

## COMPLETED PROJECTS

Continued from pg 3

sign case. KBC also provided metallurgy guidelines based on those key corrosion parameters. At this point in the project, the refiner had to purchase materials for the major equipment relatively quickly. To support the refiner's need, KBC performed the modelling work and formulated material recommendations in the short span of two weeks time.

### Energy Management Study

Europe

KBC recently carried out a study for BP on their Gelsenkirchen refineries to determine what the prognosis for their other refineries might be.

Investment in saving energy is quite attractive today, as most refiners do not know just how large the incentive is for their refineries. This information assists in investment planning, particularly when energy projects provide a payout even in times of poor margins. Such analysis is also important for defining a CO<sub>2</sub> strategy, by allowing a comparison of projects reducing energy-related CO<sub>2</sub> with other initiatives.

An analysis of all KBC energy studies identified an approximate linear relationship between the starting BT (Best Technology) index of a refinery and the savings that could be achieved. The relationship was refined to include a complexity factor and corrections for fuel type. The chart below shows the BP Gelsenkirchen results superimposed with other studies.

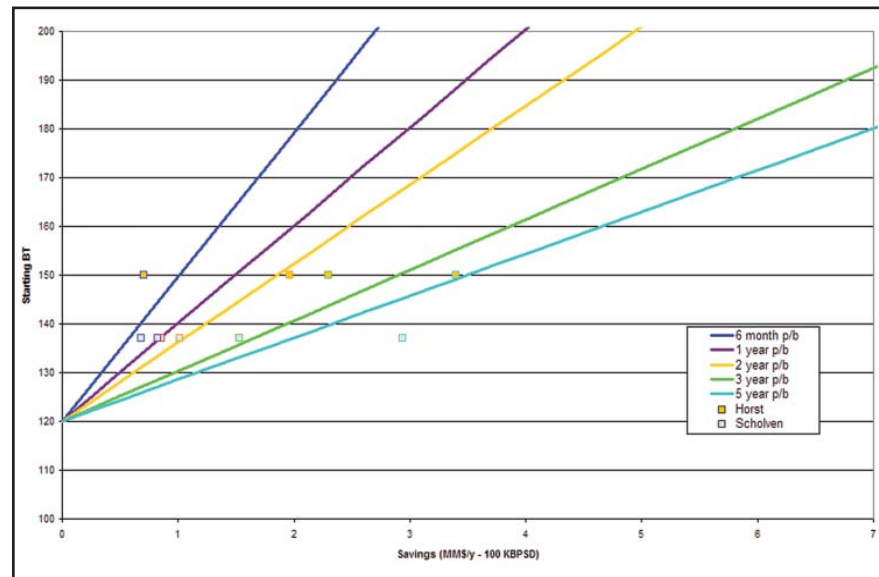


Figure 1

Using this relationship it was estimated that BP as a whole could expect to save \$87M p.a. and ~1000kta of CO<sub>2</sub> for projects with individual paybacks of up to 2 years. Total investment was estimated to be \$80M, giving an average payback of 1 year. The benefits could be approximately doubled by considering projects with up to 5 year payback.



### DRIVING EXCELLENCE

#### KBC Advanced Technologies Inc.

14701 St. Mary's Ln  
Suite 300  
Houston, TX 77079, USA  
Phone: +1 281 293 8200  
Fax: +1 281 293 8290

#### KBC Process Technology Ltd

KBC House  
42-50 Hershaw Road  
Walton on Thames  
Surrey KT12 1RZ, UK  
Phone: +44 1932 242424  
Fax: +44 1932 224214

