



GC MERGE OF LIGHT ENDS WITH ASTM D7169 BOILING POINT DISTRIBUTION

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WHEN YOU NEED TO BE SURE





Providing Solutions Across the Value Chain



SERVICES

	EXPLORATION AND APPRAISAL	DRILLING	PRODUCTION	STORAGE AND LOGISTICS	REFINING AND PROCESSING	LOGISTICS
Subsurface Consultancy	✓	✓	✓			
Well Testing Services	✓		✓			
Cased Hole Services			✓			
Production Fluids Testing	✓		✓			
Metering and Measurement Consulting			✓	✓		
Tools		✓				
Wellhead Services			✓			
Rock Properties Testing	✓	✓				
Trade Related Services				✓	✓	✓
Non-Inspection Related Testing		✓	✓		✓	
Lab Outsourcing Solutions		✓	✓		✓	
Plant and Terminal Operations				✓	✓	✓
Metering and Instrumentation				✓	✓	✓
Oil Condition Monitoring						✓
Sample Management Services						✓
Fuel Integrity Services						✓
Cargo Treatment Services					✓	✓

Refining & Processing Overview

For the refining and processing of crude oil and natural gas, SGS provides the following expertise and services:

— **LABORATORY TESTING, DESIGN AND OUTSOURCING**

— **OUTSOURCED PLANT AND TERMINAL OPERATIONS**

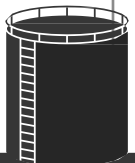
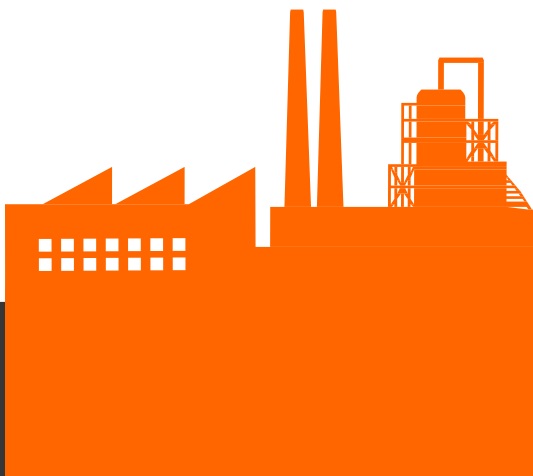
— **METERING AND CALIBRATION**

— **VALUE ADDED BLENDING AND CARGO TREATMENT**

— **MEASUREMENT, SAMPLING AND ANALYSIS**

— **OUTSOURCING SAMPLE HANDLING AND DISTRIBUTION**

— **BIOFUELS BLENDING**



SGS CRUDE ASSAY LABORATORY

- “Assay”: The combination of physical and chemical data that uniquely describe a crude oil. Usually includes **TBP distribution** of the oil. (ASTM **D7169**, **D7900**, D2892, D5236)
- Each assay is customized to meet the unique requirements of each client.
- SGS Crude Assay Laboratories, globally distributed. SGS at Deer Park (TX) services predominantly North and South America.
- Capability to perform full compositional analysis of crude oils and condensates. Full range of testing and analyses covered.
- Both Haverly and Spiral Crude Assay software suites are supported.
- SGS analytical support includes 24/7/365 laboratory operations.

HIGH TEMPERATURE SIMDIST (ASTM D7169)

- Contributions of High Temperature SimDist (D7169) to Crude Oil Quality
 - Mini-Assays (crude oil testing), substitute for TBP curve
 - Flash Assays (crude oil testing), update older assays, TBP Curve
 - Extends TBP curves in new assays to C-100 (720 °C)
 - Quality Monitoring (existing supply stream)

- Benefits & Limitations of ASTM D7169
 - (+) Quicker & cheaper than physical distillation
 - (+) TBP curve smoother, bigger range, better isomer separation
 - (-) GC Technique not actually a distillation
 - (-) IBP to about 260 °F is problematic

COMBINE D7169 WITH LIGHT ENDS (D7900)

- Replacing the D7169 front end with a Light Ends Analysis (up to nonane, 300 °F) will improve the overall results.
- Benefits & Limitations of merging D7169 with D7900
 - (+) Lightest hydrocarbons (C2, C3, C4) missed by D7169 are captured by D7900.
 - (+) Precision of C4 to C8 is improved.
 - D7900 uses internal standard.
 - D7900 eliminates co-elution problem with CS₂.
 - D7900 eliminates FID response quenching.
 - (-) Merge process is not standardized.
 - (-) Accuracy is affected by the merge point.
 - (-) Figure X1.2 illustration in D7169 Appendix is misleading.

X1.2 ILLUSTRATION IN D7169 APPENDIX

ASTM D7169 - 16

ASTM D7900 stops at 300 °F

380 °F?

