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Crude Oil Blending - The commercial driver for excellence

by Jon Moreau

Jiskoot Quality Systems

In-line blending of two or more crude oils provides a major source of competitive advantage by optimising facility feedstock costs. However, if poorly executed, a sub-standard blender design or configuration has been shown to result in blend errors in excess of 2-5%, which can result in annual losses of over $7 million - $15 million a year (for a 9mmtpa facility).

These losses can be avoided by using companies specialising in complete blending systems (not just control systems) to generate a detailed and achievable specification for a turnkey blender with a performance guarantee early in the design stages. The successful implementation of a crude oil blender hinges on consideration of the whole process from site survey through design to planned blending operations. The relatively small incremental cost of an optimally designed, bespoke blender, compared with one of a sub-standard design shows a significantly improved return on investment (ROI).

Introduction

The increasing availability of lower cost heavy crude oil has driven investment in in-line blending equipment to enhance flexibility and profitability. In-line blending is a cost effective alternative to additional tanks and batch blending and increases a facility's ability to process a wide range of crude oils.

Variation in crude quality, tank layering, inaccurate (or unknown) blend recipes combined with poor blender design (hardware, software and integration), regularly cause blend ratio errors of 2-5% or more unless blender hardware and control methodology are optimized. For a 9mmtpa throughput facility with a nominal $39 bbl crude price and a 10% discount for heavy crude, the spreadsheet below shows that at least $7-$15 million savings can be made annually by reducing blend uncertainty.

Sources of error

Error in crude oil blending is derived from two main sources:-

1. Variation in feedstock quality and blend recipes

2. Control system, field equipment and system integration

Feedstock and blend recipes

Crude oil stored in tanks is rarely homogenous even with the use of tank mixers In addition, many crude oils are blends and therefore the composition changes slightly from cargo to cargo.

Blend recipes are often calculated using a "typical" analysis and as a consequence the blend MUST use an excess of the light (i.e. more expensive) crude, thereby exceeding the optimal ratio to, ensure the process specification is met

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Blending crude oil return on investment (ROI)										
					Poor blender design				Advanced control blender	
					Total blender throughput		Current measurement Error +/- (RMS)		Blender accuracy +/- (RMS)	
Feedstock information					2000	m3/hr	2.00%		0.25%	
Crude feedstocks	Visc	Density	Price/bbl	Price/tonne	Blend ratio	Ideal blend rates m3/hr	Worse case rates m3/hr	Best case rates m3/hr	Worse case rates m3/hr	Best case rates m3/hr
Heavy discounted crude	48 Cst	0.9212	$35.0	$238.97	75.0%	1500	1420	1460	1490	1495
Light crude	7.4 Cst	0.8639	$39.0	$283.95	25.0%	500	580	540	510	505
					Production cost per tonne	$250.22	$252.02	$251.12	$250.44	$250.33
					Loss per tonne		-$1.80	-$0.90	-$0.22	-$0.11
% difference between crude prices from discounting matrix				-10.26%		Advanced control blender saving per tonne			$1.57	$0.79
				Facility Capacity	9000000	tonnes pa				
						Advanced control blender savings (pa)			$14,166,607	$7,083,303

or exceeded. Errors in the blend recipe model result in unnecessary "giveaway", which is directly proportional to the inaccuracy in the recipe.

This variation in quality can be resolved by using on-line analysers (viscosity, sulphur, density etc) to measure the blended crude and provide a dynamic feedback signal; but, to be representative the analyser system must be installed in a location that is homogenous and representative at all process conditions and be correctly compensated to standardised conditions. Representative analysis is one of the most important factors in blender design.

Control system, field equipment and integration

The heart of any in-line blending system is the selection of the correct components, their integration within the package and the performance guarantee of the total blending system. Of vital importance to the success, and hence profitability, of an in-line blender is how well the individual components perform AND how well they operate once integrated in the blender with the control system.

Crude Blender with remote control valves

Selection of appropriate blender components is the vital first stage in ensuring the quality of the final blended product. Below are listed some of the primary design considerations for key components;-

"Flow meters - Turndown, suitability for crude, susceptibility to hydraulic noise

" Control valves - Optimal control, stability and response time without adverse pressure drop

" Mixing system - Pressure drop, degree of mixing and rangeability

" Control system - Real-time three-term PID control, proven (i.e. not site-specific)

" Analyser system - Location, noise, response time, flow weighting at standard conditions

Incorrect selection or implementation of any of these components will result in fundamental system errors that are likely to be impossible to resolve. Once selection is made, it is vital to verify that the selected components are proven and can optimally function for the full range of feed and blended crude oils.

One of the most common errors when designing blending systems is a lack of attention to the critical elements; it is risky to select components without understanding how they will interact with each other, the control system and the dynamics of the site environment. This can result in savings during CAPEX but never the optimal OPEX and will therefore fail to deliver the best possible return on investment.

Case Study

Jiskoot has recently supplied a system for blending heavy Mexican crude oil (13API) with lighter (21-35API) crude. The system is a two-stream blender with on-line density measurement designed to accurately produce a range of blend crudes from 16-21 API at up to 800,000 barrels per day.

Crude Oil Blender

Providing user-friendly control, measurement and reporting of the whole blending process, the blend controller uses on-line measurement to continually optimise final product quality. Integration of the real-time blend control system with the facility's Delta-V system enabled the facility to achieve a key objective of implementing a 'maintenance on demand' system.

To guarantee accurate density measurement and ensure that the final product is homogeneous a JetMix, power mixing system, was used in the blend header. The JetMix is unique in that it mixes across a wide range of flow rates and blend ratios with no pressure drop. This, along with ultrasonic flow meters and careful component selection, allowed the blender design to be optimised for a maximum pressure drop of less than 1.5bar.

The control system with flow-weighted averaging and 3-term PID control ensures that the blended crude is on specification at all times during the by batch using unique control algorithms which respond instantly to changes in process conditions. The batch is continuously measured and feedstock adjusted to optimise quality and minimise 'give-away'. The system is designed to ensure consistent blended crude quality even during feedstock quality variations, starvation, loss of power or the unlikely failure of a system component.

The system has been operational for over 12 months with the customer stating:-

"The Jiskoot blender …… is a vital component of our facility enabling us to cost effectively and efficiently produce homogenous blended crude"

"The blender has performed to our satisfaction and over the first four months of operation has blended 37,000,000 barrels of crude oil"

It is clear that significant payback and return on investment can be achieved if the correct technology is selected. The key to success is to select and engage an engineering company specializing in blending systems at an early stage in the project and ensure they are involved in the complete scope of blending operations to maximize the value they bring to the project.

If correctly designed, installed and configured a blender can add significant value to operations. If poorly designed and executed it can result in poor quality blended product, potential revenue losses and plant downtime.

Mixing and Analysis system

MEASUREMENT SYSTEMS

DIVISION HEADQUARTERS
HOUSTON, TEXAS
+1 800 654 3760

JISKOOT QUALITY SYSTEMS
HEADQUARTERS
TUNBRIDGE WELLS, KENT, UK
+44 1892 518000
ms-jiskootinformation@c-a-m.com

JISKOOT QUALITY SYSTEMS
US TECH CENTER
HOUSTON, TEXAS
+1 281 582 9500
ms-jiskootsales@c-a-m.com

USA • CANADA • UK • CHINA • UAE • ALGERIA • MALAYSIA • INDIA • KENYA

www.c-a-m.com/jiskoot