#### KBC Advanced Technology Pte Ltd

435 Orchard Road #16-02/03  
Wisma Atria  
Singapore 238877  
Phone: +65 6735 5488  
Fax: +65 6736 4759

### LEAD STORY:

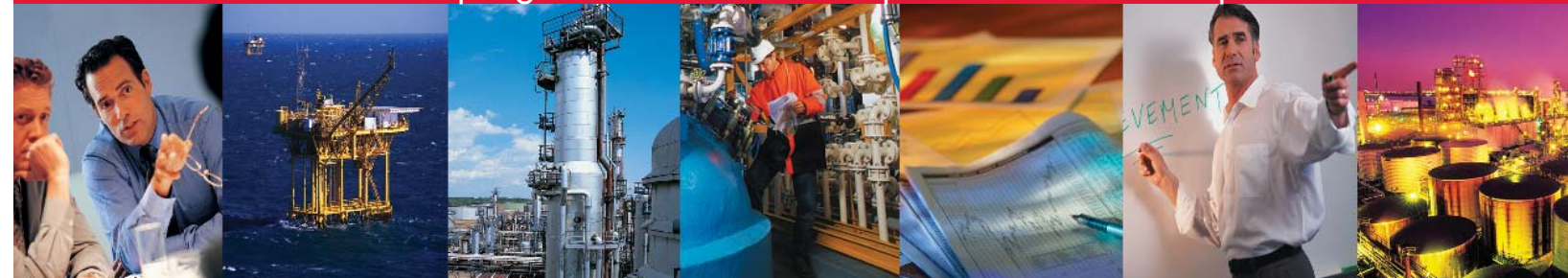
#### Compressor Failure Analysis Using Petro-SIM



# Driving Excellence

2<sup>nd</sup> Quarter 2006

Helping Clients Achieve Operational and Capital Excellence



## Compressor Failure Analysis Using Petro-SIM™ and Change Failure Analysis

by David Williams

In a process plant, one of the keys to increasing profitability and optimising operations is through improved Reliability, Availability, and Maintenance (RAM) Processes. Implementing RAM Best Practices provides a forum for measurable and sustainable performance improvement, and it assists the organisation in achieving business obligations regarding Safety, Environmental Regulations, and Quality and Asset Integrity, in addition to increasing profitability.

### Study Overview

KBC's RAM team assisted an Asian fertilizer manufacturer with the major issue of reduced capacity and efficiency of a critical centrifugal compressor used in manufacturing Urea. Over a six year period, this turbine-driven multi-stage compressor consisting of a low pressure case and high pressure case exhibited decayed performance that was accompanied by

an increase in turbine speed and horsepower demand to make up for the loss in efficiency. As an independent third-party, the KBC RAM group was asked to evaluate the compressor data over this six year time frame and provide recommendations regarding the probable causes of the loss in performance.

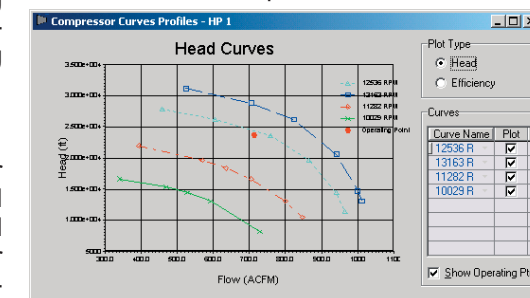


Figure 2

Substantial historical data for the compressor, including design data and pre- and post-overhaul operating data, was provided. Analysing this quantity of data manually would have taken weeks, so KBC used our Petro-SIM process modelling software to accelerate the analysis. Figures 1 and 2 show the operating point relative to the operating curves within Petro-SIM. In a three day time frame, all the cases were processed through the model and the starting point of compressor efficiency decay was identified.

Continued on pg 2

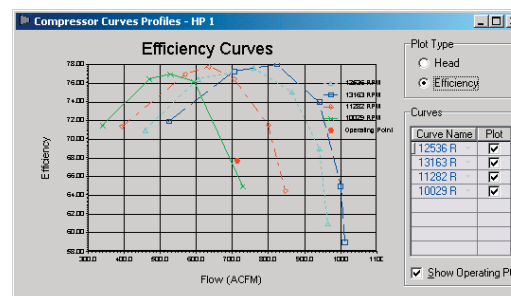


Figure 1

Continued on pg 2

KBC provides a comprehensive range of consulting, implementation, and training solutions to provide sustainable competitive advantage to our process industry clients worldwide.

