"TURNING INFORMATION INTO ENERGY SOLUTIONS FOR INDUSTRY"

ENERGY MATTERS

INDUSTRIAL TECHNOLOGIES PROGRAM

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ISSUE FOCUS:
Selling Efficiency Projects to Management

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Presenting an Energy Efficiency Project to Management

Special to Energy Matters *from the Compressed Air Challenge*

Often, the resistance by chief financial officers and other upper management executives can be a critical barrier to implementing compressed air or other energy efficiency system improvement projects. The following outline illustrates the kind of information that needs to be presented to management to successfully gain approval for such a project.

Under most circumstances, it would be appropriate to seek approval by making a formal presentation to key management staff. It would be to the presenter's advantage to have in attendance during the presentation the principal managers of all potentially affected activities. In deciding who should be invited, consideration should be given to impact on budgets as well as on operations. It is most important that all interested parties be fully informed before the meeting, so they can be prepared to participate. If your project gets approved, funding may have to come from other activities; those managers must be fully involved before your presentation, if you are to avoid having them oppose your project.

Besides gaining the cooperation of internal management, it might be wise to gain the support of outside parties, who might lend additional credibility to your proposal. For example, you might want to use a report from an independent professional, or recommendations from your utility or energy services company. For compressed air projects, it would certainly be helpful to make reference to materials produced or endorsed by the Compressed Air Challenge.

Your presentation to management must be tailored to the scope of the project, and the management style of your leadership, and must be keyed to achieving a decision. The best idea is to make the individual in your management scheme who can ultimately approve the project the focus of your presentation.

Your presentation should present all of the necessary information as concisely as possible. Do not waste valuable time with unimportant details. The more irrelevant details you furnish, the greater the likelihood that someone will start to nit-pick. This may well divert the decision-maker's attention from the true issues at hand.

The following outline suggests a format for presenting your compressed air or energy efficiency project to management.

Selling the Project to Management

A. **State the purpose of the presentation.** You want everyone attending your presentation to focus on the problem you will present, knowing that a decision will have to be made. If attendees think they are there for an information briefing, they may easily miss some of the points that will critically affect the decision.

B. **State the problem to be corrected.** What are the existing conditions that make it important that the project be considered? What costs are involved that can be reduced? How do existing conditions affect production, staffing, maintenance, and the bottom line?

C. **Describe the scope of the project being proposed.** As briefly as possible, and using a minimum of detail, describe what the project will consist of in terms of equipment, labor, time, and cost to implement. This part of the presentation will help the decision-maker and other key players get a fast understanding of what you want to accomplish and how.

D. **State the benefits to be achieved by implementing the project.** Using simple

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Presenting an Energy Efficiency Project
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data summaries and graphical displays, explain how the project will cure the problems you earlier laid out in discussing existing conditions and improvements to the bottom line. Emphasize reducing operating and production costs realizing that one of the most important parameters is the cost per unit of production. In addition to the benefits derived from energy conservation, you should illustrate other benefits, such as: pressure stabilization, improving moisture control and air quality, the side benefit of turning off machines that creates additional back-up capacity, and reductions in downtime and reduction of product waste.

E. **Clearly state the cost of implementation.** Accurately state what it will cost to perform the project. You must examine all of the direct costs involved, but also the indirect costs. Will there be additional costs for down time and start-up? Will you need temporary compressed air capability? Will there be any interruption in production? You must be ready to answer all of these questions.

F. **Explain any effect the project will have on operations.** While this project is going on, will there be any adverse effect on production or other operations? If so, how will it be accommodated? Has the resultant cost of any such impact been included in the estimate of the cost of implementation?

G. **Present the effect on the budget.** Any significant new project will affect the budgeting process. If the project is being sought for the current budget year, the effect is likely to be both large and widespread, having an effect on more than just one part of the business. If the project is for a future budget year, the planning may be simplified, but the effect will always be felt at various activities in the business. Unless a windfall of new revenue exists to fund the project, funding will have to come from existing budget items that will have to be reduced. Advance coordination with the likely targets of these budget transfers can help in getting approval. It may be necessary to clearly demonstrate a long-term benefit to be derived for the overall business to convince a senior manager that he or she can accept a short-term loss of funds to support the project.

