Best practice tames the energy beast - Design through operation

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Energy management is essential for sustainability and profitability of an operation. Second to raw materials,energy is the largest expense in most chemical and refining processes. Those refineries and petrochemical companies who invest in energy efficiency gain a competitive advantage through improved operating margins, production flexibility and better carbon footprints. Improving energy consumption should be seen as a business opportunity and embedded within all aspects of the enterprise. External and internal factors make energy optimisation an on-going challenge in any operation. Energy sources, supply and costs are changing and evolving. Feedstock shifts impose adjustments in operating strategies. Sales contracts impose constraints. Environmental regulations and taxes can force operating shifts whilst equipment ages with time and its condition impacts operating effectiveness (i.e. Heat exchangers age and get fouled).

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So, how can refinery and petrochemicals companies keep energy efficiency at front-of-mind in the midst of business complexity and uncertainty?

Tackling energy inefficiency is divided into supply-side and demand-sideareas. On the demand-side, there are various strategies for reducing energy demand. Fundamentally, making more efficient use of all heating and cooling sources presents opportunities in a plant. This is known as heat integration and is tackled during design, but also on any operating facility. Demand can be reduced through better operation and maintenance of process equipment. Heat exchangers encounter a variety of operating challenges ranging from fouling on heat transfer surfaces, vibration and hydraulic issues. Process strategies can have a significant impact on energy use, for instance, adjusting operating temperatures, tuning and adjusting column tray and flow. Reducing process variability (through optimisation and real time control) can significantly improve efficiency. On the supply-side, actively managing the available utility sources based on their temporal pricing and supply typically can achieve enormous savings.

In summary, there are four strategic opportunity areas for energy savings:

- Better design of new facilities
- Capital investment to revamp processes for energy efficiency
- Improvement in operating and maintenance strategies
- Effective management of utilities for either lowest cost or lowest energy use

It is a combination of these four elements that industry needs to undertake to respond effectively to the issues in energy efficiency and carbon footprint.

Design for Energy Efficiency

Process engineering design faces a range of design objectives starting with yield and quality targets, feedstocks, flexibility to handle changes in feedstock and product over time, safety and emissions compliance, operating stability and capital cost minimisation.When energy efficiency is relegated down the priority list there will be a negative impact over the life of the plant.

The enemy of energy efficient designs is time. Most projects today, whether large or small, are under huge schedule pressure. The most proven or easiest-to-design process (from a functional point of view) gets developed. Incorporating heat integration (pinch) analysis into this early stage can yield important lifecycle benefits. Energy efficient processes not only save lifecycle costs, but also capital through reduction in required ratings. This will help to also save hot and cold utilities.

Ways to improve energy optimisation at the early design stage include:

- Intuitive heat integration (pinch) analysis and optimisation software embedded within the process simulation enables the conceptual designer to rapidly investigate, screen and select better designs from an energy point of view.
- Detailed heat exchanger modelling within the process simulation enables the conceptual designer to look at trade-offs between heat exchanger size, efficiency and operability to achieve the best trade-offs between capital and operating cost.
- Optimisation of the interaction between heating and cooling block and key process units, such as separation columns,using optimisation methods within leading process simulators (e.g. Aspen Plus and Aspen HYSYS).

Energy conservation is important, not only to large bulk petrochemical and fertilizer processes, but also to new bio-conversion processes seeking commercial viability. Liquid Light[1] is a start-up company who are commercialising patented bio-to-chemicals processes and Pan Pacific[2] is a company addressingconceptual process design of algal biofuels production. Both organisations have made use of these earlydesign approaches to improve the economics of their novel processes. Braskem has developed an innovative energy efficient process for synthesising isopropanol from sugarcane by utilising the above approach. 30% energy saving is achieved in the early stage of process design with the right combination of process knowledge and software tools like energy analysis inside Aspen Plus.[8]

Revamping existing facilities

Diverse opportunities are available to improve energy use in existing facilities and many of these alternatives also fortuitously improve yields. The same tools, which are available during front end design, are similarly available to the engineer looking at energy conservation and plant improvement. Several of the key opportunity areas are heat exchanger reconfiguration; replacement and addition of heat exchanger; more aggressive preventative maintenance strategies to reduce heat exchanger fouling; process changes in operating parameters and configuration to improve efficiency.