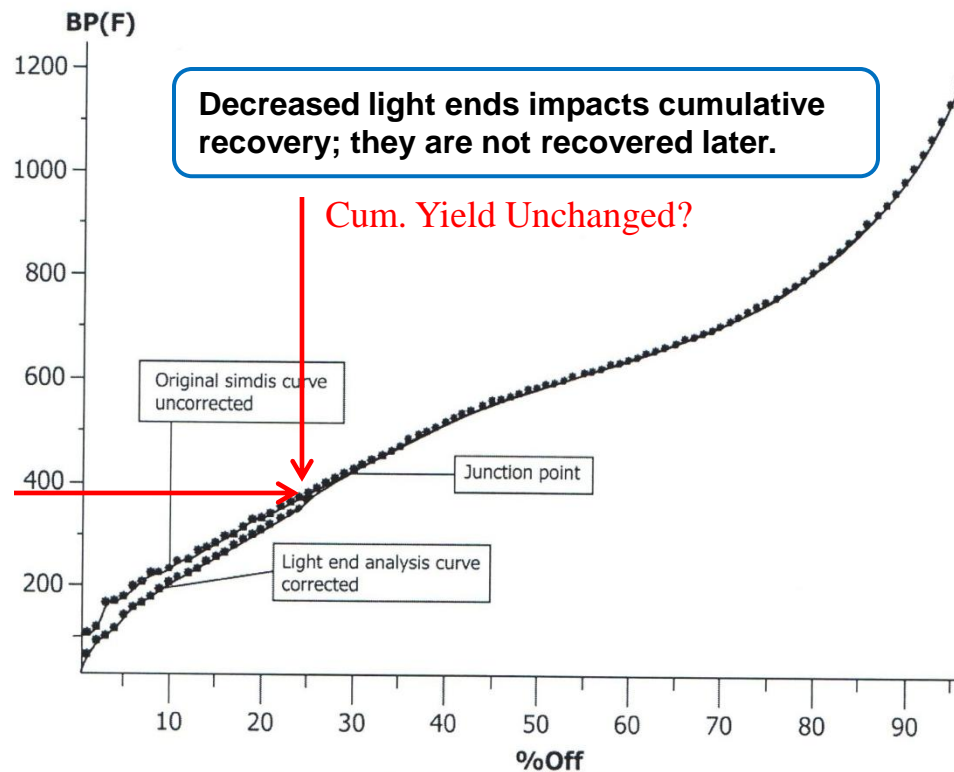
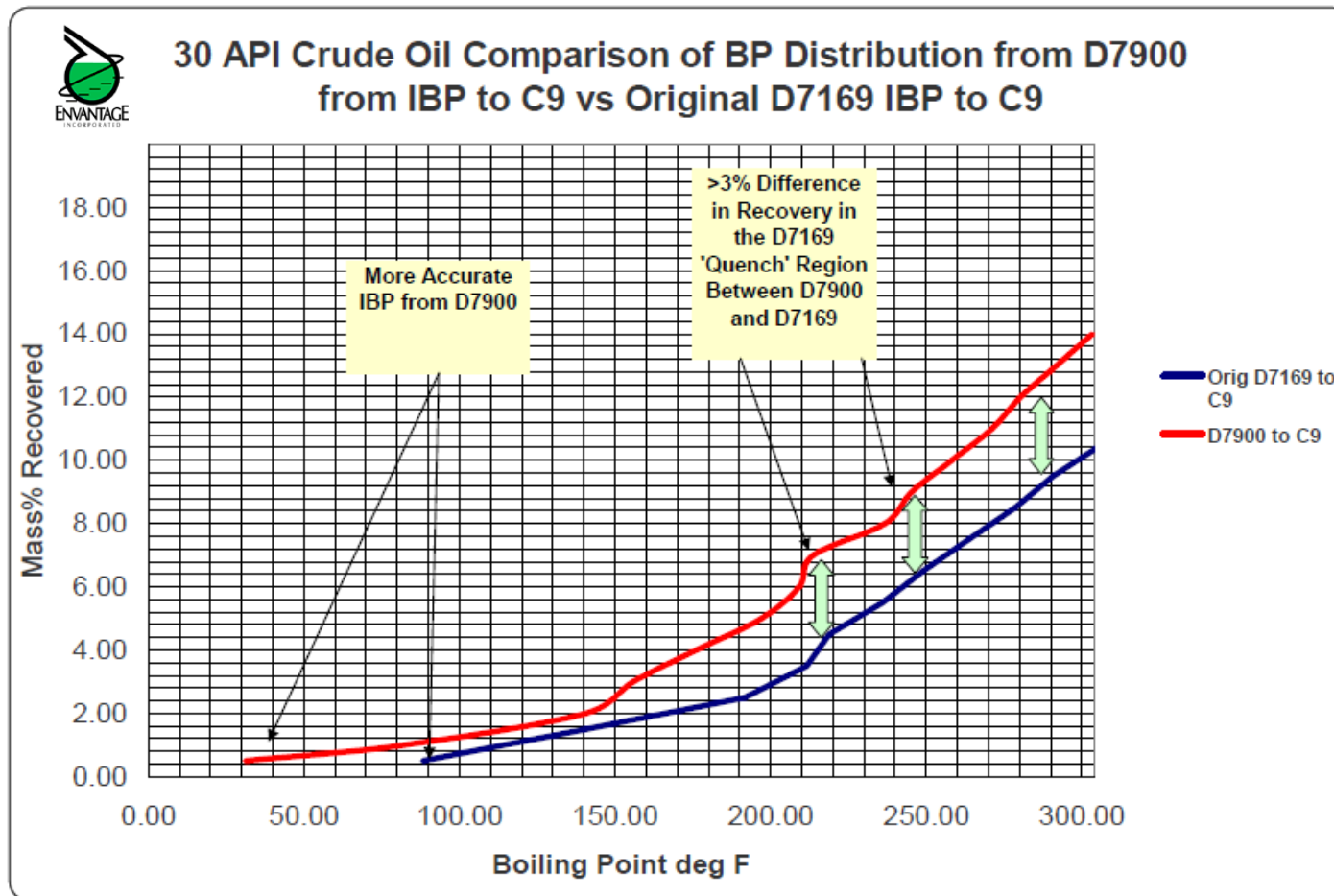