Much care should go into analyzing the Return on Investment (ROI), that is, the time over which the savings to be realized by the project equal the cost of implementing it. The shorter the ROI, the more likely the project will be approved. This part of the presentation may be a good time to compare graphically costs against time and present the expected returns to clearly illustrate the ROI. It is also a good time to restate any reduction in cost per unit of production to be realized under the project.

A major barrier to project approval is often a lack of management awareness of real operational costs. Collection or estimation of these costs, and simple graphical displays in your presentation can help highlight the need for the project.

H. **Provide a coordinated implementing plan.** The best plan, implemented poorly, can be a total failure. Coordination between and among departments, realistic work schedules, accommodation for the unexpected, clearly stated, achievable milestones, and the assignment of a fully accountable project manager are essential to making the project a success. "What if" brainstorming should always be included in the planning. Under the best conditions all of the affected activities should be in agreement on the plan before the decision briefing is presented. If such agreement is not possible in advance, the plan should include an early milestone related to achieving that level of agreed-to coordination. The timing for the project and each of the milestones are critical to the decision process. The latest date a decision can be useful must be made clear. Normally, this time estimate should allow management some time to consider options and alternatives.

I. **Summarize the project and ask for the decision.** Close the sale. Summarize the need for the project and timing, review the cost/benefit analysis, lead the

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thought process to conclude the need for a decision, and ask that the decision be made.

Provide a minimum of complicated details in the briefing itself. It is a good idea to have handy as much hard data detail as possible, in case it is requested. Spread sheets and reports, process studies, cost data and analysis are all valuable back-up to your presentation. However, avoid using these materials in the presentation itself to avoid confusion. Any data that you provide should be in a prepared format, and it should not be cluttered with ancillary, irrelevant data that may mislead or divert thinking. You should always remember that the two most critical parameters in play during your presentation are time and focus. Time is critical because the longer it takes to "make your case", the less likely you are to get the decision you want. Focus is important because you do not want the decision maker to be distracted from the very specific goal of implementing your project.

The most important factor in gaining the approval you seek, is coordinating in advance with all of the affected managers and key players within your organization. If you can get them to approve the concept informally in advance of your presentation to senior management, a favorable decision will be much more easily achieved. In most cases, it will be very difficult to get unanimous coordinated approval from all the players. And remember that because of the competition for funding, one or more of the key players will suffer some form of budget impact. ●

How to Present an Energy Efficiency Project to Management

In preparing to seek a decision by management, it will be necessary to follow a logical course of preparation. The following 10-step process, developed by the Compressed Air Challenge, is typical of the preparation needed.

1 Identify the decision-making environment

Who is the ultimate decision-maker? [Someone with authority to actually approve the project.]

How is that person influenced? [What are the 'Hot Buttons'?]

Who are the key players who may influence the decision-maker?

What is the current decision-making atmosphere? [Pro-active or reactive?]

2 Assess the presenter skills

Are you the best presenter in this case?

What is your relationship with the decision-maker?

What attitudes and loyalties are there that may affect the outcome?

Is there someone else who could make this presentation who would be better received by the decision-maker?

3 Identify potential allies and roadblocks

Who are the key players? [Both internal and external]

How will their individual circumstances impact your quest for a decision?

What roadblocks are possible? [Who will be adversely affected if you get the decision to go ahead?]

What policies and/or current objectives will either support or counter your proposal?

4 Develop a preliminary scope of work for the project

Prepare an accurate description of the over-all project.

Include any supporting activities to be required of others, such as engineering support, budget and administration, purchasing, and operations [shut-downs, overtime, etc.].

What coordination is required with other activities?

5 Collect and assemble data to support the decision-making process

Budget and finance. [What alternatives exist for funding?]

