy crude oils and petroleum distillates,
  - residues and synthetic mixtures
  - bitumen
- Suitable for the production of distillate fractions in the gas and lubricating oil as well as the production of standard residue
ASTM D5236 – Pros and Cons

PROS

• Requires a smaller sample charge (usually 1 to 5L)
• Maximum distilled temperature is approx. 1040 °F (560°C) AET (depends of the heat tolerance of the charge)
• The lowest operating pressure is 0.1 mm Hg
• Number of the fraction receivers is 12

CONS

• Low efficiency (1 theoretical plate)
• Produces smaller fractions, which can limit the number of analyses possible for any particular fraction
Blended Distillation Curves

Often to obtain a full distillation range of cuts it requires the use of both the ASTM D2892 and D5236 methods.

Inflection point for conversion from D2892 (TBP) distillation to D5236 (Potstill) distillation

Diluent inflection point for a dilbit
Fractionation Process

- If AET > 752 °F (400°C) is required, the residue from ASTM D2892 will be distilled using ASTM D5236 up to a maximum 1050°F (565°C) AET
- Distillation data (yield vs. AET) will generate distillation curves
- The mass and density of each cut or fraction are obtained and distillation yields are calculated from the mass of all fractions
- The collected fractions can be analyzed as produced or combined to produce samples specific to what is needed for engineering and product quality evaluations
- Combined distillation curves obtained from ASTM D2892 and D5236 will be an offset at the switchover point
Factors Responsible for Distillation Curves “Misalignment”

- Difference in number of theoretical plate of the columns (15 vs. 1 theoretical plate)
- Efficiency of the two different distillation methods (cut overlap of 15–20°C for D2892 vs. 50–70°C for ASTM D5236)
Correlating SIMDIST to TBP Curves
Comparing a TBP Curve to a D7900-D7169 vs D7169 Alone

Example #1: Heavy Sour Synbit

Note: D7900/D7169 correlation to TBP Curve is worse
Comparing a TBP Curve to a D7900-D7169 vs D7169 Alone

Note: D7900/D7169 correlation is significantly closer to TBP curve
Comparing a TBP Curve to a D7900-D7169 vs D7169 Alone

Example #3: Synbit

Note: D7900/D7169 correlation is closer to TBP Curve
Comparing a TBP Curve to a D7900-D7169 vs D7169 Alone

Example #4: Heavy Sour Synbit

Note: D7900/D7169 correlation to TBP Curve is much better
Comparing a TBP Curve to a D7900-D7169 vs D7169 Alone

Example #5: Light Sweet Conventional Crude

Note: D7900/D7169 correlation to TBP Curve is significantly improved
Conclusion

• High Temperature Simulated Distillations can provide a quick assessment of boiling point curve and is extremely valuable prior to an full assay or used in an Inspection assay.

• D7900 provides significant improvement in the C₄ to C₈ region and when merged with D7169 it provides better correlation to TBP Curves (most of the time) as it corrects for losses in the C₄ to C₈ region

• Obtaining and reviewing both the D7900/D7169 and the D7169 distillation curves can provide additional value for review of data sets

• There may be a need to look at additional data from a monophasic and isobarometric sample introduction for GC analysis such as ASTM D8003 for the C₄ minus components for lighter hydrocarbon commodities
Questions and Answers

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Thank You to the COQA