

DRIVING Competitive Advantage

Helping Clients Improve Profits
and Achieve Pacesetter Performance

KBC provides independent consulting services and implemented solutions to improve the sustainable profitability of our clients worldwide in the process industries.

Our Services Include:

Process Improvement

Linnhoff March®
Energy Services

Reliability, Availability
and Maintenance (RAM)

Planning Services

PEL Market Services

Profimatics™ Simulation
Software

Petrochemicals

Training Services

IN NEXT ISSUE

Are refiners focusing too much emphasis on "cost savings" rather than "profit improvement?" Is there a difference?

This article will explain the differences and highlight the value of one strategy over the other. It will explain the importance of a refinery-wide commitment to refocus their efforts on profit verses cost savings, while illustrating some of the common pitfalls encountered by many refineries.



FEATURE STORY

OptiSteam reduces operating costs at Spanish refinery.

Abstract of the paper presented at the ERTC 8th Annual Meeting, London, November 2003.

by Diego Fernandez-Polanco & Richard A. Tainsh

Energy represents the largest managed operating cost for the hydrocarbon processing industries. The best opportunities for improving plant profitability lie in the examination of the design and operations of the site's utility system. KBC's Linnhoff March Energy Services specializes in energy improvement and has over 10 years experience in utilities modeling and analysis. We offer a variety of services, including our advanced OptiSteam package. This provides utility management and optimization tools that automatically determine least-cost operational utility configurations, while taking into account fluctuations in process demand, energy costs, and environmental restrictions.

A good example of such a system was developed for Cepsa's Gibraltar refinery. This 220,000 bb/d refinery is the largest of three owned by Cepsa (Compañía Española de Petróleos, SA). This complex site significantly reduced its utility costs through the installation of two 37MW gas turbines equipped with heat recovery steam generators. While this project was a success, the new configuration resulted in a step-change in the complexity of the system. In addition, intricate contractual arrangements for power and fuel were imposed by the Spanish legislature. These combined factors made it very difficult to operate the utility system in a truly optimal way and highlighted the need for a tool to assist Cepsa's engineers and operators in this task. After a competitive bidding process, Linnhoff March was selected to develop an OptiSteam-based optimizer model of the refinery utility system, capable of handling the complexities of the physical system and the intricacies of the utility contracts.

The Figure illustrates the structure of the system implemented at the Gibraltar refinery. The system can be imagined as a set of building blocks, which can be assembled together to form a powerful, coherent structure. The foundation of the structure is the detailed model of the utility system, including all the unit operations and associated thermodynamics. This core model is then used to perform a wide range of tasks.

Referring to the "Off-line" section of the Figure, the user has full control of the inputs allowing the

model to perform simulated "what-if" analysis. The economic impact of refinery changes can be evaluated by considering power import and export of fuels and water at the battery limit. In fact, this is the ideal environment to put all project ideas that might be fighting for the same capital funding into a common perspective, since all the constraints and interactions are taken into account to define the true operating costs. An example of this is the use of the model as a support tool in the evaluation of a new cogeneration plant, which is currently in the construction phase. This plant, partly owned by Cepsa, will sell steam to the refinery and will greatly affect the optimization of the utility system.

Regarding off-line optimization, the model must find the least-cost operation that meets the process demands, restricted by physical constraints and equipment availability. The optimization problem is complex and has both continuous and integer variables with some strong non-linearities. To solve this, it was necessary to use state-of-the-art solver engines and apply a combination of Mixed Integer Linear Programming (MILP) and Non Linear Programming (NLP) techniques.

The main role of the optimizer when run off-line is that of a planning and forecasting tool. In Cepsa's case, the model had the ability to forecast utility demands for the

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Figure

FACTOIDS

To coincide with our feature story, below are a few interesting facts about Spain.

Spain is one of the fastest growing European economies, but has very limited domestic energy resources. As a result, Spain is expected to become an increasingly important energy importer.