How can impact on production be quantified?

How will maintenance operations and cost be affected?

How can the cost/benefit be quantified and displayed?

What are the projected costs over time?

What are the projected savings over time?

6 Develop the preliminary presentation

Outline the flow of the presentation.

Create a proposed list of exhibits or hand-outs.

Identify all of the potential counter arguments, and briefly defend against each.

Review the alternatives.

Prepare the closing argument to ask for the decision.

7 Shop the presentation around

Coordinate with all affected parties.

Get comments from supporters and detractors, alike.

Give credit to all who participate.

Try to reach consensus.

Evaluate credibility and value of opposition.

8 Evaluate the presentation

Revise as needed.

Repeat steps 4 through 7, if necessary.

9 Make the presentation; GET A DECISION

10 ACT on the decision

If approved, implement the project.

If disapproved, analyze the rationale and if necessary and appropriate, repeat the process.

Texas Technology Showcase Coming in March

Chemical manufacturers and refiners from across the country will converge on Houston this March for the 2003 Texas Technology Showcase. The Showcase will give chemical and petroleum refining professionals an opportunity to see energy-efficient process technologies and best practices in energy management that are now emerging in their industries.

The Office of Energy Efficiency and Renewable Energy's Industrial Technologies Program, and the Texas Industries of the Future, are teaming to present the Texas Technology Showcase, scheduled for March 17th through 19th at Houston's Radisson Astrodome Hotel.

The Texas Technology Showcase is designed to promote:

- Increased adoption of technologies and best practices that enhance energy efficiency, improve environmental performance and reduce costs in chemical and refinery facilities
- Greater industry and government awareness of the benefits and need for integration of industrial energy efficiency and environmental technology and practice improvements
- Strengthened partnerships among Texas industries, universities, associations, government, and non-government organizations to focus research and projects into high-priority areas.

The 3-day event will give refining and chemical plant managers, utility and environmental engineers, technology experts, laboratory researchers, educators, equipment suppliers, environmental agency staff

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Texas Technology Showcase
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members, local, state and federal government leaders the opportunity to:

- Learn how leading companies in energy efficiency and environmental performance are achieving results
- Find out how to incorporate energy management best practices to reduce costs
- See the latest technologies in action during plant tours and meet with technology operators and vendors
- Learn how to build support for energy efficiency within an organization, whether large or small
- Discover new resources for plant upgrades and technology development
- See what is being done to meet emission reduction requirements
- Network with industry and government leaders
- Visit the Exposition Hall and meet with more than 65 experts exhibiting technologies and services for manufacturers and refiners.

Houston has long been considered the country's energy capital. Many of the world's largest petrochemical companies operate facilities within the greater Houston area. Participating companies slated for profiling during the 2003 Texas Technology Showcase include: Calpine, Chevron Phillips Chemical Company, Dow Chemical, ExxonMobil, Merisol, Rohm and Haas Texas Inc., and Valero Energy Corporation.

Presentations from participating companies range from new technologies, such as low-nitrous oxide process heaters, to new strategies such as by-product synergies, to plant-wide energy reduction practices. One presentation is expected to cover Rohm and Haas Texas Inc.'s energy management program, in place at a plant in Deer Park, Texas, about 20 miles east of downtown Houston. The Deer Park plant is the largest Rohm and Haas plant and manufactures monomers used in key Rohm and Haas products. The plant accounts for approximately one-third of Rohm and Haas' global energy consumption. To date, the plant-wide energy management program has resulted in a 24% reduction in energy use on a per-pound-of-product basis.

The Industrial Technologies Program and Texas Industries of the Future expect more than 700 attendees at the showcase. For more information or to register for the Texas Technology Showcase, visit **www.showcasetexas.org** or call toll-free 877-648-7967. ●

$36 Million in Savings Identified in AMCAST Assessment

AMCAST and its partners applied a systematic plant-wide assessment (PWA) approach to identify energy and cost saving opportunities at the corporation's facility in Wapakoneta, Ohio. The team initially identified $3.6 million in savings opportunities resulting from increased energy and productivity efficiencies with paybacks ranging from 0 to 29 months. Additional savings opportunities surfaced as plant personnel were implementing the initial recommendations, and the total saving opportunities have grown to nearly $6 million.