FIG. X1.2 Corrected and Uncorrected Distillation Curves

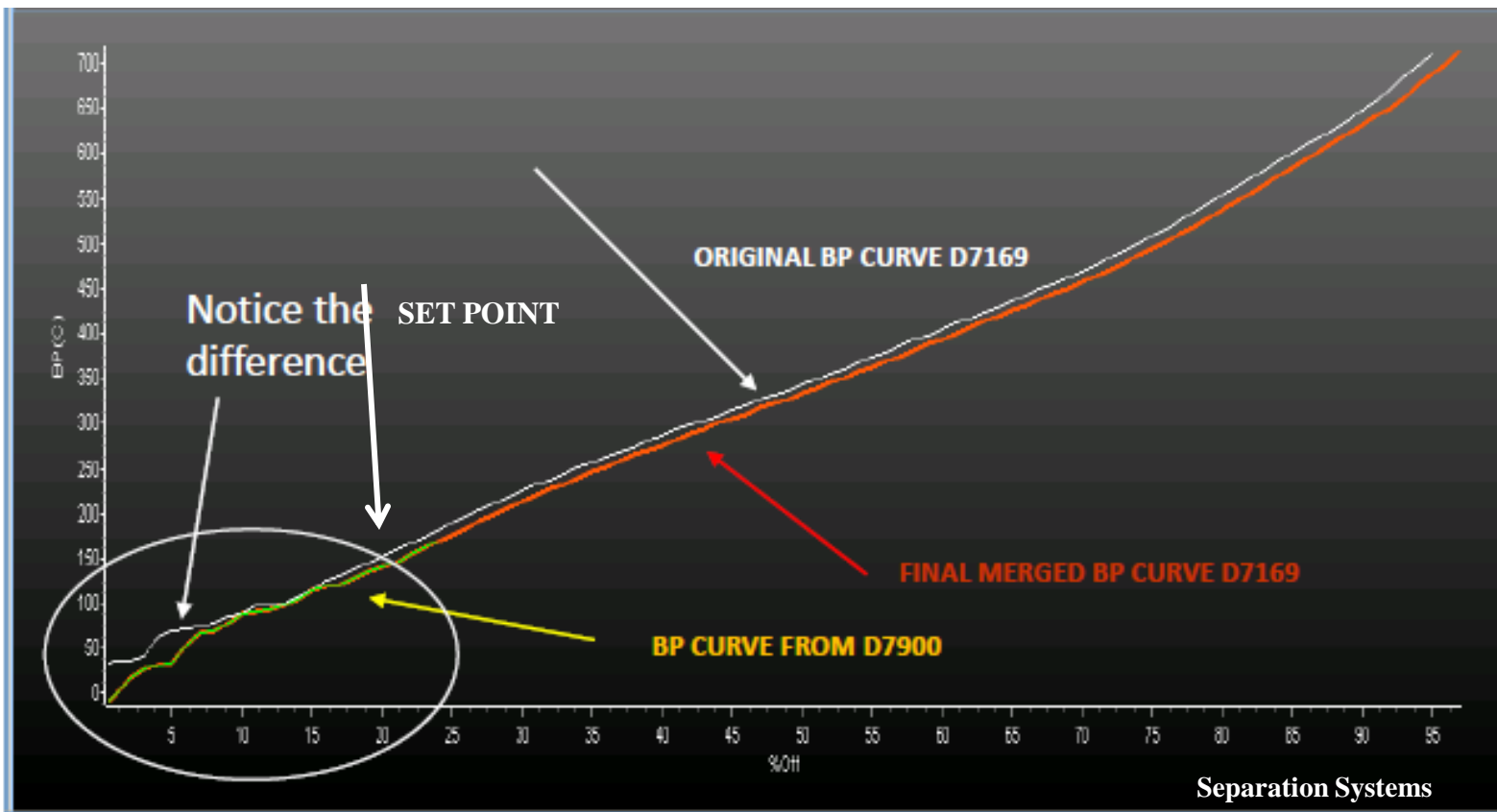
PRECISION IMPACT

- D7169 Reproducibility (R) at 300 °F, about 1.8 mass% yield
 - Integration of CS₂ solvent not quantitative!
 - Impact of quenching region can lower cumulative yields.
- Light gases variable, missing up to 3 mass% for extreme cases
 - Especially true for ethane, propane, and i-butane
 - Other SimDist methods are no better, D2887 (IBP >100 °F), D6352 (IBP >345 °F)
- Note that D7169 test method is not ideal for light crude oils.
- Relative to TBP, deviations from 2 to 5 mass% are possible!

LOSSES IN QUENCH REGION



MERGE OR COMBINE D7169 & D7900 DATA



ASTM PROPOSED MERGE PROCESS

- ASTM Task Group, D02.04L, WK64242
 - Draft method being balloted, D02.04L subcommittee
 - Currently proposing algorithm for GC processing software
- Basic Approach
 - Merged curve begins with D7900 data.
 - HTSD data is appended at set point (not to exceed BP of n-nonane) (user determined).
 - Total recoveries $\geq 100\%$ are normalized through D7169 data only.
 - Mathematics are described.
 - Additional mathematical smoothing or fitting is left to the individual user's requirements and not included in the draft.

SET POINT

- Where to put the Set Point? (transition from D7900 to D7169)
- Ideally between C8 and C9
 - D7169 impact of light ends extends up to C8 (260 °F).
 - Maximum coverage of D7900 is to C9 (300 °F).
 - GC Software usually has a default set point.
- My observations comparing against physical TBP curves
 - For lighter samples with observed losses in D7169, a set point of 300 °F is often best.
 - Where losses are less significant, a set point of 200 °F works better (correcting other deviations with D7169).
 - As with so many situations in the laboratory there are always exceptions!

