Photo courtesy of Phillips Petroleum Company

At the end of the day, it's about risk-free gasoline blending.

Introducing the ABB Easy*ir* Gasoline program.

Gasoline blending is a complex operation. The last thing you need is the risk of NIR technology that can't always guarantee success.

The ABB Easy*ir* Gasoline program allows refiners to test the capability of NIR for gasoline property measurement – at a low initial cost – while eliminating the performance and financial risks of an on-line project investment. Our turnkey Easy*ir* Gasoline program provides for a seamless, stepwise upgrade path from laboratory to process installation with identical accuracy and high performance.

With the predominant NIR technology position in the petroleum refining industry, we have implemented over 120 gasoline projects in partnership with the world's pre-eminent refining companies. As the only company that can guarantee NIR performance for your gasoline blending projects, we can set your mind at ease. Suddenly it's not such a risky business after all.

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Blending technology

Jim Kelly, ABB Canada, describes risk free NIR technology for gasoline blending.

Gasoline blending is a complex refining process, as operating personnel are required to meet fuel quality and legislative targets while operating at the lowest possible cost. To meet these operating targets, typical properties that are measured and controlled include RON, MON, RVP, aromatics, benzene, olefins, ASTM-D86 distillation points and oxygenates. Traditionally, these measurements have been obtained by periodically stopping the blend to obtain laboratory validations or have been provided by a host of classical online analytical techniques, e.g. octane engines and gas chromatographs. There are, however, a number of problems associated with these approaches. These include the high capital and operating costs of multiple techniques, slow response time and in many cases, poor analytical repeatability. These disadvantages are especially evident in the utilisation of octane engines. These performance issues can lead to significantly higher blending costs due to unavoidable 'property giveaway', as well as reduced blender throughput, coupled with increased inventory and demurrage costs.

Near infrared technology: The solution?

In the early 1990s, petroleum refiners started to implement near infrared (NIR) technology on gasoline blenders. The direct replacement of the octane engine was a primary driver in these installations. The technology promised to solve many of the problems associated with traditional analytical techniques. NIR technology would provide essentially real time analyses and was capable of multi stream and multi property application. The capital and operating cost benefits were attractive when compared to traditional approaches. The improvement in analytical speed and data quality would allow operators to blend continuously, faster and more tightly with respect to operating quality targets. This would lead to an increase in blender throughput, faster grade changes and ultimately reduced quality 'giveaway'.

What has been the experience?

Unfortunately, for many operators who invested heavily in NIR gasoline projects, the reality was somewhat different. Many projects failed to deliver pre project promises and benefits. In fact, there have been cases where identical NIR technology, implemented in two different refineries of the same company, has been a success in one and a failure in the other. Refiners continue to invest heavily in online NIR technology without any guarantee of success. It is fair to say that refiners now consider the implementation of NIR technology on gasoline blenders as a risky investment.

Advance FT-IR instrument.

Table 1. NIR gasoline blender performance

	Refinery A	Refinery B	Refinery C
RON	0.49	0.33	0.19
MON	0. 60	0.32	0.21
RVP (psig)	0.63	0.26	0.12
Benzene (wt%)	0.17	0.06	0.04
Aromatics (wt%)	2.89	1.06	0.23
MTBE (wt%)	0.91	0.36	0.21
Olefins (wt%)	2.37	0.84	0.22

(One sigma reproducibility based on standard error of cross validation (SECV). This means that one sample is removed from the calibration set, a calibration is developed and it is then used to predict the removed sample. The error is then determined. This is repeated for each sample. The average error is the SECV).

Why is NIR technology not successful in all gasoline blending projects?

The success of a project is largely dependent on two elements: the quality of both the spectrometer and the reference data on which the chemometric models are built.

There are major benefits associated with the stability and calibration transfer capability of ABB Fourier Transform NIR (FT-NIR) spectrometers. The technology has been rewarded with the dominant global market position in the refining industry for fuels blending applications, with over 120 gasoline projects installed. Despite this experience, one still cannot quantitatively define a performance guarantee for a gasoline project, without first understanding the performance of the refinery laboratory reference methods for the properties of interest.

Why?

The technique of NIR spectroscopy is a correlative secondary method, which can ultimately only be as accurate as the reference methods that provide primary calibration data, e.g. a gas chromatograph analysis for olefins or aromatics content.

Table 1 compares the calibration performance for ABB gasoline blending applications in three different refineries (A, B and C).

Using calibration data from the respective refinery laboratory for each gasoline blender project, the company delivered three projects of varying quality in terms of property accuracy. This is the case despite all three projects utilising identical ABB technology. One project was excellent, one was good and one was poor.

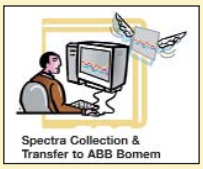
This experience indicates that the quality of the client's reference data is definitely the key driver in NIR performance, given a stable spectrometer as a base development platform. NIR will only mimic the reference data in terms of accuracy. It can match and track the data from a good reference method. It cannot improve the accuracy of a poor reference method.

Easy*ir* Gasoline: A summary

ABB and the refiner agree on the scope of the Easy*ir* Gasoline project: what streams?; what properties?

ABB provides the refiner with the laboratory equipment required to perform NIR feasibility tests on all gasoline grades. This includes a spectrometer, computer, operating software and the required accessories.

Training of lab personnel in the operation of the equipment for spectra collection.



Spectra are collected from the gasoline samples that are sent to the lab for routine analysis. Every two weeks, the collected spectra and corresponding reference method values are sent to ABB.

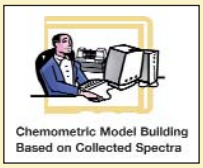
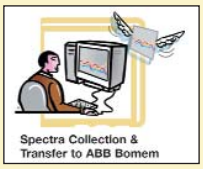


ABB begins to produce NIR chemometric models for those gasoline properties of interest to the refiner.



