Refiners Modernize their Blending Control Systems with Micro Motion® Flowmeters

Introduction

Many refiners are finding that modernizing their gasoline blending facilities can have a significant impact on the profitability of their operations. This paper describes the effect of modernizing flow measurement technology in blending systems. It also shows how process optimization software is used for studying the economic impact of improved meter accuracy.

Based on two different refineries, the possible benefits resulting from the use of Micro Motion® flowmeters for in-line blending of gasoline include:

- Optimization of blends with increased accuracy, resulting in savings up to $200,000 U.S. per year
- High accuracy to ±0.10% of rate enables consistent conformity to product specifications, without rework
- Significant maintenance cost reductions, resulting in savings of up to $30,000 U.S. per year
- Excellent turndown, which is valuable when changing recipes
- Simultaneous flow and on-line density measurement provide indication of changing fluid properties

Reformulated gasoline blending system

Blending Reformulated Gasoline

A refinery in the Southwestern U.S. recently upgraded its reformulated gasoline blending facility from a sequential blender to an in-line blender. The old sequential system of blending required a lot of time to complete the blend and required many adjustments before it would meet specification. Tank gauging was used exclusively to control the final blend volumes. It was especially difficult to blend the butane accurately.

The incentives behind the upgrade were to be able to blend more grades and double the blending rates without increasing tankage. With a more accurate system in place, the blend would be on-spec as it was filling the tank and could be moved out faster. The capacity of the new blender is up to 5,000 barrels/hour with the current throughput averaging 60,000 barrels/day.

The refinery primarily chose Micro Motion Coriolis meters over turbine meters for accuracy, turndown, and low maintenance. First, Micro Motion meters are exceptionally accurate, and they maintain their accuracy throughout their use. Micro Motion ELITE® meter accuracy is ±0.10% of rate. Micro Motion Model D meters have an accuracy of ±0.15% of rate ± zero stability.

Meter turndown is another issue. In the past, refiners had to create approximately twelve different gasoline blends. Now, with the implementation of new EPA regulations, this has been increased to approximately 24 different blends, and regulations are expected to change again. This means that flexibility is a key feature in terms of equipment and instrumentation. Therefore, the refiner did not want to be limited by a meter's turndown capability. The turbine meters were capable of only 10:1 turndown. At a turndown of 25:1, the Micro Motion ELITE meters still achieve accuracies of ±0.1% of rate.

Since Micro Motion meters have no moving parts, they are inherently reliable and maintenance-free. The refiner mentioned that during startup of the new blending system, there were inadvertent slugs of air and water. The turbine meter blades would have been severely damaged during this startup, but the Micro Motion meters came through unscathed.

Another feature that gives this blending system additional flexibility is that several fluids can be measured through the same Micro Motion meter without recalibrating the meter. Since

