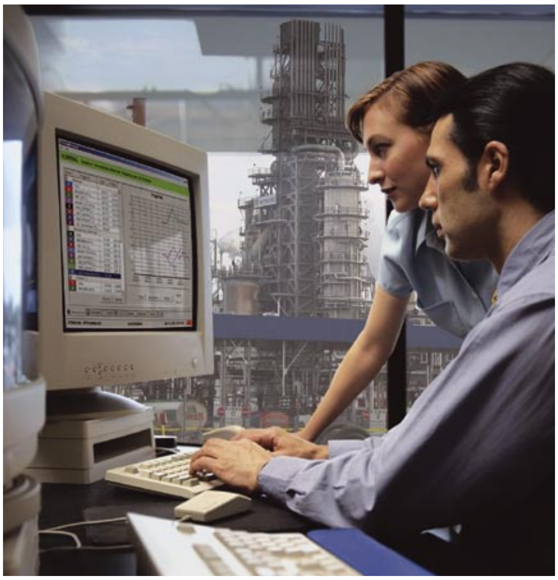
Optimize your Gasoline and Diesel Blender with Field-proven ABB FT-NIR Technology



Final Product Blending

Product blending is an important technique used in the refining industry. It is the final stage in the conversion of crude oil into useful fuels. The blender mixes together several streams from various process units to provide fuel that meets government, international or customer specifications. Due to the fact that is the final stage in a refinery process, the optimization of this process is vital. Regardless of how efficient the upstream process units may be, this can be negated if poorly optimized blending produces a substandard fuel. In many respects it is the most important process to optimize and can also bring the maximum benefits in terms of payback.

ABB has a vast amount of experience in providing optimization of blending units. The first stage in optimization of the unit is measurement of the properties themselves that are to be optimized. ABB's field-proven FTIR solution can deliver several benefits to the refiner. ABB's reliable, rugged NIR spectrometer is the heart of the analysis system. It uses the latest and most advantageous NIR spectroscopy technique, Fourier Transform Near Infrared (FT-NIR) spectroscopy. The ABB spectrometer is specially designed to operate in process environments so the user does not need to make allowances for a fragile optical instrument.

This spectrometer is housed in a rugged industrial enclosure with hazardous area certification. A fully incorporated temperature controlled sample system provides stable, accurate results. Full Windows® process software is included to provide outputs to the plant DCS system (ModBUS, OPC, 4-20mA).

ABB will work in close partnership with you to develop customized solutions that meet your specific needs. We offer a wide range of customer support services, including method development, in-house and on-site personnel training, as well as start-up and after-sales service. ABB has been manufacturing FTIR spectrometers and accessories since its foundation in 1973. By intensive research and development activities, and through a close partnership with our customers, we have developed a unique expertise in quantitative analysis using FTIR and FT-NIR technology. As a result, we are now the world leader in FTIR and FT-NIR process analyzers. We have an installed base of over 150 currently operational analyzers used in the refining blending field and other refinery applications. We have an accumulative database of approximately 40,000 spectra that can accelerate the implementation of any new blending project. Our expertise and experience means we can confidently claim to be a world leader in this field.

Common Operating/Problems

Final product blending represents perhaps the most quality-critical aspect of refinery operation. Tight product quality characteristics are defined, and must be met for product release.

If these criteria are to be met economically (i.e. with minimized high-cost product giveaway, and by the use of the available blending feedstocks with the lowest cost), then both rapid and accurate on-line product (and feedstock) property measurements are necessary.

The measured product qualities are then available in real-time for feeding to an on-line blending optimizer, thus ensuring the most economic blending operation to achieve blend targets.

Conventionally, this has been done with a large variety of physical property analyzers and on-line engines to monitor blend properties and octane. These sets of analyzers are extremely expensive, in terms of both capital and on-going maintenance.