The refiner continues to send spectra and reference values to ABB for model building until the sample set represents the operating ranges of the blended gasoline grades. This typically takes place over a two month period notwithstanding seasonal grade changes.

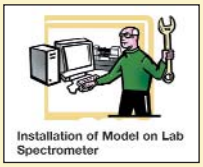


ABB installs a working NIR chemometric model on the lab spectrometer. This model will predict target gasoline properties on grades of interest. This is done at the end of the data collection period.

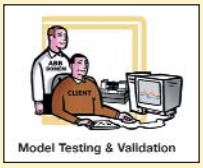


ABB and the refiner test the validity of the model according to ASTM protocols. This step can include further model tuning by ABB if necessary. The validation period will last as long as is necessary for the refiner to gain confidence in the model performance.

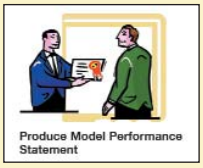
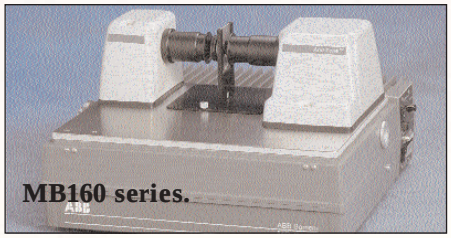


ABB writes a report on the model performance and produces a guarantee of performance statement for use of the technology on the grades tested. This covers both lab and online process implementations.

- At this point, the refiner has three options:
  - The refiner can purchase the lab equipment and property models. The price is determined at the beginning of the project.
  - The refiner can upgrade to a process analyser with pre calibrated models that are seamlessly transferable from the laboratory spectrometer to the online system. The performance will be identical to that achieved in the laboratory feasibility test.
  - The refiner can return the equipment to ABB.

In this way, with Easy*ir* Gasoline, the refiner can successfully implement an online NIR blender project in a stepwise, risk free manner.



What about ASTM performance?

The data also indicates that the NIR prediction performance can be better, identical or worse than ASTM standards. Again, this depends entirely on the capability of the lab reference methods meeting ASTM performance. ABB is often asked by refiners if its technology can meet ASTM performance standards. The answer is 'yes', if the refiner's reference methods can.

Given the experience previously outlined, conventional approaches to process NIR gasoline projects result in significant performance and financial risks for the refiner. Large investments can be made in process NIR implementation with no guarantee of success.

How can a refiner avoid the risks but gain the benefits of NIR technology?

Easy*ir* Gasoline

An Easy*ir* Gasoline program provides operating data on the projected performance of an NIR gasoline application in an online blender environment. The program allows refiners to test the capability of NIR for gasoline property measurement, while eliminating the performance and financial risks of an online project investment. The program uses a laboratory approach that significantly reduces initial investment while allowing a stepwise upgrade path to a process installation if performance is found to be satisfactory.

For a monthly fee, all lab equipment, training and chemometric modelling expertise is provided, allowing the refiner to test the performance of NIR in the gasoline blender. At the end of the program, the refiner has a definitive NIR performance guarantee that will minimise investment risk in any future online NIR blender projects. This approach also allows the refiner to calculate project payback with real performance data.

Can laboratory models be successfully transferred to an online NIR analyser?

Using ABB technology, model transferability from a lab unit to an online analyser is seamless. Each calibration model

Table 2. Comparison of predictions obtained at two refineries			
Measurement	ASTM standard deviation	US refinery lab to online (difference)	Brazilian refinery lab to online (difference)
RON	0.21	0.05	0.04
MON	0.32	0.06	0.05

will perform identically. Since developing a calibration model is costly and involved, it is essential to be able to seamlessly transfer between instruments.

Table 2 details a comparison between predictions obtained from the lab and online NIR systems, installed at two separate refinery sites.

The stability of its instruments allows the company to guarantee transferability of property models between spectrometers. This permits the refiner to undertake an Easy*ir* Gasoline project with the confidence that it will determine online process NIR performance.

What streams and properties can be investigated?

The streams can include all finished gasoline products including seasonal variations. Blendstocks can also be included if required.

Properties that can be investigated include RON, MON, RVP, ASTM distillation, aromatics, olefins, oxygenates, benzene, E200 and E300, among other parameters.

The defined scope is determined between ABB and the refiner at the outset of the project.

Previous experience in NIR gasoline projects

ABB Bomem holds the predominant NIR technology position in the global petroleum refining market. It has implemented over 120 gasoline applications and a host of other refinery process installations. The company has approximately 40 000 gasoline spectra from historical projects that can be used to accelerate the implementation of any new blender project.

The company has installed gasoline projects in partnership with many of the global players in the petroleum refining industry. These companies include Shell, BP, TotalFinaElf, ChevronTexaco, Mobil, Phillips Petroleum, KOA Oil, Valero, LG Caltex and many others during its 10 years in the NIR gasoline business.

Conclusion

The benefits of Easy*ir* Gasoline inlcude the following:

- Eliminate financial and performance risks associated with conventional NIR gasoline blender projects.
- Low initial investment in the implementation of gasoline blender NIR technology.
- Stepwise upgrade path from lab to process blender implementation with confidence.
- Obtain a definitive NIR performance guarantee.
- Calculate payback of your blender optimisation project with real analytical performance data.

Refiners can now eliminate the performance and financial risks associated with conventional NIR technology approaches for gasoline blending. An Easy*ir* Gasoline program will lead to an increase in blender throughput, faster grade changes and ultimately reduced quality ‘giveaway’ by rigorous implementation of NIR technology. Suddenly, implementing NIR technology is not so risky after all.