Case Study 311

The Long-term Performance of an Online Process MRA for Enhanced Reformer Advanced Control

A Process MRA Refinery Installation

Case Study Objectives
To evaluate the long-term performance and reliability of online Reformer analyser based on the measurement principles of Magnetic Resonance. To reassess the economics of the project based on user experience.

Potential Users
Reformer or Aromatics operations that require stream characterisation as part of a project to maximise the profitability of the unit. It is seen as essential to those users who have variable product demands and feed quality specifications

Investment Cost
R.O.I within 12 months (2000 pricing)

Savings Achieved
Audited Measurable & Sustainable benefits of 4cc/bbl as part of APC project.

Case Study Summary

The Process MRA solution has now been functioning online for over two years. Providing stream characterisation since April 2000 to the advanced control process improvement strategy.

The 34,000 bbl/day UOP Platformer is one of the major refinery units, designed to increase the octane number of Naphtha & ICCS streams. The downside is that it is also the major contributor of Benzene & Aromatics into the blend pool.

The project involved the integration of stream characterisation from Process MRA and APC software, to optimise Octane against Benzene give-away constraints.

Working in partnership with BP Coryton, INVENSYS-Foxboro GB Ltd, supplied a measurement solution that has now been successfully extended to include Aromatics & valuable feed forward information for blend pool management. The availability has been high (>98%). With prediction models being updated remotely (typically once per year)
The measurements cover some RON,MON, Benzene & Aromatics.

Host Organisation
BP Oil UK Ltd
Coryton Refinery
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Project Rationale

The catalytic reformer is a key unit in the refinery, designed to increase the octane number of naphtha and intermediate catalytic cracked spirits. However with ever more demanding European environmental legislation, reformer operating conditions have to be changed so as not to violate Benzene & Aromatics constraints..

With changes in Crude oil purchasing strategy and downstream unit operating conditions, feed chemistry changes have a direct affect on reformer unit operation. Due to changes in Benzene precursors in the feed stream. A feedback measurement solution was required as part of the APC scheme to regulate reaction severity and indirectly for feed composition control.

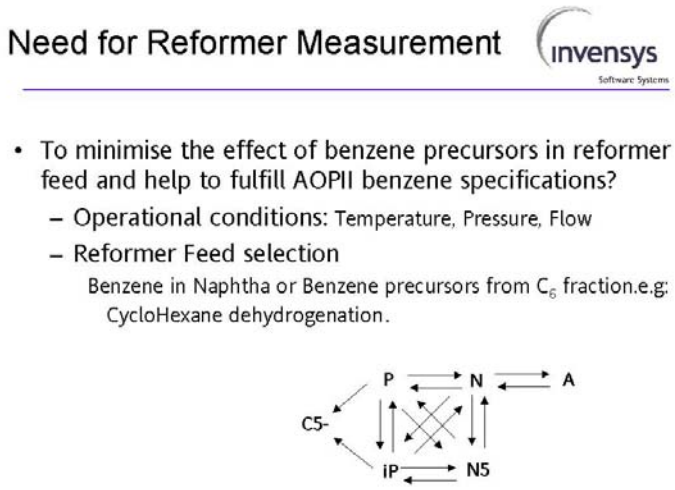
The analyser was required to replace an obsolete, out-of-service octane inference device. In addition the analytical scope was extended to include Benzene as a key component of the control scheme.

A study investigated a number of options (Discrete, NIR etc) but mainly due to its cost plus measurement linearity, project execution for model development and high availability, Process MRA was seen as the online analyser of choice.

It should be stated that this decision was taken on the perceived risk that the MRA was at beta-test release and that this would be the first European installation.

THERE WAS A 6 MONTH TRIAL AND SOME FURTHER DEVELOPMENT WORK PRIOR TO ACCEPTANCE TO IMPROVE THE AVAILABILITY FROM < 75%

Note: Since commissioning an MRA has been installed in Indonesia providing feed-forward & feedback control. This ran a fast-track model development phase, using the BP & other refinery Octane, Benzene & Aromatics models as the starter model set..



The Process MRA System

The Process MRA System is based on magnetic resonance technology utilising high-resolution FT-NMR proton spectra in conjunction with partial least squares modelling techniques to obtain highly linear and robust predictive models. Modelling requirements are limited with single predictive models being used to predict across the entire variability range of each property.

How does it work? The technique, developed in the 1950's, reveals the hydrocarbon structure of the fluid being analysed without the need of temperature or chemical pre-conditioning. This is due to the fact that when a hydrogen proton is introduced into a homogeneous magnetic field, the random nature of their magnetic fields align, this magnetic moment is known as a vector. If the sample is then given a short duration radio frequency pulse (at its resonant frequency), the vectors will rotate by up to 90^0. Once the radio frequency pulse stops, the vectors relax back to the original state, depending on the proton location within the structure. If a Fourier Transform is performed, the structural information is revealed and is commonly known as chemical shift. These shifts have textbook locations

And with the use of partial least square chemometric software the chemical compositions are correlated.