Extractive Analyser Sample System for Final Product Blending Application

Solution / Benefits

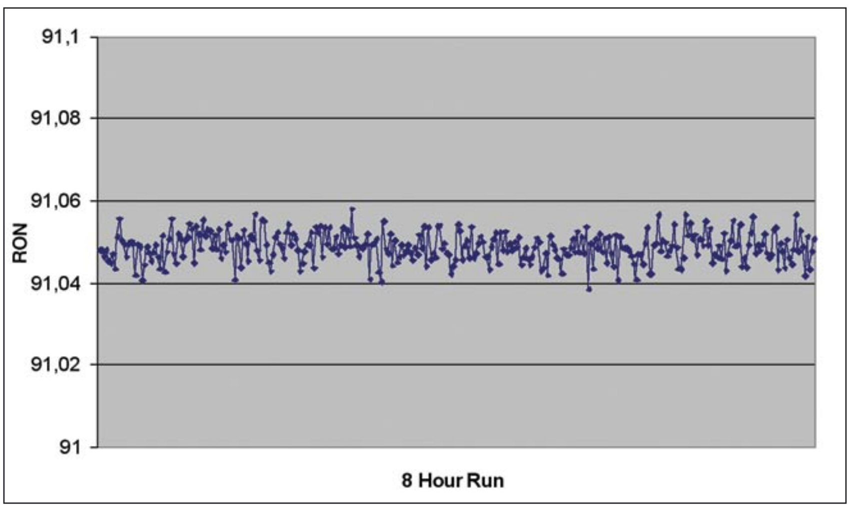
The ABB range of Process FT-NIR analyzers for on-line gasoline and diesel blend optimization allows for rapid multi-stream and multi-property quality determination of gasoline and gasoil blending components and final product streams. The calibration methodologies employed, and the transferability of calibrations and calibration databases between ABB laboratory analyzers and process blending analyzers, allow for rapid project startup, and minimize the amount of site-specific calibration work needed. For these reasons, the cost of ownership can be significantly reduced, compared with conventional final product blending analysis methods.

By accurately measuring final product qualities in real-time, the analyzer will allow feeding any on-line Advanced Blend Control blend optimizer with the required product qualities, will minimize product re-blends and quality giveaway, and will allow the use of lower-cost feedstocks while still meeting final product quality targets. Accurate measurement of blending component qualities as they arrive at the blend header will also allow the optimizer to determine the best achievable blend order.

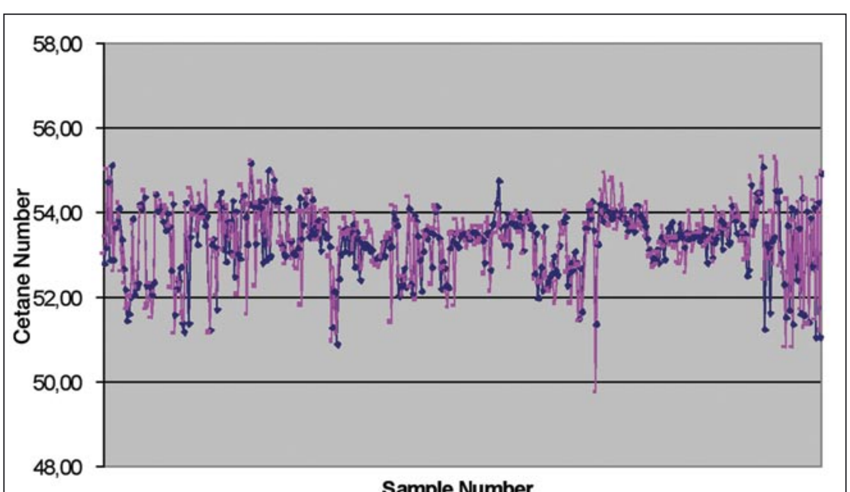
Analyzer Performance and Repeatability

As a correlational technique, process FT-NIR will yield an analytical accuracy exactly as good as the ASTM laboratory reference data used to develop the calibration models, provided good statistical practices are followed. However, it is perhaps not always fully appreciated how much the analytical repeatability and analyzer availability can be improved by using process FT-NIR as compared with conventional multi-analyzer blend optimization schemes. For light hydrocarbon streams, which can be easily and successfully prepared for analysis by simple sample-conditioning filtered fast-loops, the inherently ultra-low-noise optical technology of FT-NIR can yield exceptional analytical repeatability compared with conventional physical analyzers.

The outstanding repeatability of FT-NIR gasoline or gasoil property measurement is of significant benefit to the blend operator. True changes in blend properties can be tracked precisely during a blend, changes that would be otherwise 'lost' in the noisy results obtained from classical analyses. The operator or multi-variable control scheme can then make process decisions to maintain optimized blending with the assurance that the property deviation is real. In addition, this increased repeatability over the traditional lab method means that property giveaway can be reduced. See the example shown for RON.



Process FT-NIR Repeatability (RON, locked sample)



Laboratory Reference Method vs. Process FTIR Control Chart

Since the process FTIR analyzers used for refinery process stream analysis and unit optimization are secondary analyzers, dependent for their operation on correlational models using laboratory reference data, it is important for validation purposes that an on-going SQC track-record of performance relative to laboratory standards is maintained. There are useful ASTM guidelines to this practice covered in ASTM D6122 and ASTM E1655.

