4th Quarter 2002

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Helping Clients Improve Profits and Achieve Pacesetter Performance

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Clean Fuels Impact Reviews

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Pinch Technology Applications

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Change Leadership

Implementation Services

Technical Services

Upstream & Downstream Risk Management

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THE PACESETTER'S APPROACH TO ENERGY EFFICIENCY

By Eva-Lena Strömberg, Scanraff
Zoran Milosevic, KBC Process Technology Ltd.

Presented at DRI/WEFA European Oil Refining Conference, Monaco, June 2002

At the end of 2001, KBC conducted an energy conservation study at Scanraff refinery in Lysekil, Sweden. Scanraff was known to be a very efficient site, and at 129% Best Technology (BT), it was the most energy efficient refinery that KBC had surveyed.

The "gap" analysis showed following areas of relative inefficiency:

- Power generation efficiency: Around 50% at Scanraff (the combination of backpressure, condensing and imported power), the Best Technology power generation efficiency is 80%, with 8 points on BT scale attributable to this inefficiency.
- CDU preheat train: Scanraff preheat temperature is 245°C (260°C at the start of run), meaning that Scanraff preheat train performs as if it was designed for an approach temperature of about 60°C. KBC's Best Technology preheat train features a 20°C approach. Such preheat train would achieve a preheat temperature of about 300°C, and resulting BT index would reduce by 12 points.
- Fired heaters efficiency: Average efficiency of Scanraff's heaters is high at 89.4%; however, BT efficiency is 92%. Three points on BT scale attributable to this inefficiency.

The conclusion is that the two main inefficiency areas are the crude unit heat integration and the power generation.

The energy efficiency at Scanraff has not always been at such a high level. The refinery was designed and built before the energy crises of the mid 1970s when units were designed for lower energy efficiency than they would be today. A series of energy conservation measures followed shortly after the start up and still continue.

Since 1990, Scanraff has used Solomon's Energy Intensity Index (EII) to benchmark their energy performance. Figure 1 shows the steady declining trend in EII from 1990 to 2000.

Decline in EII

Year	EII
1990	81
1992	79
1994	77
1996	70
1998	72
2000	69

KBC Study Results and Recommendations

KBC identified a number of non-investment energy saving opportunities, uniformly distributed across the following three main areas, with total identified potential benefits in Figure 2:

- Process improvements (hot feeding, optimizing the reflux ratios, optimizing the use of hot streams)
- Steam system improvements
- Fuel system improvements (minimizing the flare, maximizing fuel oil use up to the environmental limit)

Continued on pg. 2

Total Identified Potential Benefits

US$ used	Non and minor Investment	Moderate Investment	Investment Projects
Steam & Power	115,000	400,000	2,700,000
Fuel System	350,000		
CDU/VDU		600,000	
NHT/Reformer, ISOM	215,000	400,000	1,500,000
SYNSAT		100,000	
FCC and CAT POLY		160,000	
Visbreaker	100,000		
Furnace excess air control	50,000		
TOTAL	830,000	1,660,000	4,200,000

Steam System Improvements

Benefits of around $500,000/year were identified, with the main opportunity found in using process waste heat to preheat boiler feed water. Other recommendations included boiler blowdown control and optimization of use of process turbines.

Two excellent payback (< 2 years) investment projects were identified in the steam system. These consisted of replacing two condensing turbines with high-efficiency backpressure turbine drivers.

Process Units

More than 20 ideas and opportunities were identified in the process units, with the main benefits found in following areas:

- Crude unit preheat train modifications including use of twisted tubes
- Hot feeding VDU and SYNSAT units
- Optimization of reflux ratios
- Optimization of the use of waste heat

The opportunity in the example below showed the complexity of the approach and the level of detail required when addressing possible energy savings in a pacesetter refinery.

Example: Optimize The Use Of Naphtha Heat And Improve Heat Integration

The naphtha splitter in the isomerization unit (T-1) has two reboilers. This column can be reboiled using either LP steam (in E-1) or naphtha heat (in E-2), as shown in Figure 3. In the base case, the duty was supplied predominantly by LP steam (25 t/h of LP steam is used and almost no naphtha heat).

The logic is that downstream of E-2, naphtha feeds the reformer naphtha splitter (T-2) at 150°C, and this column is reboiled using MP steam. Increasing the feed temperature should save MP steam in E-3 at the expense of LP steam in E-1.

