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Identifying and Implementing Energy Saving Process Changes

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INTRODUCTION

Excluding feedstock costs, energy is the largest cash cost to a refinery. On average it accounts for as much as 60% of the total cash costs, excluding feedstock. As a result, the refining industry has always been proactive in seeking out energy savings. Lately, with increased crude and natural gas pricing, the industry has put even more emphasis on energy savings. Voluntary GHG (Green House Gas) reduction programs like Kyoto and internal corporate mandates have put additional pressure on refineries to not only reduce the cost of energy, but reduce consumption[1]. These programs' targets are either absolute GHG reductions or intensity-based reductions.

Energy savings can be accomplished in two ways; by improving the efficiency (or cost) of supplying the required energy, or by reducing the required energy either on an absolute or intensity-based level. In this paper, these will be referred to as supply-side and demand-side energy improvements respectively. Most of the emphasis to-date has been concentrated on supply-side improvements like improving furnace efficiencies, adding cogeneration facilities, and maximizing heat and power recovery. Sophisticated toolsets have been developed for analyzing supply-side systems[2]. On the other hand, very few studies focus on demand-side opportunities. The reason for this is that identification and evaluation of demand-side opportunities requires a thorough understanding of process technologies in use in order to determine under what scenarios the energy benefits are greater than the potential yield (or Gross Margin) debits. This understanding of energy and yield tradeoffs is often not available within groups that offer energy assessments to refiners. In addition, that process knowledge needs to be comprehensive enough to follow, by modeling if appropriate, the relative yield and energy benefits from the point of change though to final product blending.

I Cubed Energy Consulting, Inc. offers a unique Energy Assessment program to refiners which focuses on both supply-side and demand-side opportunities. We are refinery process engineers who do energy assessments, not energy engineers who offer energy assessment programs to a diverse set of industries including chemicals, paper and pulp, brewing, dairy, etc. Clearly with such a wide spectrum of process technologies, these cross-industry energy assessment programs can not focus on demand-side opportunity identification.

This paper outlines I Cubed Energy Consulting's Energy Assessment program and presents a couple of examples of simple demand-side energy opportunities which would be overlooked in a program focused primarily on supply-side energy opportunities. In each example the facts have been altered slightly to protect the identity of the refinery, yet still preserve the bases for the energy improvement. In a number of the examples, the benefits are both energy savings and yield improvements.

I CUBED ENERGY'S ENERGY ASSESSMENT PROGRAM

The I Cubed Energy Assessment program is divided in three phases based on the three **I**'s of performance improvement; **I**dentification, **I**mplementation and Continued **I**mprovement. Every potential energy opportunity passes through each of these phases, though not on the same schedule.

Phase 1: Identification

The Identification phase starts with benchmarking. Benchmarking compares the study refinery's performance and practices against industry norms and the assessment team's collective experiences from performance assessments at other refineries. Since each of the process and energy system experts at I Cubed Energy Consulting has experience on dozens of performance assessments, over 60 in some cases, these benchmarks are truly a comparison of performance and practices to the some of the best performances and practices in the industry. The team uses typical process data and roundtable discussions with the refinery technical and operations personnel, to determine these benchmarks. In some cases, test runs are performed to arrive at a more complete and accurate determination of current performance. While benchmarking does not identify opportunities directly, it does point to where opportunities are most likely to exist.

Once the benchmarks, both quantitative and qualitative, have been determined, opportunity Identification commences. Initially, a large number of potential opportunities are identified. Although no formal screening of the opportunities is done at this stage, the ideas are filter based on the process and energy experts' understanding of the refinery and unit economic drivers and constraints. For some of the opportunities, the economic benefits and technical feasibility will be obvious. These opportunities are identified as "quick hits." In most cases, the "quick hits" alone pay for the identification phase of the Energy Assessment program.

For the opportunities where the economic benefits and technical feasibility are not obvious, additional evaluations are performed. These evaluations are performed at a level of detail required to prove both the economic benefit under a range of scenarios, and the technical feasibility under a range of potential operations. At the conclusion of this phase, an outline of an action plan for implementing of the identified opportunities is completed with the refinery's collaboration.

Phase 2: Implementation

In the Implementation phase of the assessment, the action plan is executed. In reality, implementation starts as soon as the first "quick hit" opportunity is put into operation. In the implementation phase, opportunity implementation is tracked and the benefits from each implemented opportunity are compared to projections. The action plan is periodical updated to reflect the current state of opportunity implementation, and the updated plan and benefit projections are review with the responsible operations and management teams.

Often opportunities can not be implemented exactly as defined in the action plan, or are not economically attractive due to a change in pricing and cost. The benefits of these economically unattractive opportunities still need to be tracked, so that they can be implemented in economic scenarios where they are attractive. The major challenge in the implementation phase arises when an opportunity is technically infeasible due to new constraint, or constraints not known at the time the opportunity was evaluated. In many of these cases the concept behind the opportunity is still valid; however the means of implementing the opportunity must be modified to overcome the constraints. This is where experienced refining engineers working with the refinery's staff, can turn a seemingly infeasible opportunity into a success.