The following example shows such a laboratory reference vs. process FT-NIR comparison for a Gasoil Blending application (cetane number) monitored over an extended period.

This is a very important aspect of maintaining the reliability and credibility of an installed process FTIR analyzer, and is of particular significance for critical optimization and quality giveaway applications. The discipline of monitoring the on-line analyzer performance versus the site laboratory reference allows for rapid detection and adjustment in case of divergence. Medium-term drift and offset of the laboratory reference needs to be compensated, and calibration modeling impacts caused by significant changes in blend order or blending component availability need to addressed.

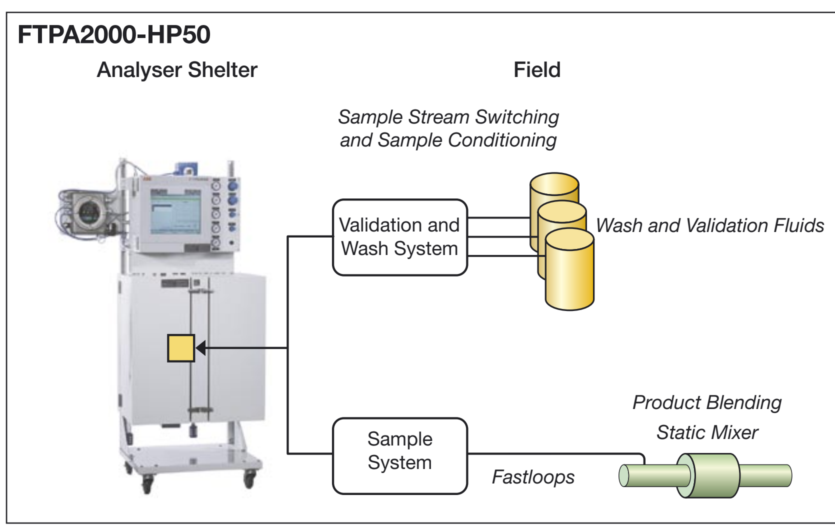
Typical FT- NIR Analyser Performance Data for Final Product Gasoline		
Property	Accuracy (SECV) at 1σ	Precision (r) at 1σ
RON	0.28	0.01
MON	0.32	0.01
% Aromatics	0.8	0.02
% Olefins	1.2	0.03
% Benzene	0.1	0.005
% Oxygenates	0.2	0.01
RVP (kPa)	0.9	0.16
D10% (degC)	1.8	0.1
D50% (degC)	2.1	0.1
D90% (degC)	3.2	0.1
E170	1.6	0.08

Typical FT- NIR Analyser Performance Data for Final product Diesel		
Property	Accuracy (SECV) at 1σ	Precision (r) at 1σ
Cetane Number	0.33	0.08
Cetane Improver Vol%	0.0034	0.0015
Aromatics Vol%	0.23	0.06
PAH Wt %	0.18	0.05
API Gravity	0.16	0.04
10% Rec	2.2	0.3
50% Rec	2.0	0.6
90% Rec	5.2	0.5
Cloud Point	2.1	0.3
Flash Point	1.7	0.4
Viscosity(cSt at 40°C)	0.032	0.009

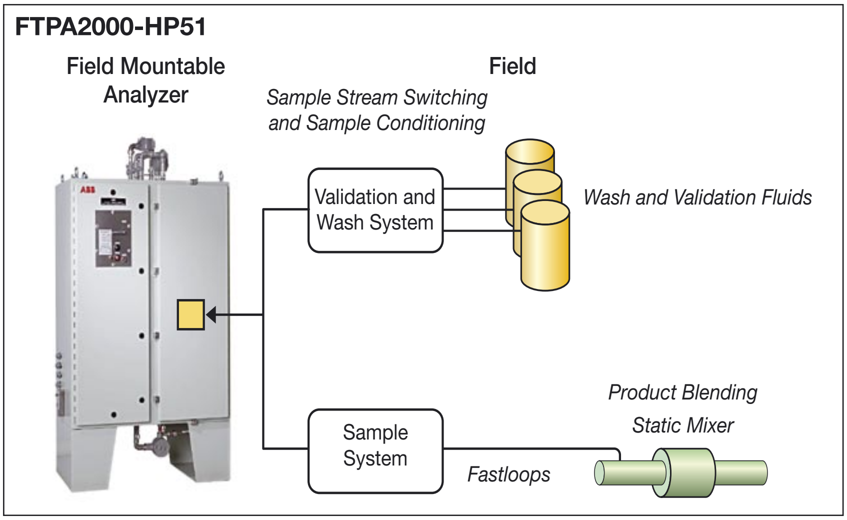
Typical FT-NIR Calibration Performance Data for a Refinery with a good Reference Laboratory

Typical Analyzer Field Installations for Final Product Blend Optimization

Example A: Final Product Blending Analyzer configuration, showing a Dual-Cell process FT-NIR analyzer system installed in an Analyzer House, with fast-loop sample conditioning systems and wash/validation fluid systems for sample cell maintenance and analyzer validation. Uses physical stream switching to select streams for analysis. Uses separate cells for blending components and final product.