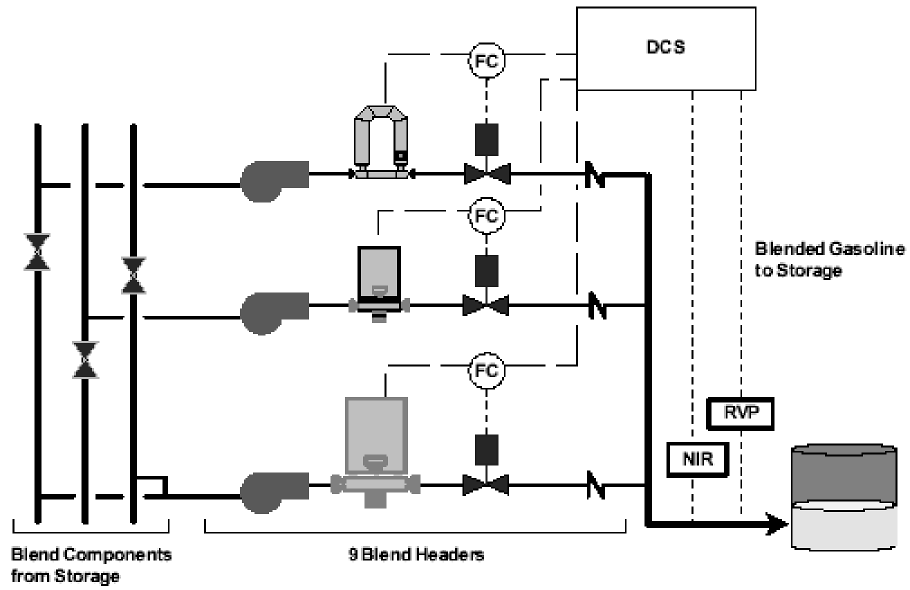

Figure 1. Simplified gasoline blending schematic

startup, the Micro Motion meters have not required calibration or maintenance of any kind. Final blend volumes continue to fall within 0.25% of the final tank gauge readings.

High-accuracy density measurement is a Coriolis meter feature that the refinery valued. The density accuracy for all the meters used in this project is ±0.0005 g/cc. The refiner has set up tight gravity ranges in the DCS for each component, with an alarm to notify operators of any deviations. This is valuable for several reasons. Many of the blend component pipe headers are cross-connected on the suction side of the blending pumps. The density reading is used as a good indication of cross-contamination. The operator can also see when streams are changing, such as when stratification of the tanks occurs. In addition, some fluid properties can be inferred from the density.

A schematic of the system is shown in Figure 1. An NIR analyzer is used for octane and composition analyses, and an RVP analyzer is used for vapor pressure to monitor the quality of the blends on-line. According to the unit's operations engineer, the refiner is able to blend consistently and accurately to the correct specifications.

Blending Directly to a Pipeline

A second refiner uses Micro Motion meters to blend gasoline components directly into a pipeline. It is especially critical in this case to have accurate and repeatable measurements, because there is no opportunity to adjust the blends before shipment. The old system used turbine meters to measure components. It was necessary to prove each meter every other month to keep the blends within specification. The standard rate for proving a flowmeter using either a compact or standard ball prover is around $500 U.S. Proving nine meters every other month, the annual cost of proving was approximately $27,000.

During revamping of the blending unit and control system, the turbine meters were replaced with Micro Motion meters. One of the main incentives for using Micro Motion meters in this application was a reduction in maintenance costs. The Micro Motion meters were in service for over a year without requiring a second proving. The meters were proved after installation as was required by the pipeline company, but because there was no shift in calibration with time, the blends have been within specification since startup.

The customer also wanted to have the ability to change from volumetric to mass blending in the future. Mass flow measurement is more reliable than volumetric measurement because mass is unaffected by changes in pressure and temperature. Switching to mass flow measurement eliminates the need to quantify these effects mathematically and make assumptions about volumetric expansion of each of the components. Measuring by mass is a much simpler, more direct way to measure flow.

Blending Optimization Model

A study to evaluate the effects of improved flow measurement on the profitability of gasoline blending was performed in conjunction with one of the world leaders in advanced process control and information systems for the hydrocarbon processing industry. The study indicated that errors as small as 0.3% can substantially decrease profitability. Any error in measurement drives the actual blend recipe away from the optimum recipe. This effect will be present whether the optimum recipe is determined with an offline planning device or by an online optimizer.

This study investigated the degree to which small differences in accuracies might affect blending profitability using a Blend Optimizer. The Blend Optimizer calculates the optimum recipe to maximize profit for a particular grade of gasoline while satisfying all property specifications. Once the optimum recipe was determined for a particular case, a second blend was added to simulate a situation in which there is a measurement error of the limiting component.

A number of cases representing various operating conditions were run for the study. The cases included conditions such as the availability of a very high octane reformate or the availability of alkylate. Pricing for the components and finished products was based on published Gulf Coast prices.