Oil:

Oil plays a major role in the Spanish energy sector, although its share of primary energy is decreasing. In 2001, oil accounted for roughly 52% of Spain's primary energy consumption, down from 73% in 1973. Nonetheless, oil consumption has increased. Spain imports nearly 99% of its crude oil, mainly from Nigeria, Mexico, Libya and Saudi Arabia.⁽¹⁾

Refining:

Spain has nine major refineries. Four are owned by Repsol-YPF, and another is owned by a Repsol-YPF subsidiary, Petronor, in which Repsol-YPF has an 86% stake. Petronor and Cepsa's Gibraltar are the two largest oil refineries in Spain. Cepsa owns three refineries while BP owns one.⁽¹⁾

Natural Gas:

Within the European Union, Spain is regarded as having the fastest growing natural gas market. Natural gas consumption has grown from 2% of total energy consumption in the 1970s to 12.8% in 2001. The Gas Natural Group (GN) is the leading natural gas conglomerate in Spain.⁽¹⁾

Liquefied Natural Gas:

Spain is Europe's second-largest liquefied natural gas (LNG) importer, behind France. Algeria is Spain's largest LNG supplier. Spain also imports LNG from the United Arab Emirates and Qatar, as well as Trinidad and Tobago, Nigeria and Oman.⁽¹⁾

Coal:

Coal is Spain's most plentiful indigenous energy source. Production has fallen in recent years, and the decline is expected to continue as Spain works to meet environmental standards. Currently, 95% of coal is used to generate electricity, and 42.3% of Spain's electricity was generated from coal, according to Spain's National Energy Regulatory Commission.⁽¹⁾

Electricity:

Spain has the fifth largest electricity market in Europe (behind Germany, France, the United Kingdom, and Italy), and it is growing quickly.⁽¹⁾

Sources:

⁽¹⁾ Energy Information Administration, US Department of Energy, <http://www.eia.doe.gov/emeu/cabs/spain.html>, Last modified: March 14, 2003.

⁽²⁾ The World Factbook, Central Intelligence Agency, <http://www.cia.gov/cia/publications/factbook/geos/sp.html>, Last modified: December 18, 2003.

FEATURE STORY

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refinery processes since they developed correlations of unit throughput and demand. With that, the tool was able to analyze production plans over any selected dates. Typically, depending on the dates selected for analysis, it becomes necessary to model (and optimize) several discrete operating scenarios. The system interface guides the user through this complex task and quickly produces Excel-based reports showing the optimized results from each scenario, plus a summary of the optimized plan.

The "On-line" section of the Figure shows the software using current plant data from a Honeywell Plant Historian Data (PHD) system to perform real-time optimization. Before the raw data can be confidently used, it undergoes preliminary validation and reconciliation steps in dedicated routines developed by Linnhoff March. First, it is validated against predefined bounds and user overrides before statistical noise filtering is applied. The pre-filtered data is then sent forward to the data reconciliation model. Larger problems with more than 900 constraints and 1,500 variables are solved using a powerful Quadratic Programming (QP) engine. The reconciled data is reported along with the results from statistical tests, giving an indication of the confidence of each measured value. This information can be used to identify faulty or inaccurate meters and consequently increase the precision of the plant data.

Once a reconciled set of real-time data is produced, it is possible to determine the optimum operational configuration. The main degrees of freedom available are: boiler selection and loads, turbogenerator operation and extraction/condensing flows, fuel selection, and gas turbines operation (power generation, steam injection, etc.). Unlike the off-line model, which can run at every engineer's desk, the on-line model is

hosted in a dedicated, powerful Windows® 2000 server. With no direct user interaction at all, the data collection and filtering runs every 10 minutes, while the reconciliation and optimization runs every 30 minutes. There are three different levels of user access to allow for changes in equipment availability (control room level), prices and tariffs (managers and engineers level) and model structure (programmer level).

As the reconciliation and optimization is completed, the system automatically exports the results in two ways: web-based reports (a current set of results is published to a set of web pages on the company intranet) and a custom-built SQL Server database (Cepsa's preferred choice). Other options are storing results in the site data historian or an Access® database. In each case, status flags reporting the feasibility of the solution, the "health" of the software, and other key items are included with the results.

The system described in this paper was developed during the first half of 2003 and it was implemented at the Gibraltar refinery during the summer. The latest results available at the time of publication were analyzed to provide an indication of the savings predicted by the model resulting in more than 350 completed optimization runs showed an average reduction in operating cost of 3%.