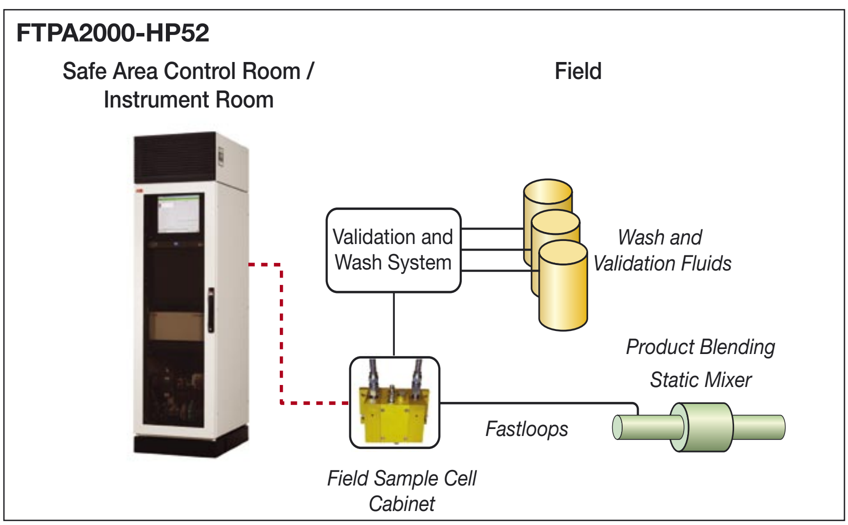


Field Analyser Installation for Gasoline and Gasoil Blending (A)



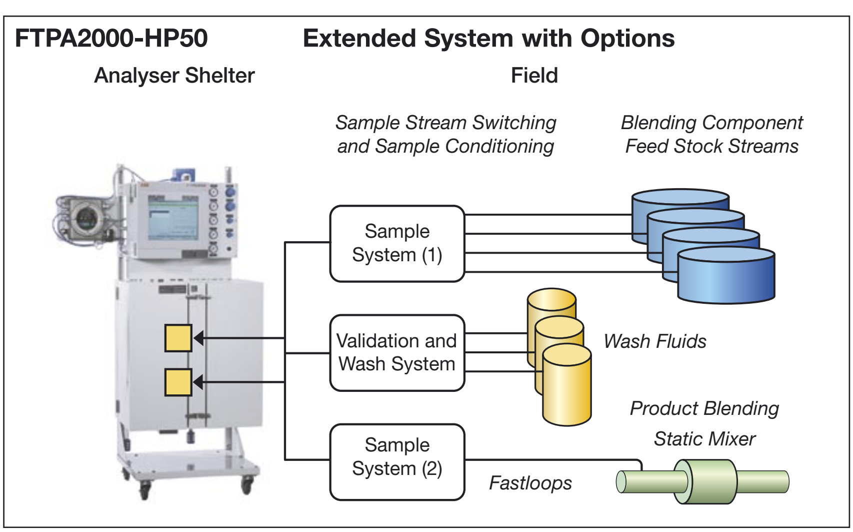
Field Analyser Installation for Gasoline and Gasoil Blending (B)

Example B: Final Product Blending Analyzer configuration, showing an FT-NIR analyzer system for Field-Mounting without the need for a full-specification Analyzer House. Uses fast-loop sample conditioning systems and wash/validation fluid systems for sample cell maintenance and analyzer validation. Uses physical stream switching to select streams for analysis.



Fibre-optic Analyser Installation for Gasoline and Gasoil Blending (C)

Example C: Final Product Blending Analyzer configuration, showing a remote fiber-optic process FT-NIR analyzer system installed in an Control Room or Instrument Room, with integral rack-mount PC controller. Uses separate cells for blending components and final product streams, and can use multiple cells where physical stream switching is to be avoided. Sample cell cabinets can be remote or local to sample take-offs.