Encouraged by these savings, AMCAST has replicated the PWA methodology at five plants throughout the corporation and introduced projects from the assessment into its other plants. AMCAST's strategy is succeeding; company-wide savings will reach nearly $36 million over the next several years.

AMCAST SAVINGS ASSESSMENT

	Annual Savings
Corporate-wide savings	$36 million
Wapakoneta plant savings realized	$6 million
Wapakoneta electrical energy savings	671,907 kWh
Wapakoneta natural gas savings	9,146 MMBtu

The Wapakoneta facility spends millions of dollars and uses energy-intensive processes in its production of low-pressure aluminum castings for automotive suspensions. The assessment team focused on all energy-intensive plant systems, including furnaces, boilers, electrical equipment, compressed air, fans and pumps. Scrap reduction also resulted in increased productivity.

DOE funded the assessment at $75,000 and required at least a matching amount from AMCAST. The accompanying table highlights the overall savings opportunities identified.

For plant-wide assessment program information, contact Graze Ordaz of the DOE's Industrial Technologies Program by phone at 202-586-8350 or by e-mail at grace.ordaz @ee.doe.gov. For technical details about the assessments, visit **www.oit.doe.gov/bestpractices/factsheets/amcast.pdf**, or contact Bob Leach of the Oak Ridge National Laboratory by phone at 865-946-1352 or by e-mail at leachre@ornl.gov. ●

Clarification

A table in the Autumn 2002 issue of Energy Matters *included an incomplete statement. The table, "Comparison of Motor Rewind v. Replacement Costs and Efficiencies" accompanied the article "Making Good Motor Decisions—The Ellensburg Wastewater Treatment Plant." The table included a row with an option labeled "Replace with NEMA Premium motor." This option did not clearly state that the $12,673 cost reflected the cost of replacing the entire aerator, not just the motor component. Steve Dunnivant, field consultant who worked on the Ellensburg study, said his records from the February 2001 analysis contained no cost for just the NEMA premium efficiency motor. Consequently, the simple payback in years for using a NEMA Premium efficient motor cannot be calculated, and this information is incorrect. Companies should carefully review estimates for the cost of rewinds before making a repair/replace decision. In addition, the article was contributed to* Energy Matters *by the Northwest Energy Efficiency Alliance and its Electric Motor Management program.*

Boiler Blowdown Energy Recovery

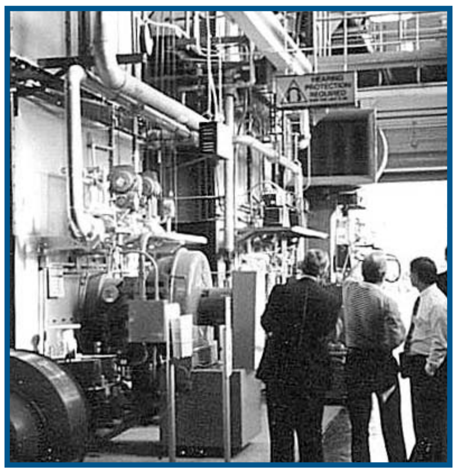
By Greg Harrell, Ph.D., P.E.,
The University of Tennessee Energy, Environment and Resources Center

Boiler blowdown is essential for the continued operation of any boiler. Without blowdown chemical concentrations within the boiler water can increase above acceptable limits, leading to boiler damage. Typical problems associated with insufficient blowdown are tube scale, corrosion, and liquid carryover.