#### OUR SERVICES INCLUDE:

##### CapX - Capital Excellence

- Market Analysis & Forecasting
- Process Strategy Review & Implementation
- Merger, Acquisition & Integration Studies
- Feasibility Studies
- Capital Project Support

##### OpX - Operational Excellence

- Operational Planning
- Process Optimisation
- Energy
- HSE
- Reliability, Availability & Maintainability
- Human Performance Improvement

## In This Issue...

- Upcoming Training ..... 2
- Events ..... 2
- Refining Margins ..... 3
- Completed Projects ..... 3

## FEATURE STORY

Continued from pg 1

After eight runs on the model, it became obvious that there was a problem with the compressor, specifically with the 4<sup>th</sup> stage. It was suggested that if the efficiency of the 4<sup>th</sup> stage was as bad indicated by the model that some process indication of this would exist. To validate the model, the client company was asked to confirm these indicators. With the 4<sup>th</sup> stage showing signs of degraded efficiency, we would expect that this stage would be a barrier to normal process flow, resulting in restricted flow from the 3<sup>rd</sup> stage, increasing the discharge pressure in this stage, and increased overall horsepower demand. The client confirmed that these indicators were exhibited,

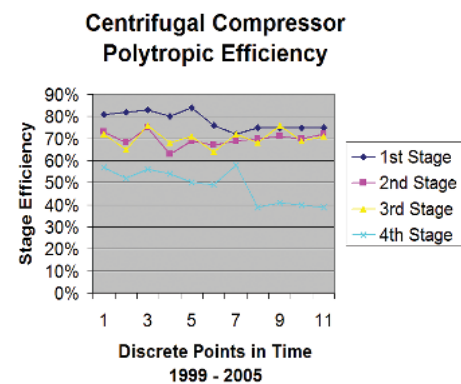


Figure 3

which validated the Petro-SIM model.

One of the tools used in failure analysis is a change analysis. This type of analysis identifies when system response with the same inputs is different from historical results. By identification of this point of divergence one can investigate and hypothesize what would cause a different outcome from what history shows to be normal. The client provided additional run data covering the last six years including pre- and post-overhauls; with this data, the point of divergence was identified.

Figure 3 represents the polytropic efficiency for each stage of the compressor at discrete points in time over a six year period. In this time frame, the polytropic efficiency for the first three stages of the machine became stable (in the 70% range) in the last couple of years. However, the 4<sup>th</sup> and last stage of the compressor dropped noticeably from the 50% range to 40% polytropic efficiency. Correspondingly the energy per stage depicted in Figure 4, stabilized over the same time frame with a noticeable increase in energy for the 4<sup>th</sup> stage at the same point in time for the drop in efficiency.

The compressor had experienced such a negative step change in 4<sup>th</sup> stage performance that the required turbine rpms and

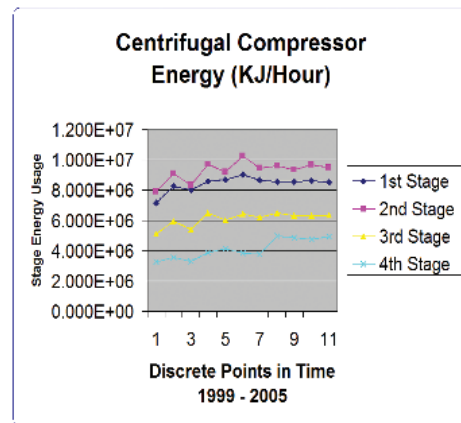


Figure 4

horsepower were close to maximum to achieve the desired flow rates and pressures. The point of divergence was identified to have occurred around the time frame of an overhaul of the compressor about two years prior to this analysis.

### Recommendations

Since the compressor's performance proved to be sub-standard, KBC provided recommendations regarding the probable causes of the loss in performance.

With this independent, third-party analysis performed by KBC, the client initiated a dialogue with the compressor manufacturer to discuss these findings and to resolve the compressor performance issue long-term.