In summary, the model-centered system described can be used to simulate different "what if" scenarios to validate and reconcile data, or to optimize the operation by finding the least-cost configuration. While it can run off-line (manual execution), its most sophisticated mode is linked to the refinery data historian and works as an on-line, open-loop optimization tool. This user-friendly system presents the results by generating web-enabled reports and stores the main variables in an SQL Server database.

NEWS & INNOVATION

KBC NEWS

Improved KBC Website

KBC is launching its newly redesigned website, available March 12th at www.kbcat.com.

Visitors to the site will find:

- dramatically improved navigation
- improved product and services organization and detail
- a stylish new look and feel.

KBC celebrates the opening of its new Moscow office.

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KBC announces our first Singapore Symposium, June 2004.

For details, contact asia-pacific@kbcat.com.

EVENTS

Industrial Energy Technology Conference, 20-22, April, Houston

Joseph Davis, Jr., Energy Consultant, KBC, will present, "Sales Manager Overcoming Fuel Gas Containment Limitations to Energy Improvement."

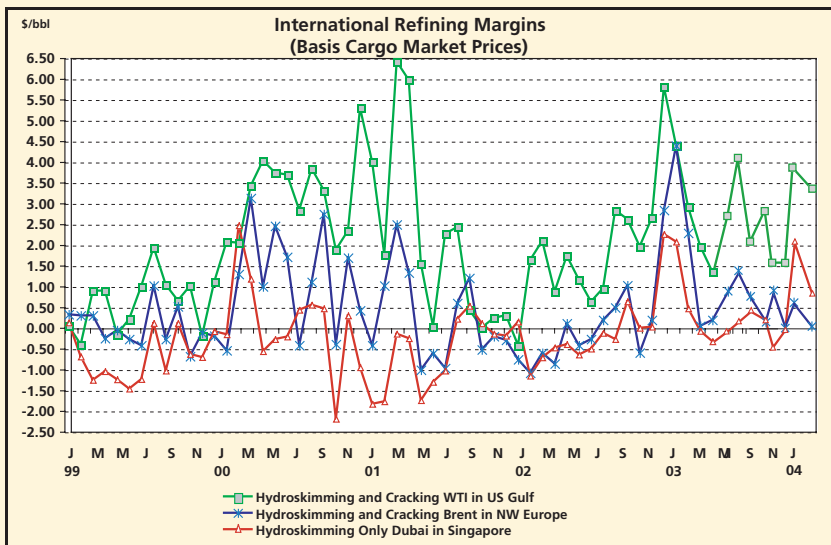
Joseph Davis, Jr., Diego Polanco, and Alan Eastwood, KBC, will present, "Real-time Utility System Optimization."

The paper builds on previously presented papers from 2002 and 2003 focusing on "second generation" optimizers using case studies.

Refining Margins

February's refinery margins in both the US and Singapore have weakened from January levels, but nevertheless, they have remained high in the context of the last two years. A tight products balance has supported products in both regions relative to crude despite strong crude oil prices. US gasoline is dominating price developments and is increasingly becoming the market leader, underpinning crude as well as product prices. This is adding to local support for products in East of Suez markets, where a return to robust growth demand has allowed a sharp increase in refinery utilization over the past few months.

In contrast, European refinery margins are just above marginal cost breakeven for hydroskimming and cracking operations, but have not recovered from the underlying level of the past 12 – 18 months. By and large, Europe has been reliant on arbitrage opportunities to the US and Asia for support to products. High freight rates have ensured that local prices have had to be significantly below those other regions to open the arbitrage.



Refining & Petrochem Business Conference, 21-22, April, Moscow

Mark Bilcliff, Vice President, KBC Profimatics, will present, "Profit Improvement through an LP Revamp."

Bilcliff's paper will describe part of a project to upgrade the performance of the Linear Program (LP) at an existing refinery site. The study highlights the interaction required between planning and operations in order to ensure a successful commissioning of the revamped LP model.

AIChE Spring Meeting, 25-29, April, New Orleans

Joseph Davis, Jr., KBC, will discuss, "Real Time Energy Management Solutions."

Davis' paper will explore the use of an advanced utility optimization tool coupled with proven energy management techniques to identify and sustain energy performance improvement.