Mathematically, boiler blowdown is expressed as a fraction of boiler feedwater flow as described by,

$$ß = \text{Blowdown amount} = \frac{\text{Quantity of blowdown water}}{\text{Quantity of feedwater}} = \frac{\dot{m}_{blowdown}}{\dot{m}_{feedwater}}$$

The equation is a ratio of mass flow rates, $\dot{m}_{blowdown}$ —blowdown mass flow rate (and feedwater flow rate). Boiler blowdown can range from less than 1% when high quality boiler feedwater is used to more than 20% when poor quality water is available. Boiler feedwater enters the boiler with a relatively low energy content from the deaerator—deaerator pressure-saturated liquid and feed pump energy. Blowdown exits the boiler with a relatively high energy content—saturated liquid at boiler pressure. Fuel energy was required to achieve this energy increase. As a result, the activity of blowdown, although necessary, represents an energy loss to the boiler. Therefore, blowdown management is essential for proper boiler energy management.



Blowdown is done typically for two primary purposes, both of which involve boiler water quality control. One function is to remove any solid materials precipitated in the boiler. Generally this takes the form of intermittently removing water from the boiler's lower portions where these solids tend to accumulate. Target areas for this activity include the lower boiler drum, intermediate headers, and other places where loose solids can accumulate. Intermediate header blowdown is often done only when the boiler is taken out of service due to the possibility of upsetting internal boiler water circulation patterns.

Boiler blowdown's other primary function is to control the concentration of dissolved minerals in the boiler water. Typically the vapor-liquid interface is the primary target area for this activity, which involves removing liquid boiler water from just below the interface. This blowdown either can be continuous or intermittent.

Reducing the loss associated with boiler blowdown is achieved through two primary avenues. First, blowdown rates are reduced through improved feedwater quality with the main focus on make-up water treatment, recycled condensate quality, and proper chemical treatment in the boiler. The second avenue centers on recovering the resident energy in the blowdown. A boiler operating with the best quality boiler feedwater will require some amount of blowdown to maintain water chemistry. Therefore, it is beneficial to investigate any benefits associated with recovering thermal energy resident in the blowdown stream.

Measuring the amount of boiler blowdown is essential to determining the magnitude of the loss and the savings potential associated with recovering the energy resident in the blowdown stream. The boiler blowdown amount is typically measured and controlled by chemically analyzing the boiler water itself. Blowdown flow is typically not measured directly because of flow meter difficulties—even though traditional flow meters can be effectively applied. However, accurate estimates of the blowdown amount are found by chemically analyzing chloride, silica, or other chemical components when continuous blowdown is employed.

Water treatment personnel can generally provide the chemical analysis needed to provide an accurate calculation of the blowdown. Probably the most common blowdown control

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Compressed Air System Improvement Enhances Foundry Production

International Truck and Engine Corporation implemented an optimization project on the compressed air system that serves its Indianapolis Casting Corporation (ICC) foundry in Indianapolis, Indiana. The project included a leak repair campaign along with measures to stabilize pressure and improve air quality. Because of the project, the system's efficiency was greatly improved. The project's implementation also resulted in significant maintenance savings and production that is more reliable. The project's total cost was $800,000. The annual compressed air energy and maintenance savings were $395,000 and more than 7.2 million kilowatt-hours (kWh), yielding a simple payback of just over 2 years.

Configuring and maintaining a well-designed compressed air system that generates a stable, uncontaminated supply of air is important for reliable production and leads to energy savings and long equipment life. In the case of ICC, severe fluctuations in air demand patterns and inadequate air treatment prior to the project led to excessive use of compressor capacity and resulted in energy waste. Furthermore, the system's data acquisition and control strategy forced compressor operators to wait until the system pressure fell to an unacceptably low level before they brought additional units online. This caused production downtime. By implementing a project that stabilized and lowered system pressure, eliminated moisture and lubricant carryover, and reduced system demand by repairing leaks and correcting misapplied end uses, plant personnel caused their compressed air system to perform more effectively and efficiently. This resulted in substantial compressed air energy and maintenance savings, and increased foundry production.