However, the logic may be incorrect because:

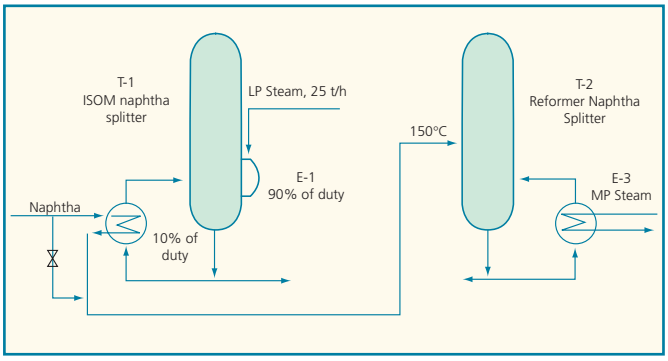
- Increasing feed preheat does not save T-2 reboiler duty in direct proportion (because the reflux increases); the "feed preheat recovery factor" is less than one
- Using naphtha heat in E-2 saves LP steam in direct proportion
- Feed temperature of 150°C to naphtha splitter appears unnecessarily high

Furthermore, the analysis of the steam system showed that MP steam is only slightly more expensive than the LP steam (because not much power is extracted between the MP and LP levels and the low cost of power).

Modeling of the naphtha splitter suggested that the "feed preheat recovery factor" is 0.5-0.6 (only 50-60% of the heat added to T-2 feed can be saved in E-3).

It was found that by increasing the duty of E-2 and reducing T-2 naphtha feed temperature to 120°C saves about 7 t/h of LP steam in E-1, but increases MP steam consumption in E-3 by just over 4 t/h. The annual savings are $215,000/year.

Two Naphtha Splitters Arrangement



In summary, the steps necessary to take in order to identify the above opportunity are:

- Model steam and power system and identify the marginal mechanisms
- Identify marginal cost of fuel
- Calculate marginal steam costs
- Understand and question the existing heat integration pattern
- Model T-2 to find E-3 reboiler duty with reduced feed temperature

Conclusion

Scanraff energy study proves what KBC firmly believes; even the most energy efficient sites offer large scope for improvement and make energy studies worthwhile in terms of quick returns. It is the strength of KBC "Best Technology" benchmarking procedure that is crucial in identifying the areas of opportunity. BT methodology compares the actual energy performance versus the best available practice, and not only with the industry average. Being best in class does not mean that further improvements are not possible.

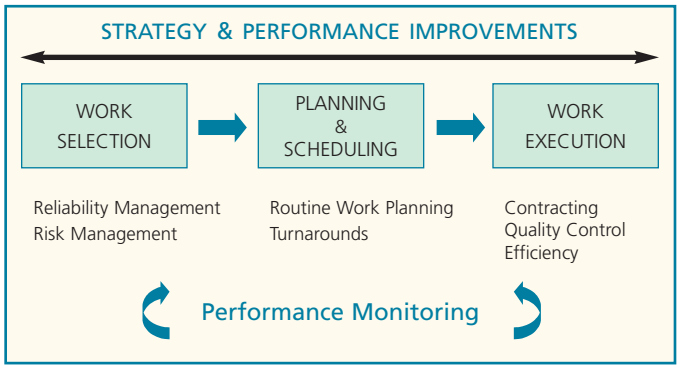
RAM Program At Bapco Provides Major Cost Savings

KBC was engaged by the Bahrain Petroleum Company Ltd (BAPCO) to assist in achieving strategic objectives with respect to their refinery maintenance performance. BAPCO refinery has a crude processing capacity of some 260,000 barrels per day.

BAPCO's strategic targets were to reduce maintenance expenditure while maintaining high availability. In order to achieve this, KBC provided Reliability, Availability and Maintenance (RAM) consulting services, targeted at providing significant and sustainable cost reduction measures through the implementation of risk management and maintenance best practices.

KBC's systematic approach to maintenance is split into three main functions (Figure 1) and supported by the enabling strategic and continuous improvement elements.

Figure 1 Systematic Approach to RAM



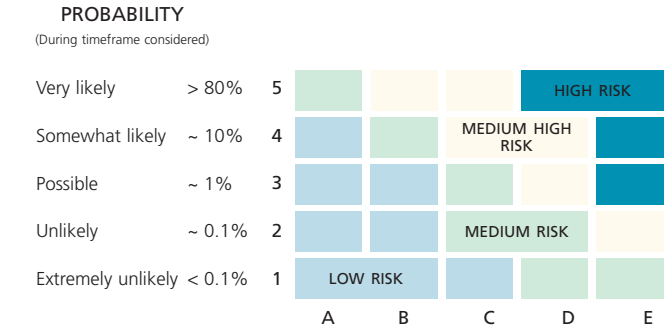
Specifically, KBC was contracted to provide RAM services covering the following areas:

- Risk Based Work Selection (RBWS)
- Routine Maintenance Planning and Scheduling (P&S)
- Turnaround Strategy and Optimization Program
- Contracting Strategy
- Maintenance Function Organization Development

Implementation of this program commenced in January 2001 and spanned fifteen months. The rollout was applied in a modular manner whereby early benefits were captured, making the program cash positive within a year.