Project Execution

The project commenced in January of 1999 with pre-installation work.
Over the next six months models were built correlating Octane against Knock-Engine and laboratory methods. This extended period was required to capture the chemistry changes in the process. Being a beta system there was no starter model available to fast-track the project. However the system was online to measure the high octane transition for Y2K Gasoline blend.

The system was accepted by BP in the September, with closed loop control achieved in the April of the following year.

Operational Experience

The system was installed and commissioned without any disruption to production and within the operational constraints of the local maintenance, engineering and laboratory staff.

The operators trust the measurements.

Aromatics models were installed and validated with some 30 samples.

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Since the system has gone closed loop the on-stream time has been very high, with minimal maintenance required from the Analyser department.

What is the analytical performance?
Being a correlative analytical method, a good working relationship with strict adherence to ASTM methodologies is required for project success.

The defining feature of Process MRA is the robust single fluid model, which is utilised across feed types for 365 days operation.

Running rigorous test cases has shown that this simple model does fully express the chemistry changes in the process.

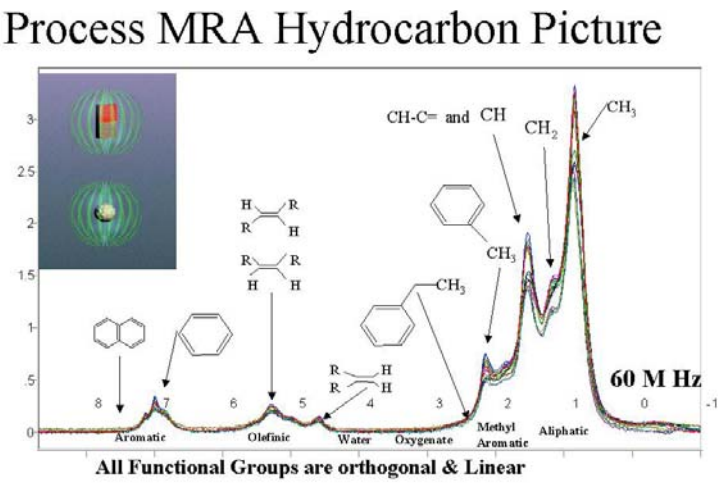
Process MRA makes available a higher fidelity measurement, superior in terms of **R**eproducibility and **r**epeatability to that previously available.

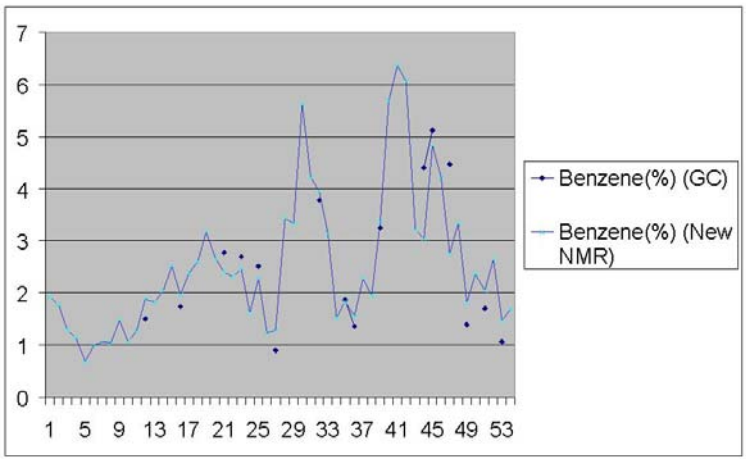
Parameter	Method	Range	R	r
RON	D2699	90-104	0.4	0.04
MON	D2700	80-94	0.4	0.04
Benzene	D3606	< 7	0.25	0.03
		< 1	0.12	0.03
Aromatics	D4420	<33	0.75	0.06

Any Sampling issues?
Since the sampling requirements are straight forward, the system was integrated into the established analyser house for other analytical equipment. Associated with the Platformer. No water removal is required and the filtering can be set at 140 microns to prevent valve seat damage only. As a note the sample passes through a relatively wide bore 6mm tube.
For the multi stream sampling an in line heater is preferred to clamp stream to stream temperatures to +/- 5^0c.

What are the bottom line improvements?

Benefits of 4cc/bbl have been reported. With required reduction to the blending pool being achieved in a sustainable manner.





Resultant Linear and Robust Online Process Model

Comments from Client

"This has proven to be a cost effective and worthwhile project. The MRA analyser once commissioned and bedded in, gave better accuracy, repeatability and up-time with lower maintenance. Furthermore we have extended the application beyond the original scope to include feed-forward measurements for blend optimisation, reducing potential benzene give-away. We required a minimal model update after installation to achieve results to our demanding Specifications.
Invensys took on the responsibility of support of the system for two years from validation and to date we have had a couple of selection valve replacements, a software release update and adjusted the models on average once per year. The availability remains above 98% for the past two years – ie after acceptance".

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