Phase 3: Continued Improvement

Performance improvement should never stop. In the continued improvement phase of the assessment, systems are put in place to insure that the identified opportunities are in operation whenever they are economically attractive. Continuous opportunity benchmarking, identification and implementation are institutionalized in this phase. Energy re-assessments of a more limited scope than the initial assessment should be scheduled on a biannual basis, and the identified opportunities added to the current action plan for implementation.

EXAMPLE 1: MINIMIZE DELAYED COKER HEATER FEEDRATE BY ELIMINATING INTERMITENT INJECTIONS INTO THE FRACTIONATOR

The primary energy consumer in a delayed coking unit is the heater. This heater provides both sensible heat and heat of cracking for the coking reactions. Typically the heaviest portion of the coke drum product is condensed, combined with the fresh feed and re-vaporized in the coking unit heater. The rate of this recycle stream is set based on coker product quality targets. The duty required to heat and re-vaporize this recycle stream can be a significant portion of the coking unit heater duty.

While clearly some recycle is required to meet product quality targets, incremental recycle above and beyond the target, reduces the amount of fresh feed that can be processed and/or increases the coking unit heater duty. Typical designs inject hydrocarbon condensate from the backwarming of the offline drum and wax tailing from the blowdown tower into the main fractionator flash zone on an intermittent basis. These intermittent injections produce incremental recycle above what is required to meet product quality targets. This increment recycle can be up to 2% on fresh feed. For a typical 60 KB/SD coking unit, 2% incremental recycle require approximately about 2.8 MM Btu/Hr of additional coking unit heater absorbed duty. With a fairly typical marginal fuel cost of $ 8/MM Btu this incremental recycle would cost approximately $ 450,000/year in energy alone. The yield selectivity benefit would be of this same magnitude. However, the greatest benefit is achieved when the coking unit heater is the primary unit bottleneck, and additional coker feed is available. In this fairly typical case, the benefit of incremental feed would be over $ 4,000,000/year at a conservative feed margin of approximately $ 12/BBL.

This opportunity was implemented by directing the warm-up condensate to the coking unit blowdown scrubber bottom. In the blowdown scrubber the condensate was dewater and mixed with the wax tailings. From the blowdown tower, this combined heavy slop was ratably injected into the quench nozzle in the overhead of the coke drum in place of heavy coker gas oil product, which is typically used to quench the drum overhead vapors. With this operational modification, the majority of heavy slops were vaporized as they would be in the flash zone, but not at the cost of additional recycle on heater firing.

This opportunity was sustained by monitoring the dispositions of warm-up condensate and heavy slop from the blowdown tower. Like all implemented opportunities, deviations from the preferred practice were assigned a cost, prioritized for corrective action and reported in varying level detail to the responsible groups within the refinery.

EXAMPLE 2: ELIMINATE FUEL GAS CONTAINMENT BY IMPROVED LPG RECOVERY

Without a capital intensive project such as cogeneration, fuel gas containment can limit supply-side energy improvement opportunities[3]. However, operational modifications can often reduce, or eliminate, fuel containment and make room for additional energy reduction opportunities.

In the benchmarking of an FCCU gas plant, the LPG recovery was identified as atypically low. As well the normalized lean oil rate to the primary absorber was also identified as atypically low. Simulations showed that by doubling the lean oil rate to the absorber, the LPG recovery could be improved by over 10%. The lean oil rate had been purposely kept low to minimize energy usage. However, the refinery was always flaring fuel gas due to a containment problem. Therefore, purposely minimizing lean oil was not saving any energy at all. The additional LPG recovery due to increased lean oil circulation, more than paid for the incremental energy required to stabilize the lean oil. As an added benefit, this opportunity moved the refinery out of fuel gas containment and eliminated flaring.

The net benefit, LPG recovery minus incremental stabilizer duty, for this opportunity to a 50 kB/SD refinery with a 20 kB/SD FCCU was approximately $ 400,000/year. In addition, eliminating flaring was a significant community relations benefit and the net reduction is combustion help the refinery meet their corporate mandated CO_2 emissions target. With fuel gas containment no longer a constraint, the refinery now had incentives to implement a number of other attractive energy reduction opportunities.

SUMMARY

These examples above illustrate how an understanding of both the supply side and demand side of the energy balance can reveal significantly more energy opportunities. Energy assessment programs that primarily focus on the supply side, limit the potential benefits. Unfortunately, to study both the supply-side and demand-side of the refinery energy balance requires a special pool of engineers with in-depth experience and understanding of refinery process technology. I Cubed Energy Consulting has such a resource pool, and offers an unique Energy Assessment program which explores both sides of the energy picture, therefore maximizing benefits to its clients.

REFERENCES

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