EXAMPLES, EXPLANATION

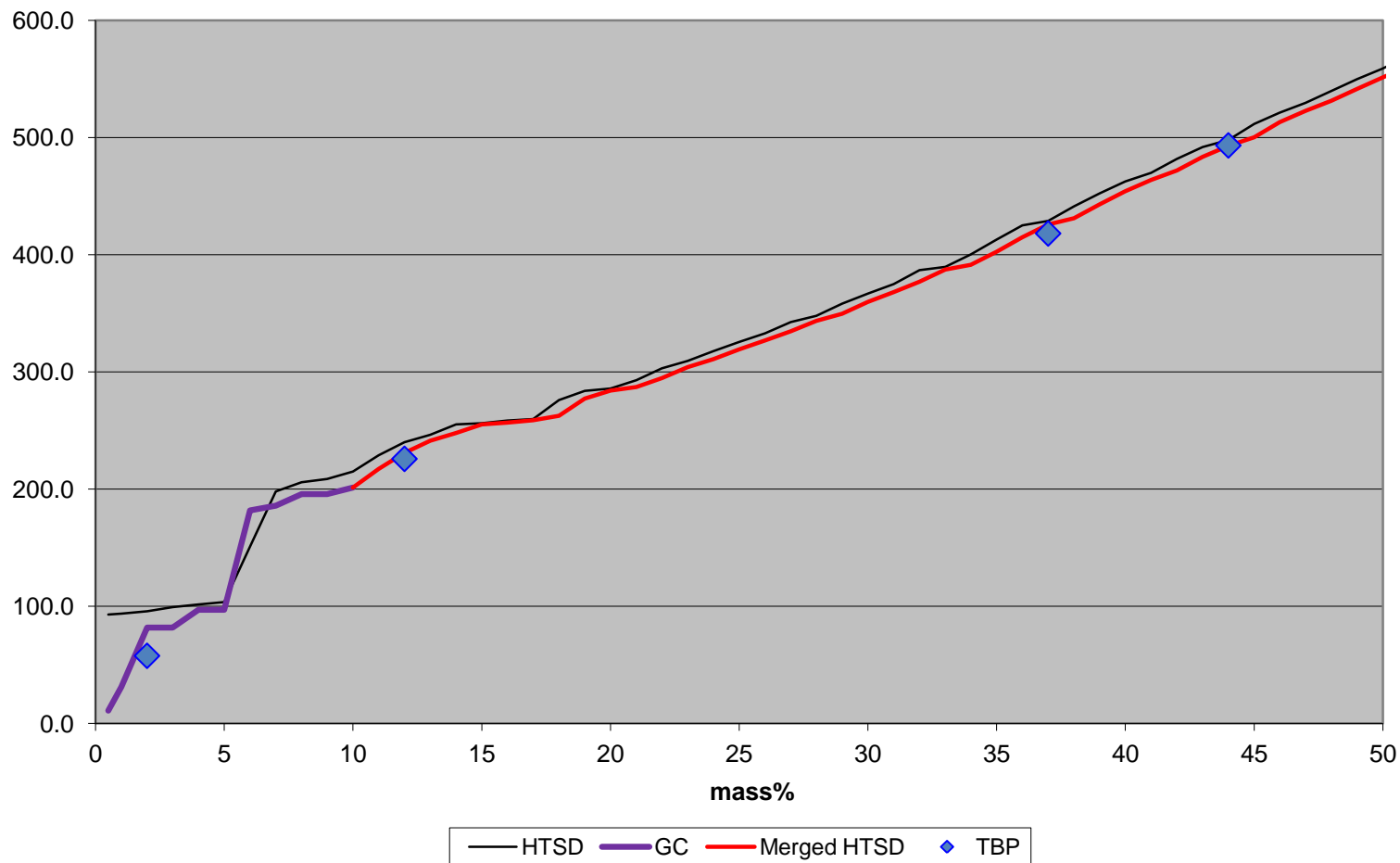
- Following examples are provided to illustrate how the light ends merging process might look.
- The calculation method used is not identical to that being considered by ASTM.
 - Proposed ASTM method is specific for GC processing (e.g., small increments, 0.01 mass% recommended).
 - Proposed method utilizes data arrays to manipulate cumulative mass percent vs. boiling point tables.
 - The following merge examples were generated independently of GC processing. Approach is similar; calculations are different.
- Examples are actual samples. Data has been altered for effect.