With Risk Management representing one of the key elements of the program, KBC assisted BAPCO with the development and subsequent implementation of a site-specific risk matrix. This matrix reflected business objectives and provided a framework for decision-making throughout the organization, thereby ensuring a level of consistency across the site, inline with the overall strategic objectives. An example simplified risk matrix is shown in Figure 2.

Figure 2 Example Simplified Risk Matrix



CONSEQUENCE	SAFETY/ENVIRONMENTAL	AVAILABILITY	FINANCIAL CREDITS (Annualised)
A	Small Contained Release	Energy/Yield Debit	2:1
B	Minor Fire/Minor Injury	Unit Slowdown	5:1
C	Localised Fire/Reportable Exceedence Non Toxic/Non LPG Release	Minor Unit Shutdown Major Unit Shutdown > 20%	10:1
D	Major Fire/Serious Injury Spill to water/LPG Release	Major Unit Shutdown	100:1
E	Multiple fires/explosion/fatalities Major LPG/Toxic Release	Major Extended Disruption	1000:1

The BAPCO risk matrix has been applied to all routine and turnaround maintenance as a screening and prioritization tool. As a result, significant work scope reductions have been achieved as well as major reductions in the amount of "urgent" routine maintenance. The matrix has also been used to assist in optimization of Preventive/Predictive Maintenance programs.

By completion of this program, the implemented maintenance cost savings were in excess of $4.7MM per year, with identified benefits of some $7 to $8.5MM per year. In addition, significant operating credits from increased on-stream time have also been implemented.

BAPCO's Views about KBC:

Selection of KBC among other consultancy groups was a right choice by BAPCO Management. KBC was one of the few consultants that BAPCO has known and managed to achieve the target savings set in the beginning of the program.

BAPCO benefited greatly from the high standard of KBC consultants and the professionalism they exhibited. We thank KBC management for this achievement.

Following a slight upturn in June, refinery margins have fallen back again during the third quarter with generally negative returns on processing the marginal barrel in Europe and Asia, and a low and diminishing margin in the US. While the continued absence of growth in oil demand and ample stocks of petroleum products remain important contributory factors, the prime cause of poor margins has been the resurgence of a growing 'war premium' in the price of crude that has not been fully reflected in products prices.

In the absence of conflict, refiner margins are unlikely to show a measurable improvement until such time as the excess in stocks of petroleum products has been substantially reduced. The focus is moving seasonally to middle distillates. Though there has been no typical seasonal rise in stocks of these products over the past couple of months, in either the US or Europe, they remain more than ample in both regions. Growth in oil demand is likely to resume in the fourth quarter, if only in comparison to weak year earlier levels. Nonetheless, in the likely absence of an early start to winter weather in the northern hemisphere, some overhang in middle distillate stocks is expected to persist. However, whether margins improve or not during the fourth quarter is likely to continue to depend on crude price developments.

The level of crude prices will depend principally on two factors: the ebb and flow of market sentiment regarding military conflict with Iraq and the level of OPEC crude supplies. OPEC action should ensure that oil prices do not increase on a sustained basis to above the ceiling to OPEC's price band, equivalent to $30/bbl for WTI. PEL Market Services expects that crude oil prices will remain strong until such time as either the threat of war with Iraq recedes, in the unlikely event of an unhindered return of UN weapons inspectors, or until initial military action confirms that there is no serious threat to Middle East oil supplies. Refiner margins are only likely to improve if Iraq readmits weapons inspectors and the 'war premium' in crude prices collapses, or in the event of military action. The latter, seems unlikely before the first quarter unless Iraq refuses to cooperate with UN/US demands. However, war with Iraq would instigate additional buying of petroleum products for security stocks and military use, and result in a spike in refiner margins in Europe and East of Suez markets.

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Web site: www.kbcat.com
E-mail: kbc@kbcat.com

KBC Process Technology Ltd
KBC House
42-50 Hersham Road
Walton on Thames
Surrey KT12 1RZ
UK
Telephone: +44 1932 242424
Facsimile: +44 1932 224214

KBC Advanced Technology Pte Ltd
435 Orchard Road #16-04
Wisma Atria
Singapore 238877
Telephone: +65 6735 5488
Facsimile: +65 6736 4759

KBC Advanced Technologies Inc
14701 St. Mary's Lane
Suite 300
Houston, TX 77079
USA
Telephone: +1 281 293 8200
Facsimile: +1 281 293 8290

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U.S. POSTAGE
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