A comprehensive energy analysis of an existing process facility may identify dozens of individual opportunities for improvement, some of which involve significant capital expense and others involve trade-offs in production achieving both energy reduction and yield improvement. LG Chem, in a recently published case, gained both energy savings and a 10% yield improvement through column integration and better process sequencing.[3]

Operations and maintenance strategies

A range of operating practices and strategies are available to collectively improve the energy use within a plant. Several of these include:

• Visibility of energy use KPIs:

Visual KPI dashboards representing plant performance are the starting point for operational improvement. When all operators, maintenance personnel, planners and managers understand the impact of their actions on plant energy use and costs, it gives each individual in an operating environment ownership of the energy challenge.

• Heat exchanger maintenance:

Heat exchanger fouling imposes both energy and yield penalties. Tuned process and heat exchanger models can be used in combination with real-time plant data to predict heat exchanger fouling and to drive improved maintenance schedules that reduce plant outages, energy use and yields. Organisations, such as INEOS[4] and Dow Chemical,[5] have documented significant revenue impact from these strategies

• Efficient production/energy planning and scheduling:

Establishing a link between production and energy scheduling ensures secure energy supply for plants; reduces the need for flaring of surplus fuel gas and venting of surplus steam and helps forecast possible bottlenecks. Better daily scheduling and reacting to changes quickly with enhanced execution is crucial. Aspen PIMS, Petroleum Scheduler and Aspen Utilities Planner are the tool sets that provide a comprehensive ability to synchronise the production planning, scheduling and energy planning for these complicated objectives. Supply-side management in the production planning process, energy costs and emissions targets are becoming an integral part of planning. Operational benefits can be gained by planning for inbound and outbound energy use (i.e. process equipment and facilities energy use, feedstock sched-

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uling, purchase of external utilities versus use of internally available sources). State-of-the-art forward-planning tools, such as Aspen PIMS, can help evaluate the trade-offs between production, energy sources and costs and emissions, enabling a true optimal operation to be defined. Aspen Utilities Planner software can help plan the optimal utilities system's set up and also advise operations personnel on actions they can take on a real-time basis to improve energy and economic performance. Rompetrol has realised significant values and improved the bottom line of refinery operation by adopting the approach above to close the gap betweenhydrocarbon planning and energy planning.[6]

• Real-time optimisation combined with advanced control:

Advanced process control (APC) can manage a process to reduce variability and enable the plant to be run closer to its desired performance. This in turn can reduce overall energy budget for the process and better manage emissions within permitted limits. Aspen DMC3 software is a new generation of advance process control that makes an advanced control system more intuitive and maintainable. Real-time optimisation can be combined with advanced process control to further achieve energy reduction. By running an analytical process model continuously against plant data, operating strategies can be continuously revised based on actual plant performance. Fertilizer manufacturer, Profertil, is an example of an organisation that achieved millions of dollars in annual benefit from this strategy.[7]

Making the difference

The priority that companies place on energy management fluctuates in concert with trends in energy prices and price uncertainty. This is a short sighted view. In the longer term horizon, investments in energy minimisation will-pay off over an asset's lifecycle. By achieving the same outcomes through less energy usage, organisations can implement more efficient processes and embrace advanced technology to improve performance. Energy improvement has the side benefit of improving process yields. It also has sustainability benefits. Process plants as major energy consumers will be increasingly under regulatory and public scrutiny related to their carbon footprint.

By considering total energy and utilities systems, leading energy management software tools provide a process organisation the perfect solution to taming the energy beast from design through operation and help dramatically improve margins.

For many enterprises, the value of energy reduction on profitability is usually evident. The challenge is in clearly identifying opportunities for improvement and their capital and operating implications. State-of-the-art process simulation, analysis, planning, scheduling, optimisation and control software optimises energy usage by managing operations across the enterprise. Capital savings can be made by implementing more energy efficient operational measures, resulting in increased production and reduced emissions.

Adopting best practice improves the way companies source, trade and use energy. Operating existing utilities with minimum cost and maximum reliability delivers the optimum production plan while considering ever-changing environmental, organisational and technical constraints. Managers can use best practice to make calculated, measured and sustainable decisions, while meeting regulations and improving production standards. By considering total energy and utilities systems, leading energy management software tools provide a process organisation the perfect solution to taming the energy beast from design through operation and help dramatically improve margins.

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