ARTC 7th Annual Meeting, 28-30, April, Singapore

Zoran Milosevic, Sr. Staff Consultant, KBC, will present his case study, "Model-based Steam System Management at NPRC Sendai Refinery." The case study will describe the primary use of the model and the development of daily operational strategies for energy cost reduction.

ARTC Reliability, 28-30, April, Singapore

Haije Stigter, Sr. Staff Consultant, KBC, will present, "Business Venture Risk Management." His paper will explore the key elements of a business venture risk management (BVRM) program, and how the KBC approach was successfully applied at a North American refinery prior to a multi-billion dollar conversion project designed to exploit new upstream opportunities.

Implemented \$12MM/yr in Benefits and Technical Services

North America

Over a two-year period, KBC consultants have been working closely with our client to successfully implement 31 projects with an incentive of \$12 MM/year. The majority of these projects were no or low cost initiatives. The work started with a comprehensive survey of all the units, including processing strategies, economic drives and energy utilization. The unit data was reconciled and used to develop detailed simulation models for each of the units. These models were then incorporated into KBC's proprietary refinery flowsheet software, PETROfine, that permits evaluation of potential opportunity effects through product blending. In addition, a detailed energy balance was developed for the refinery. These opportunities included modifying operating strategies and unit conditions, changing catalyst selection, utilizing additives and changing stream routings. The key items included: improved product recoveries at the crude unit by optimizing steam stripping and utilizing alternate product draws, increased severity at the reformer, and increased severity at the FCC unit.

To ensure implementation of the various strategies, fulltime onsite assistance was provided. For long-term sustainability the refinery economic and monitoring tools were reviewed and modified. This included providing LP modifications to track issues, such as unit hydraulic limits, heater firing limitations, and the impact of changes in operating strategy and feedstock. In addition, KBC conducted a review of the refinery monitoring practices, revised these to reflect worldwide best practices. This involved creating new monitoring tools in some areas for comparing actual versus expected operating conditions, yields, catalyst runlength predictions, and key performance indicators. These tools allow for tracking and valuation of opportunities, as well as quickly identifying deviations. As a result, the refinery now has better utilization of equipment capacity and catalyst.

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COMPLETED PROJECTS

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KBC's worldwide consulting experience and tools developed in this endeavor were applied to various capital projects being considered by the client. KBC made recommendations that improved the project returns and lowered the capital costs. This involvement demonstrated KBC's ability to add value in all areas of process engineering, operations improvement, refinery planning, and ensuring the best utilization of capital expenditures.

Review of UK LNG Outlook

Europe

A major European gas player contracted PEL Market Services to appraise the viability of LNG imports into the UK to better understand the pipeline gas import implications and trading opportunities, particularly for peak winter loads. The

client needed a third party snapshot of the UK marketplace and its interface with the continent of Europe.

The first objective of the study was to define the UK gas import needs. It's clear that directionally, the UK is likely to move to import deficit and the timing of this remains critical for investment purposes in new supply. PEL reviewed various demand scenarios, especially the gas needs in the power market, and examined a number of potential production profiles. This enabled a view to be taken of the crossover point for demand and supply. We also looked at the seasonal and peak day nature of winter demand to identify peak import needs.

The study concluded that the gas deficit is not as high as many expected over the next few years. The previously committed investments to Interconnector capacity and LNG into the Isle of Grain, and the projected plans for the Petroplus and ExxonMobil plants

at Milford Haven, further demonstrates that the UK is likely to be adequately supplied.

A second study objective was to consider the relative economics of pipeline versus LNG imports. Until the late 1990s it was almost inconceivable to envisage the UK becoming a significant LNG importer, notwithstanding depletion of its own production. Imported pipeline gas would have filled the gap, but the economics of LNG have been transformed by economies of scale in larger trains (and an emerging use of 200,000+ cu meter LNG vessels). Peak seasonal UK gas prices provide adequate netback values to LNG sellers. With input from Andy Flower, formally head of BP's LNG division, the study reviewed the international trading opportunities for LNG, taking advantage of trans-Atlantic price arbitrage opportunities, and thereby providing a degree of risk diversification for LNG schemes with a prime UK market target.

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