The BestPractices team participates in plant assessments and demonstration projects. Take a look at what others in your industry have done to increase their energy savings by reading their case studies. You can view these documents at **http://www.oit.doe.gov/bestpractices/case_studies.shtml.** Or, order a document from the Industrial Technologies Program Clearinghouse. You can e-mail the Clearinghouse at Clearinghouse@ee.doe.gov, or call 800-862-2086. ●

mechanism measures boiler water conductivity, which is a gross indication of boiler water chemical concentrations. This measurement is repeatable and reliable making it an excellent control measurement. This measurement is also effective in providing a general indication of the blowdown flow rate. Often a conductivity value is maintained in the boiler water by continuously modulating the amount of blowdown water removed from the boiler. In general, conductivity measurements should be supported by periodic boiler water chemical analysis.

Evaluating the boiler blowdown rate based on chemical analysis is based on a mass balance of a chemical component entering the boiler with the feedwater. A chemical component must be chosen with minimal solubility in the steam that exits the boiler. As a result, the amount of the chemical entering the boiler with feedwater must equal the amount exiting the boiler in the blowdown stream—under steady-state, steady-flow conditions inflow must equal outflow. Therefore, the ratio of the concentration of the chemical entering in the feedwater flow divided by the concentration of the chemical exiting the boiler in the blowdown stream is a measure of the blowdown rate, or fraction of feedwater flow. This is expressed in the equation,

$$ß = \text{Blowdown amount} = \frac{C_{feedwater}}{C_{blowdown}} = \frac{\dot{m}_{blowdown}}{\dot{m}_{feedwater}}$$

Where, $C_{feedwater}$ and $C_{blowdown}$ are the measured concentrations of the selected chemical in the feedwater and the blowdown, respectively. The accuracy and precision of the measurement must be taken into account when conducting this evaluation.

Care must be given to evaluating boilers using only intermittent blowdown. Intermittent blowdown can be effective for controlling and managing the boiler water chemistry of relatively small-capacity, low-pressure boilers. Intermittent blowdown is done many times each day and consists of releasing a significant stream of boiler water for several seconds. This type of blowdown control allows the chemical constituents in the boiler water to concentrate until the blowdown occurs. The blowdown significantly reduces chemical concentrations in the boiler water and allows continued boiler operation. This control method releases more blowdown water than continuous control for the same maximum chemical concentrations. Therefore, in larger capacity boilers continuous blowdown will generally be more economically attractive.

Blowdown amounts are generally less than 10% of the total feedwater flow, however, a blowdown rate of 2.0% may be excessive for a given system. The correct blowdown amount for a given boiler is a function of steam pressure, feedwater purity, and chemical treatment program. The main factors to be controlled by blowdown are the chemical concentrations in the boiler. Typical chemical concentration limits for boiler water are provided in the accompanying table displaying boiler water chemical limits.

TABLE 1. BOILER WATER CHEMICAL LIMITS

	Boiler Pressure (psig)					
	150	300	600	900	1,200	1,500
Parameter	Chemical Concentration (mg/liter)					
TDS (maximum)	4,000	3,500	3,000	2,000	500	300
Phosphate (as PO_4)	30-60	30-60	20-40	15-20	10-15	5-10
Hydroxide (as $CaCO_3$)	300-400	250-300	150-200	120-150	100-120	80-100
Sulfite	30-60	30-40	20-30	15-20	10-15	5-10
Silica (as SiO_2)	100	50	30	10	5	3
Total Iron (as Fe)	10	5	3	2	2	1
Organics	70-100	70-100	70-100	50-70	50-70	50-70

Each plant or manufacturing facility should work with its site water treatment expert to develop the most appropriate water treatment plan.

