

Measuring Distillation in Gasoline Blending Across Wide Range of Vapor Pressure



ABOUT MICRODIST

The PAC MicroDist online analyzer is designed to quickly and accurately determine the boiling range characteristics of various commercially available petroleum products, light and middle distillates, on process streams.

The easy-to-use MicroDist performs a complete distillation of the sample in less than 10 minutes. The results obtained correlate to the ASTM D86, ASTM D7345, ISO 3405 test methods and their analogs.

APPLICATION

Gasoline blending is a refinery operation that blends different component streams into various grades of gasoline. The Reid Vapor Pressure (RVP) is set depending on the average temperature of the location the gasoline will be used. (Cold temperatures require a higher RVP than warmer climates.) Distillation is one of the key parameters used in the gasoline blending process. A study was conducted to evaluate the performance of the MicroDist online analyzer as compared to the laboratory Herzog Optidist ASTM D86 atmospheric distillation analyzer. The objective was to determine if it could be used online in the blending process to provide real-time process control.

CHALLENGE

Ruggedness testing on a wide range of vapor pressure samples identified several areas for improvement for the MicroDist including a software revision that increased the internal pressure during the distillation from 150 kPa to 300 kPa, improved sample cooling to allow reduced sample consumption to increase the number of tests that could be performed for a small sample (<4 L), and improved sample handling and introduction to prevent the loss of light products.

After the implementation of these analyzer improvements, a complete study was conducted to evaluate the performance of the MicroDist to assess the site precision and relative bias to the lab for gasoline samples over a wide range of vapor pressure reflective of the expected seasonal blends. The criteria for success was $\leq 3^{\circ}\text{C}$ bias between the lab and process across the range from initial boiling point (IBP) to final boiling point (FBP).

TEST SETUP

The MicroDist analyzer was set up to mimic the performance of an analyzer in a process condition while allowing single sample injections. Additional sample cooling was included to reduce the sample temperature at least 15°C below the IBP, and all sample lines were insulated.

A major refinery provided one gallon each of eight non-ethanol containing gasoline samples (R1-R8) to serve as unknowns and 20L of a quality control (QC) non-ethanol gasoline sample to be used for the determination of site precision, as well as a check sample during the analysis of unknowns. The unknowns were base gasoline samples, as well as blended samples to represent the full range of expected vapor pressure in gasoline blending operations. A portion of all samples was provided to the refinery lab for D86 analysis performed on the refinery's OptiDist laboratory analyzer for comparison.

SITE PRECISION

The testing process spanned four days, with site precision testing being conducted during the first two days. As many replicates were analyzed as possible per day, with each sample analysis separated by switching to a recirculating gasoline stream to mimic what would happen in the gasoline blending process.

The results were statistically evaluated by a statistician and showed that the deviation at each point was less than or equivalent to the laboratory analogous instrument site precision for each boiling point cut (initial boiling point, 5%, 10%, all the way up to final boiling point). Having passed the site precision test criteria, the unknown sample analysis could proceed.

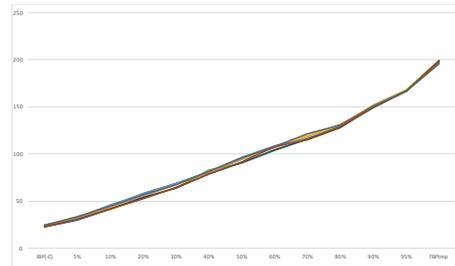


Figure 1: QC Sample Data Results Overlay. The first two days of quality control testing demonstrated a site precision for the MicroDist that was better than or equivalent to the refinery D86 laboratory instrument.

SAMPLE RESULTS

A test matrix was developed and implemented over the last two days to intersperse the QC at various times of day among the unknowns to ensure there were no other variables impacting the study. The relative bias between lab D86 versus online MicroDist results was statistically evaluated using ASTM D6708 (weighted regression) to assess the relative bias between lab and analyzer results. The MicroDist analyzer agreed well with the lab results over the entire range of vapor pressure samples.

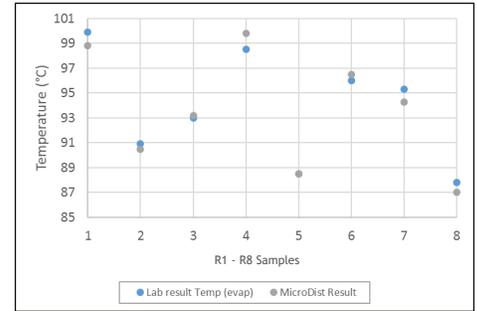


Figure 2: T50 Agreement Between Lab and Process Met $\leq 3^\circ\text{C}$ Performance Specification

T-50% Distillation Results				
	MicroDist Result Temp ($^\circ\text{C}$)	D=Base sample plus naphtha	Lab result Temp ($^\circ\text{C}$) (evap)	RBOB VP Spec
R1	98.8		99.8	65 kPa
R2	90.5	D	90.9	
R3	93.2	D	93.0	103 kPa
R4	99.8		98.5	90 kPa
R5	88.5	D	88.5	
R6	96.5		96.0	80 kPa
R7	94.3		95.3	
R8	87.0	D	97.8	

Table 1: T-50% Distillation Results MicroDist vs. Lab Result Agreement for Full-Range of Vapor Pressure

CONCLUSION

The MicroDist analyzer predicted the lab results over the full vapor pressure range. The testing performed demonstrates that the online analyzer meets the criteria of $\leq 3^\circ\text{C}$ bias between the lab and process across the range from IBP to FBP and can be used online in the blending process to provide real-time process control.