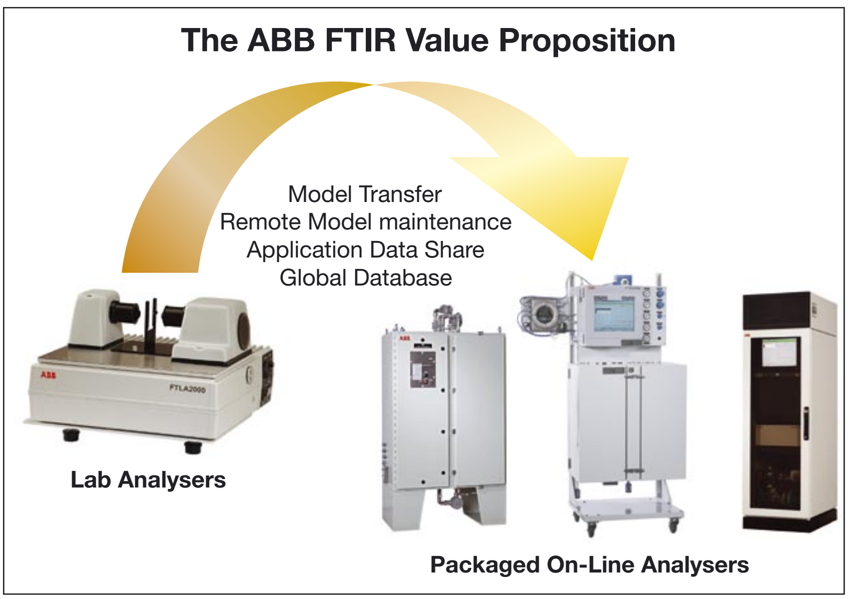
These schematics show typical ABB Final Product Blending FT-NIR system configurations. For more details please refer to the HPI FT-NIR Solution Datasheets for FTPA2000-HP50, -HP51 and -HP52.

Improving the Refining margin with on-line analysis and optimization

The calculation below represents the "baseline" giveaway associated with an analytical uncertainty of 0.1 PON.

Cost of Octane Giveaway, $M per year 0.1 PON (Pump Octane) per 200,000 bbl/day CDU Capacity		
Item	Factor	Value
A	Octane Giveaway	0.1 PON
B	Multiplier for APC 99% Confidence Level	2,58
C	Refinery Margin, $/Octane-Gallon	0,015
D	CDU to FPB Conversion Ratio	0,562
E	Average Throughput (CDU) bbl/day	200 000
F	Average Throughput (CDU) gals/day	8 400 000
	Lost Profit, Octane Giveaway/day	$18 270
	Lost Profit, Octane Giveaway/year	$6 668 550

This can never be reduced to zero, of course, but a crucial impact on overall refinery margin can be obtained by minimizing it as much as possible. What the numbers show is that for a very conservative improvement in analytical precision of 0.02 to 0.05 PON, consequent upon operation of real-time on-line process FT-NIR final product analysis, annual ROI can realistically be expected to be in the $1.5M to $3.0M range.



Final Product Blending – Summary

FT-NIR is the technology which currently offers the best price-performance-value-risk trade-off for on-line final product blend optimization. As an optically-based technology it allows for the most flexibility in terms of multi-stream, multi-property applications since it is compatible with both local, fully extractive sampling and remote, multi-cell extractive fiber-optic based analyzer systems. It offers multi-property analyses with rapid analysis cycle times well tuned to the requirements of an Advanced Blend Control optimizer. It is also well established, with hundreds of installations globally providing examples of successful implementation. Historically, the limitation to any spectroscopic measurement for on-line final blended product control has been the difficulty in developing, and more particularly maintaining, robust and stable calibration models. This has been to a large extent mitigated by recent developments including very well-controlled analyzer-to-analyzer variability, allowing easy maintenance and transferability of developed calibrations, the use of globally applicable product databases to speed up calibration development, and the exploitation of sound modeling procedures to minimize the sensitivity of developed calibrations to changes in blending recipes.

ABB Bomem has the predominant NIR technology position in the global petroleum refining market. We have implemented over 100 analyzers on gasoline/gasoil applications and a host of other refinery process installations. These range across the entire refinery from Crude Oil analysis to Sulfur Recovery Unit feed characterization.

ABB has installed gasoline projects in partnership with many of the global players in the petroleum refining industry. These companies include Shell, BP, Total, Chevron, Texaco, Mobil, KOA Oil, Preem, Ultramar, Saudi Aramco, Tesoro, LG Caltex, Conoco Phillips and many others during many years in the NIR gasoline business. We are respectfully proud to say that ABB is the number one choice for many of the pre-eminent refining companies.

We have invested in a truly global support team of refining industry application specialists. They are located in all of the major refining regions around the globe. We are committed to serving our customers with regional teams to most efficiently serve their needs. This structure enables closer partnerships with operators, which in turn improves the success of any NIR project.

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