TYPICAL CHROMATOGRAMS

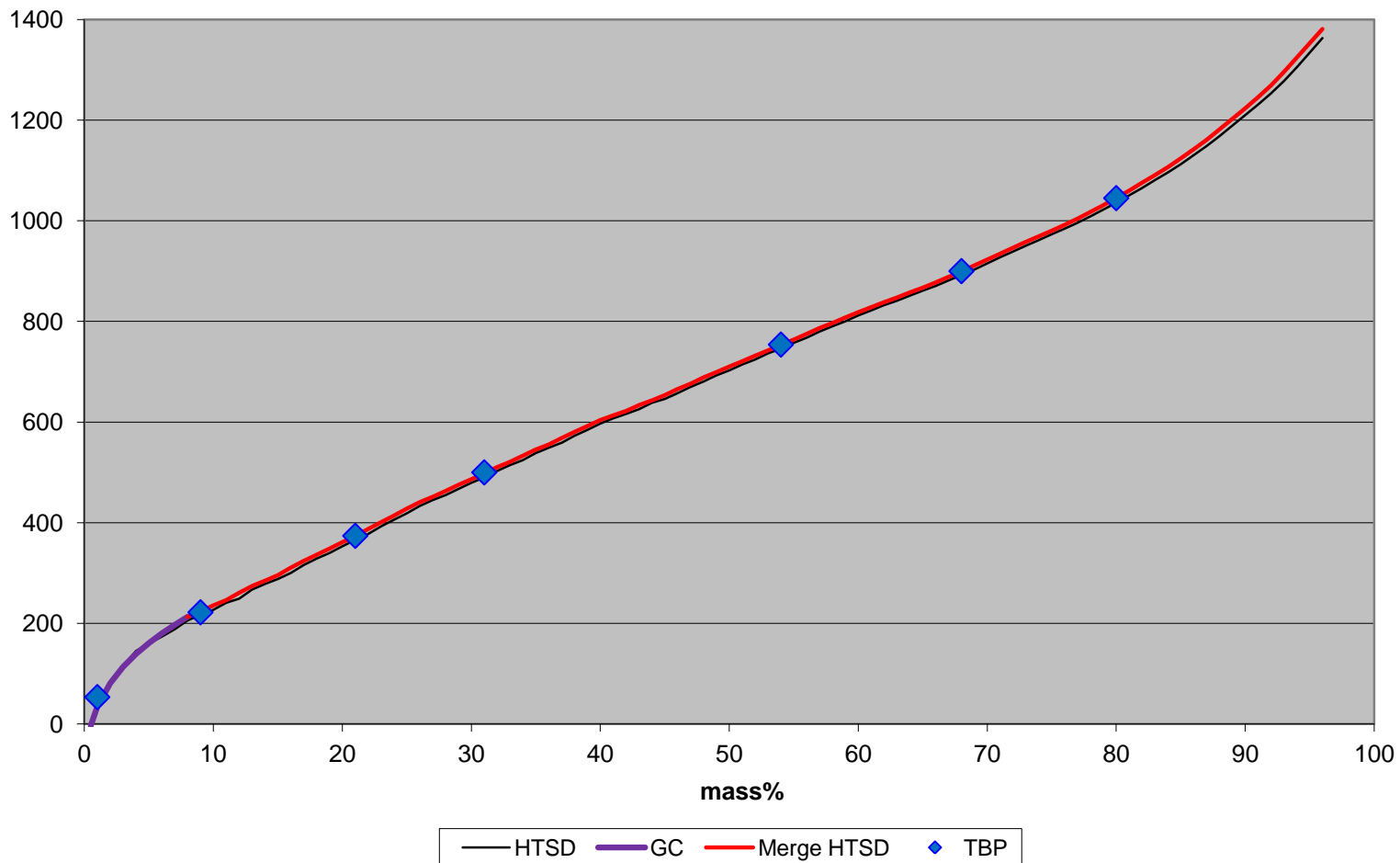
TYPICAL RESULT, EXAMPLE #1

Merged HTSD #1



SMOOTHED LIGHT ENDS, EXAMPLE 4