## UPCOMING TRAINING SEMINARS

### Improving & Sustaining Operational Excellence (OpX) in Process Plant Operations

• 20-22 Sept – Denver, CO, USA

### Training Skills for Process Plant Trainers

• 16-18 Aug – Houston, TX, USA

### Improving and Sustaining Process Plant Operator Performance

• 18-20 Oct – Houston, TX, USA

### Supervising for Operational Effectiveness

• 1-3 Nov – Houston, TX, USA

To register, visit us online at: [http://www.ttsperformancesystems.com/Seminars\\_toc.php](http://www.ttsperformancesystems.com/Seminars_toc.php).

## Express

Continued from pg 1

stream property tables. For easy setup, fast calculations, and quick data access, Petro-SIM Express features a graphical interface, built-in plots, and an interactive calculation engine. It can also read files created in other process simulators to maximise your simulation investment.

One feature available only in Petro-SIM and Petro-SIM Express is KBC's best-in-class refinery oil characterization package, proven in modelling over 120 refineries worldwide. The package has the capability to manage in-house assay information, as well as access the acclaimed BP assay data through KBC's

crude assay database (CADB). Over 100 refinery-based properties are available, many of which are only available from KBC.

Petro-SIM Express can be easily upgraded to include any of the KBC PROFIMAT-ICS SIM reactor models, including REF-SIM for catalytic reforming, FCC-SIM for fluid cat cracking, ALK-SIM for alkylation, DC-SIM for coking, VIS-SIM for visbreaking, HCR-SIM for hydrocracking, and N HTR-SIM, D HTR-SIM, VGO HTR-SIM or RHDS-SIM for Hydrotreating. Petro-SIM Express can also be upgraded to Petro-SIM for multi-unit modelling or refinery-wide optimisation.

## EVENTS

### 2<sup>nd</sup> Asia Pacific Refining Conference

12-13 Sept – Bangkok, Thailand

John Russel, Vice President - Asia Pacific from KBC's PEL Market Services, will present "Outlook for Asia Refining."

### 14<sup>th</sup> Asia Petrochemicals Summit

14-15 Sept – Bangkok, Thailand

John Philpot, Petrochemicals Business Leader, will present a paper entitled "Operational Improvement in an Asian Aromatics Complex".

### North African Oil & Gas Summit

18-20 Sept – Madrid, Spain

KBC will present: "North African Oil & Gas - A Growing Role in the World" by Neil Atkinson, Senior Consultant for KBC's PEL Market Services.

### RPTC-Russia/CIS Petrochemicals Technology Conference

25-26 Sept – Moscow, Russia

"Refinery and Petrochemical Optimisation" will be presented by KBC's John Philpot.

### RRTC-Russian/CIS Refining Technology

28-29 Sept – Moscow, Russia

Andrew Graves of KBC's Process Consulting will present "Cogeneration and Site Utility Systems," which will discuss selecting the optimum system using Total Site Analysis and KBC's ProSteam software.

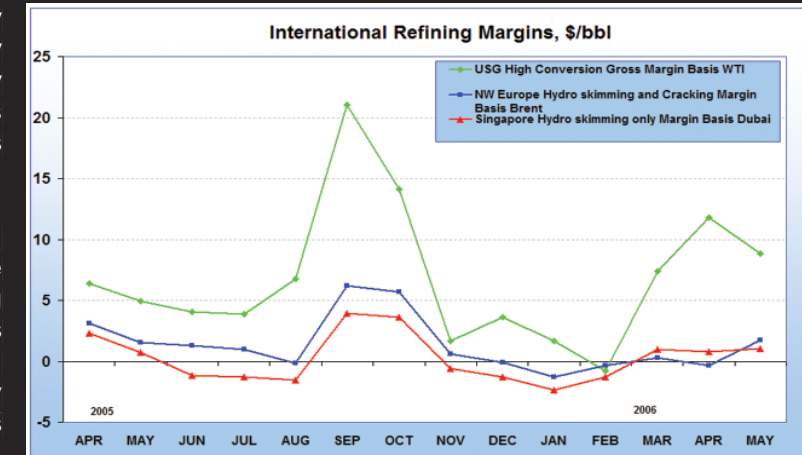
## REFINING MARGINS

by Richard Warner

Refining margins in the US have opened up in the second quarter of 2006, while remaining compressed in other regions. As the US market has approached the summer driving season, it has become sensitive to potential supply shortages due to the phase out of MTBE and anxiety over its replacement by ethanol in gasoline blending. Furthermore, a reduction in the sulphur content in diesel to 15ppm has ensured diesel prices have only marginally lagged those of gasoline; indeed, from mid-May prices began to exceed those of gasoline. Reduced refinery output as a result of both planned and unplanned shutdowns has further bolstered margins, ensuring that products markets were relatively tight on a forward cover basis.