A 0.3% flow rate difference was used in the study. The result of the study showed that limiting a component to 99.7% of its optimum recipe causes the optimizer to seek a new optimum which was always less profitable than the original optimum. The reduction in profitability from these small measurement errors ranged from $.02 per barrel to $0.65 cents per barrel. This yields a range of $7,000 to $200,000 per year for a blending operation that produces 100,000 barrels per day (see Table 1). An output example from the blend optimizer for one of these cases is shown in Table 2.

	Potential Savings
Increased accuracy for blend recipe optimization	$7,000 - $200,000
Maintenance Reduced proving costs and replacement parts	$10,000 - $30,000

Table 1. Summary of potential cost savings

Conclusion

The use of Micro Motion meters in a gasoline blending operation provides many benefits to refiners. First, the increased accuracy, especially over time, helps to keep the blends optimized to maximize profits. The accuracy also prevents reblends or adjustments to the blend to allow the refiner to move products out of the plant faster. Second, maintenance costs are significantly reduced, not only in proving costs, but in the replacement of parts in mechanical meters, which wear with time. Third, the flexibility of the blending systems utilizing Micro Motion meters is increased because of wide turndown and the independence of the measurement from changes in fluid properties. With all the new and continuously evolving regulations challenging refiners, all of these factors become important in maximizing profitability.

Table 2. Output from blending optimization software

Blend Recipes		Blend One Unleaded 87	Blend Two Unleaded 87
C4		0.0%	0.0%
Lt. Naptha		11.5%	11.6%
Full Naptha		13.2%	13.3%
Reformate		40.0%	39.9%
MTBE		0.0%	0.0%
High Octane Reformate		20.0%	20.0%
Alkylate		15.2%	15.3%
Lt. FCC		0.0%	0.0%
Hvy FCC		0.0%	0.0%
Not Used		0.0%	0.0%
Total		100.0%	100.01%
Results		**Unleaded 87**	**Unleaded 87**
RON (Linear)		90.0	90.0
	Min	90.0	90.0
MON (Linear)		85.3	85.3
	Min	84.0	84.0
Road Octane		87.7	87.7
	Min	87.0	87.0
RVP (psi)		9.00	9.00
	Min	0.00	0.00
	Max	9.00	9.00
D86 10E (°C)		57.3	57.3
	Min	0.0	0.0
	Max	70.0	70.0
D86 90E (°C)		144.7	144.7
	Min	0.0	0.0
	Max	180.0	180.0
D86 FBP (°C)		187.5	187.5
	Min	0.0	0.0
	Max	215.0	215.0
% Benz		4.6%	4.5%
	Max	100.0%	100.0%
% Olefin		5.8%	5.8%
	Max	100.0%	100.0%
Price ($/bbl)		$25.94	$25.94
Comp. Cost ($/bbl)		$24.95	$24.96
Vol % Pool		50.0%	50.0%
Revenue		$25.940	$25.940
Total Cost		$24.951	$24.958
Cost of Lead Additive		$0	$0
Profit		$989	$982
$/bbl Difference			$0.0065

Micro Motion ELITE CMF300 meters on gasoline blending system in California

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Micro Motion, Inc. USA
Worldwide Headquarters
7070 Winchester Circle
Boulder, Colorado 80301
T (303) 527-5200
(800) 522-6277
F (303) 530-8459
www.micromotion.com

Micro Motion Europe
Emerson Process Management
Wiltonstraat 30
3905 KW Veenendaal
The Netherlands
T +31 (0) 318 549 549
F +31 (0) 318 549 559

Micro Motion Japan
Emerson Process Management
Shinagawa NF Bldg. 5F
1-2-5, Higashi Shinagawa
Shinagawa-ku
Tokyo 140-0002 Japan
T (81) 3 5769-6803
F (81) 3 5769-6843

Micro Motion Asia
Emerson Process Management
1 Pandan Crescent
Singapore 128461
Republic of Singapore
T (65) 6 777-8211
F (65) 6 770-8003

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