Merged HTSD #4



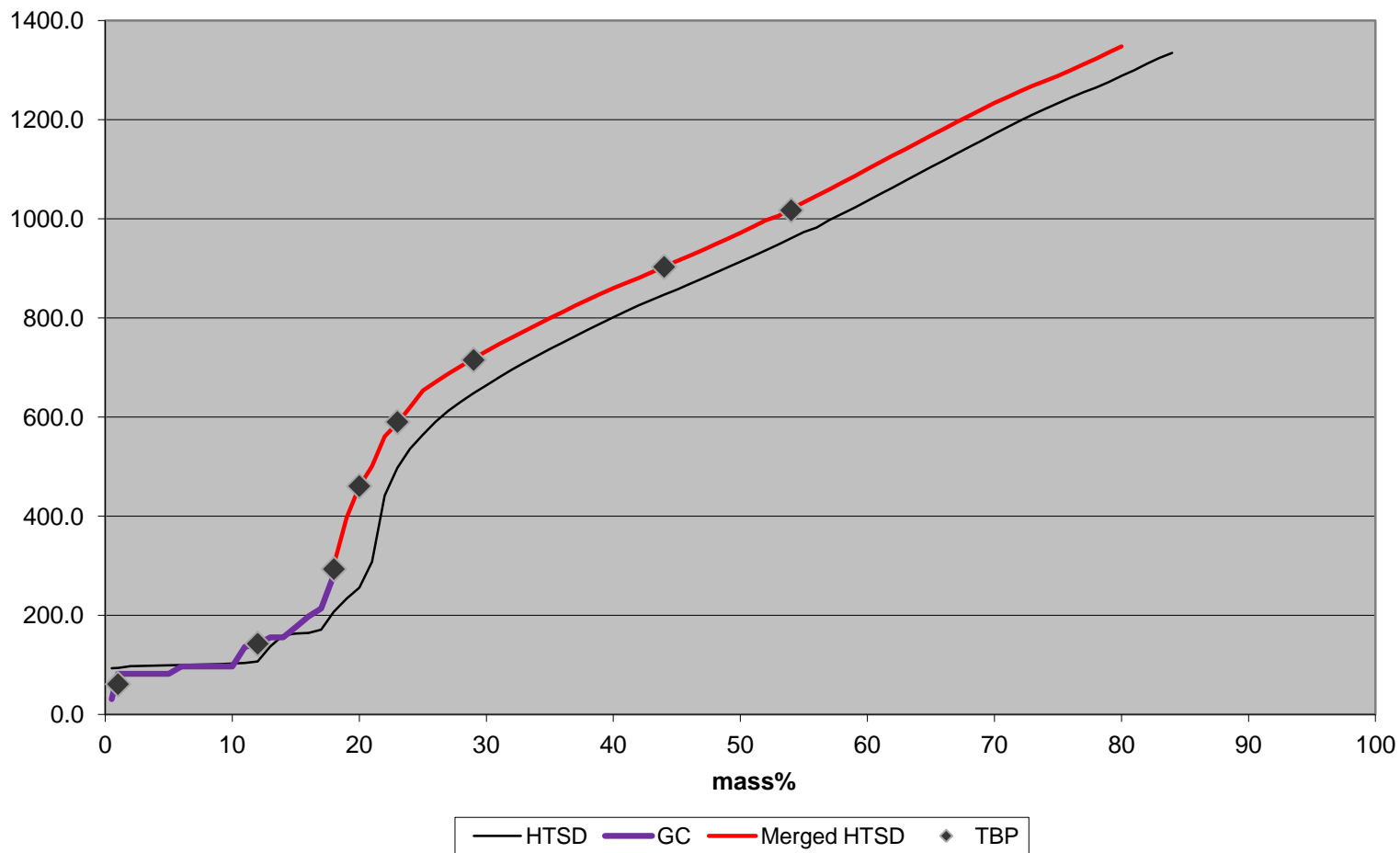


LESS TYPICAL CHROMATOGRAMS

(D7169 GETS IT WRONG)