Once the blowdown amount is known, the loss associated with the blowdown can be estimated. The blowdown loss equation can be written as,

$$\lambda_{blowdown} = \frac{\text{Energy in the blowdown stream}}{\text{Total energy added to the boiler with fuel}}$$

$$\lambda_{blowdown} = \frac{\dot{m}_{blowdown}\left(h_{blowdown} - h_{make\text{-}up}\right)}{\dot{m}_{fuel}\,HHV} (100)$$

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Compressed Air System Upgrade Results in Substantial Energy Savings

BWX Technologies completed a retrofit project on the compressed air system at their Lynchburg, Virginia, manufacturing plant. An internal review of the system's performance allowed plant personnel to determine that certain components needed to be retrofitted with more optimal devices. The project included replacing antiquated compressors and over-sized dryers, implementing a more sophisticated control strategy, and constructing a special room to capture heat generated by the new compressors. The total cost of the project's implementation was $487,000. The total annual savings were $264,000, or 4.2 million kilowatt hours (kWh), leading to a simple payback of less than 2 years.

The replacement of a compressed air system's components is most appropriate when done within the context of a system-level strategy to improve the overall system's performance. Because the compressors at the BWX plant were worn, plant personnel decided to replace them with more cost-effective compressors that better served the plant's needs. Applying the proper size of compressed air components to meet the plant's needs also guided the decision to purchase new dryers. If plant personnel had purchased a dryer similar in size to the existing one, they would have had a dryer oversized for 70% of the plant's normal needs. By using a systems approach towards equipment replacement and selecting the size and type of equipment that best suited the plant's requirements, BWX was able to optimally match its air supply to its air demand, increasing the efficiency of its compressed air system. Configuring the system this way has yielded energy savings and greater plant efficiency.

The BestPractices team participates in plant assessments and demonstration projects. Take a look at what others in your industry have done to increase their energy savings by reading their case studies. You can view these documents at **http://www.oit.doe.gov/bestpractices/case_studies.shtml**. Or, order a document from the Industrial Technologies Program Clearinghouse. You can e-mail the Clearinghouse at Clearinghouse@ee.doe.gov, or call 800-862-2086. ●

DOE and Flying J Refinery Cooperate to Determine Energy Savings

By Sabine Molden Brueske, Energetics; Stuart Smith, Flying J; Robert Brasier, UOP

Flying J, based in Ogden, Utah, operates a 25,000 bpsd refinery in North Salt Lake. The refinery, with a staff of 130, processes a combination of crude oils from Utah, Wyoming, and Canada. Refinery products include gasoline, diesel, propane, and wax intermediates. The refinery supplies fuel products to many of the company's highway travel plazas and fuel stops.

As part of the Utah 2001 Showcase held in August 2001, DOE and Flying J refinery cost-shared a broad-based study to recommend energy efficiency improvements at the North Salt Lake plant.

The DOE showcase provided a setting for Flying J to combine input from a range of energy experts and university personnel, resulting in a comprehensive evaluation of plant-wide energy use. Implementing the recommendations benefited Flying J by reducing electrical consumption by 5% to 6% and by reducing purchased natural gas use by 35% to 40%, resulting in cost savings of approximately $900,000 in the first year.

The study included three elements. First, a study was done involving utility plant systems, including process heating, pumps, compressed air, steam, and insulation. Second, a team of engineering faculty and students from Texas A&M University analyzed plant operations. This included a 2-day assessment of Flying J plant operations to identify, evaluate, and recommend opportunities to conserve energy, increase productivity, and prevent pollution. Texas A&M is one of 26 DOE-sponsored, university-based Industrial Assessment Centers. Third, Flying J chose to work with UOP Refinery Profitability Services Group to conduct a 4-month refinery-wide study of energy use in the process unit.

An energy systems audit was performed beginning in April 2001. Findings from the utility plant systems and the plant operations assessment teams were made available to the consultants for use in their energy study.

UOP began a 4-month, refinery-wide study of energy use in 10 process units in April 2001. This study had four primary objectives:

- To summarize the energy consumed in the refinery on a per-unit basis
- To benchmark the energy consumption to industry standards
- To install a computer-based program that allows for continual energy monitoring
- To generate a preliminary list of projects to help improve energy efficiency.