European refinery margins have remained around breakeven, however, by May they started to improve as healthy gasoline and middle distillate prices began to filter through to refining margins. Nonetheless, they remain relatively constrained as weak fuel crack spreads continued to undermine profitability. Also, naphtha's premium over crude has been eliminated by ample supply and a lack of arbitrage opportunities, which has further curtailed margins.

Singapore margins on a hydroskimming only basis were fairly consistent over the quarter as rises in gasoline margins were largely cancelled out by heavily negative fuel oil crack spreads. The strong gasoline crack spread has been supported by a reduction in Chinese exports as state-administered retail prices were increased; additionally, arbitrage flows to the US further constrained regional supplies. Healthy economic growth and tightening diesel specifications also ensured that distillate prices remained well supported in the region.



## COMPLETED PROJECTS

### Profit Improvement Program

Middle East

The implementation project of the Profit Improvement Program between KBC and Saudi Aramco started on February 2005 and lasted one year. The scope included the generation, implementation and sustainment of profit improvement opportunities to improve the bottom line performance of the Ras Tanura refinery at minor or no capital cost, and to improve aware-

ness and capabilities within the organisation in order to sustain the benefits.

The driving force behind the program was the refinery-wide simulation model in Petro-SIM that uses rigorous and non-linear simulation models of the refinery interconnected in one platform to evaluate economic viability of opportunities. KBC's Profit Tracker™ and unit monitoring tools were setup to track KPIs and progress of all opportunities. Training was provided to the engineers in the use of the tracker and simulation models. Profit awareness culture and improved communication between departments was fostered in the refinery staff by leveraging KBC's expertise in the form of tools, methodologies and best practices.



The above photo commemorates the Profit Improvement Program close-out. Both KBC consultants are holding an award for outstanding performance, which was presented to them by Aramco at the close-out meeting.

**Pictured (left to right):** Hussain Qahtani (Aramco - Operations and Engineering Superintendent), Richard Platt (KBC Consultant), Ibrahim Naimi (Aramco - Refinery Operations Manager), Nasir Faruqui (KBC Consultant), Hamad Rugaib (Aramco - Process Engineer), Samer Hokail (Aramco - Process Engineer).

The total annual benefit of the opportunities implemented at Ras Tanura was over \$80MM/yr (or 42 ¢/bbl). One of the opportunities included increasing kerosene production by 7MBD at the expense of lower valued naphtha exports, resulting in net benefit of \$7MM/yr. Kerosene production was maximised by increasing stripping steam in the side stripper and reducing top temperature of the crude tower. Targets from refinery-wide Petro-SIM models

were incorporated into the plant's MVC system to help implement and sustain the opportunity. As a result, a record high level of kerosene production from the tower was achieved by running both normal and spare pumps.

### Canadian Crude Processing/ Capital Project Support

North America

A North American client enlisted KBC to assist in evaluating the prospects for increasing Canadian crude processing at their facility. KBC provided a two day on-site evaluation of the operating issues related to Canadian crude processing. The review addressed issues related to specific crudes being considered by the refiner and general Canadian crude processing.

Following the Canadian crude review, the client requested that KBC evaluate an ongoing crude vacuum capital project. The refiner wanted to determine whether the original metallurgy selections were still appropriate for an alternate crude slate featuring higher TAN Canadian crudes than were used in the original design basis. KBC synthesized the refiner's crude assays in our proprietary Petro-SIM commercial simulator. Then, we modelled both the base case design and an alternate design case with higher TAN Canadian crudes. Using KBC's Petro-SIM technology, we provided the refiner with the key corrosion parameters of temperature, sulfur, and TAN number for all the key crude and product streams in the new de-

Continued on pg 4