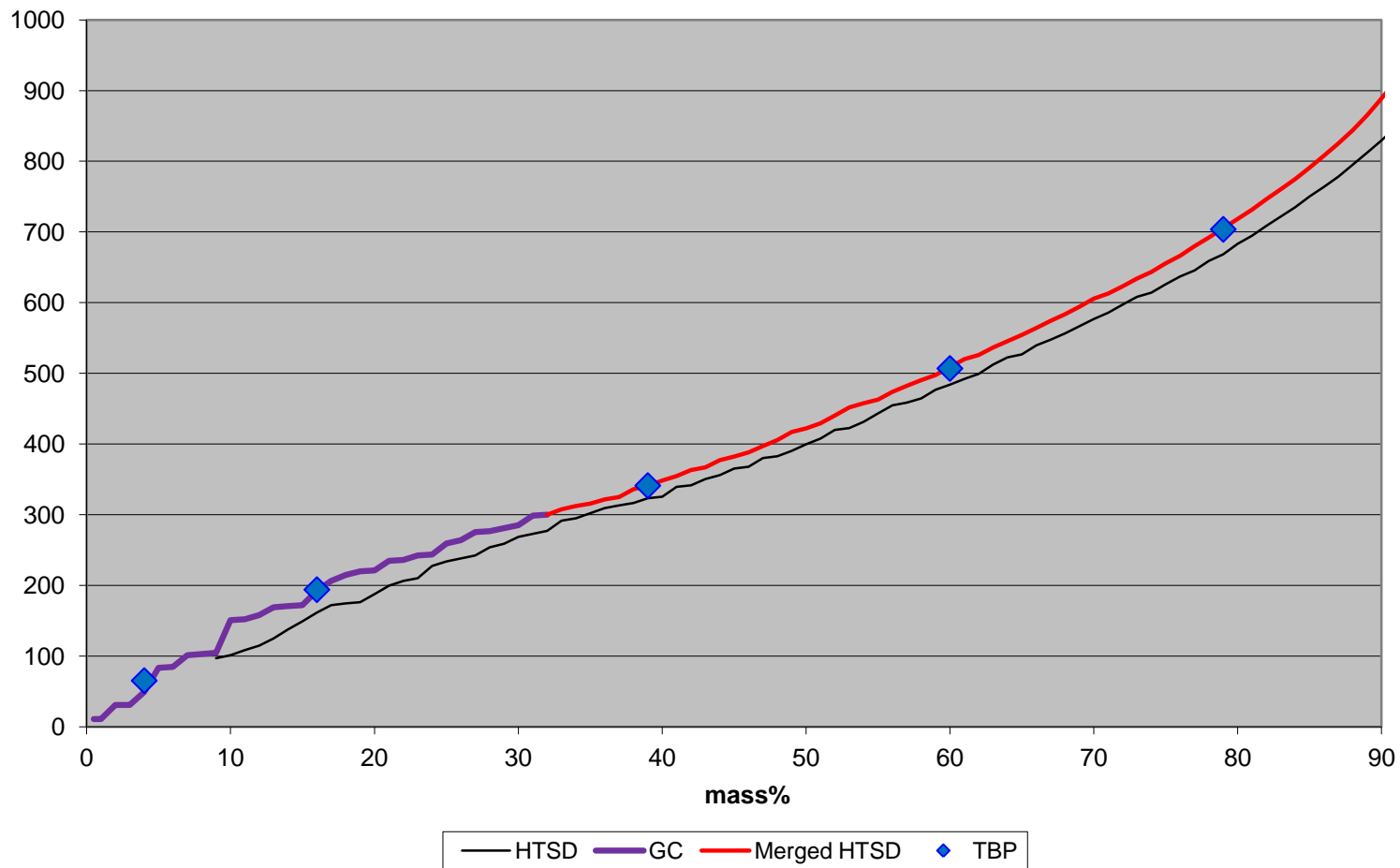
HEAVY CRUDE, DILUENT, EXAMPLE #2

Merged HTSD #2



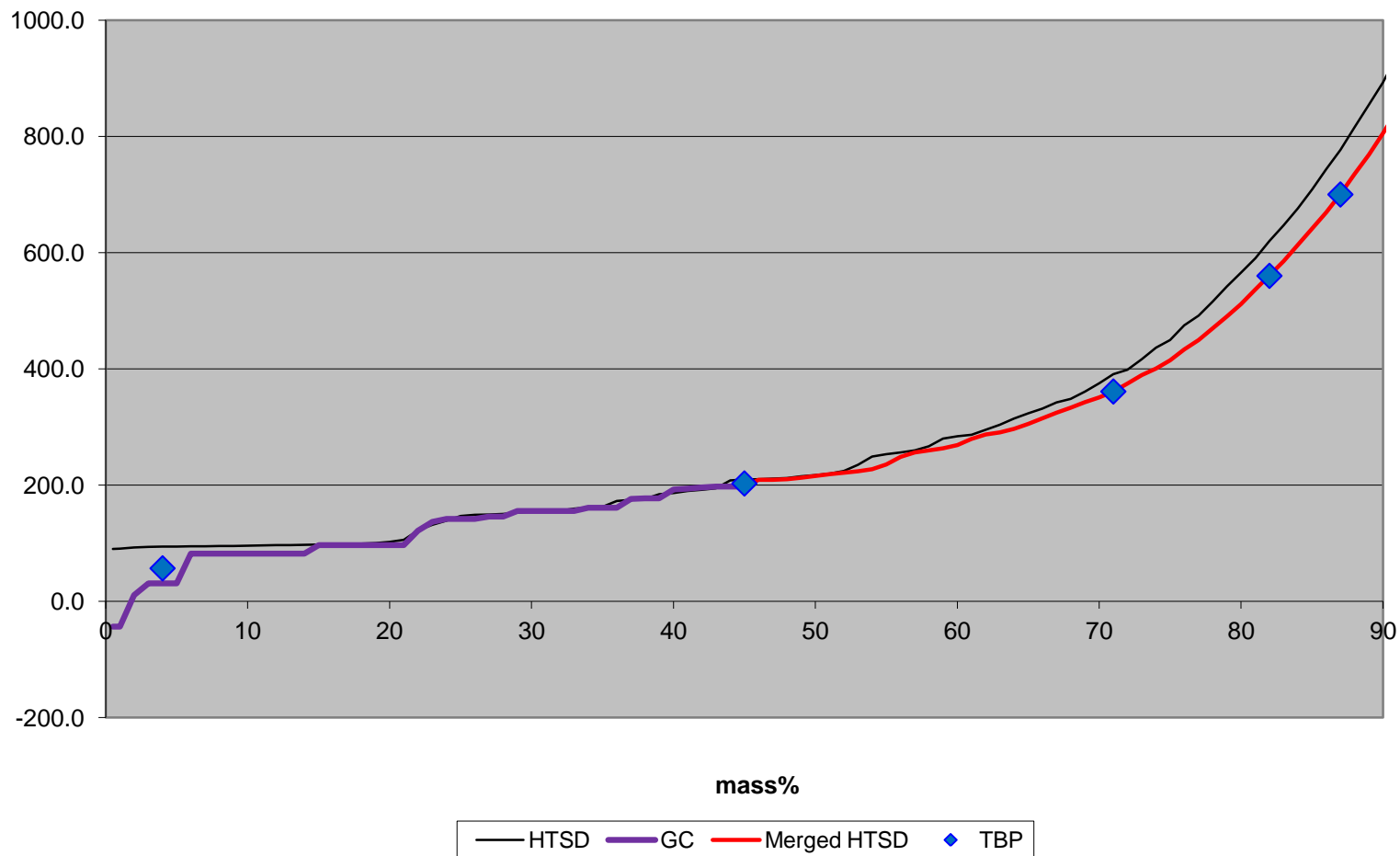
D7900 IMPROVES HTSD, EXAMPLE 3

Merged HTSD #3



VERY LIGHT CRUDE, EXAMPLE #5

Merged HTSD #5



SUMMARY

- High Temperature SimDist analysis of Crude Oil offers quicker estimate of TBP curve.
- However, losses & deviations in the quenching region (C4 to C8) can be quite significant for D7169.
- D7900 provides more accurate results in C4 to C8 range.
- Merging with Light Ends analysis (ASTM D7900) corrects for losses in the quenching region.
- I recommend that the original D7169 data be separately provided when merged results are offered.
- Draft standardization of merging process is currently under review at ASTM (D02.04).
 - Proposed merging GC algorithm written by ASTM work group is in-ballot at sub-committee level.
 - As proposed the algorithm would be inserted in the appendix (non-mandatory) of D7900. D7169 would reference this section.



QUESTIONS & ANSWERS

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