To prepare for the analysis phase of the study, the project team conducted process unit walk-throughs, held brainstorming sessions, and collected operating data for each of the units being studied. Also, early in the evaluation process experts in industrial energy management best practices provided in-plant technical assistance to help Flying J identify opportunities for increased savings and productivity in industrial energy use systems. The experts worked with Flying J to evaluate energy savings opportunities in process heating, pumps, steam, insulation, and compressed air systems.

Energy consumption was calculated for each of the process units included in the study. Consumption values were benchmarked against industry-wide standards as well as against consultant designs. In addition to industry benchmarks, a customized "refinery target" was generated for each unit. These more refined and adjustable refinery targets were based on the best actual performances recorded during the test period. The intent of the customized benchmarks was to create obtainable energy targets for each unit, and to identify transient energy losses associated with short-term upsets or control problems. The graphs below show actual energy performance for each process unit compared to the benchmarks and refinery target.

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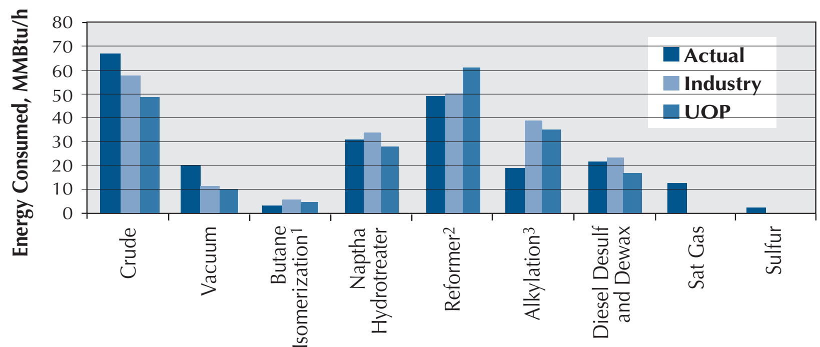
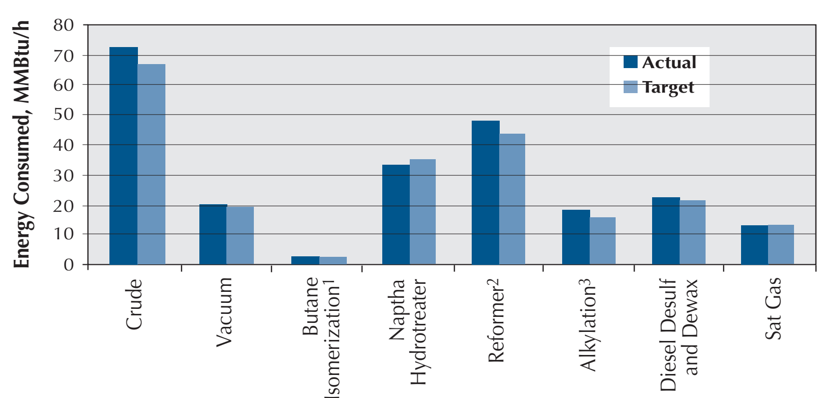


1. Butane Isomerization – Flying J reactor is integrated into the Reformer circuit. Benchmarks based on standard isomerization configuration.
2. Reformer – High-pressure unit. Benchmarks based on latest technology using low pressure, high conversion configuration.
3. Alkylation – Excessive fluctuations in data; actual energy varied from 75% to 130% of UOP benchmarks.

Snapshot of daily energy use compared to benchmarks.



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Snapshot of daily energy use compared to refinery target.

TABLE 1. RECOMMENDATIONS FOR POTENTIAL ENERGY SAVINGS

System	Study Area	Potential Savings
Process Heating	Employ oxygen control for flue gases	$100,000/yr
	Recover waste heat	$1,1000,000/yr
Pumps	Minimize throttle losses on two 200 hp charge pumps	$39,000/yr
	Shut down 250 hp pump during low flow operation and minimize throttle losses during high flow	$28,000/yr
	Reduce or eliminate 75 hp wax crude recirculation flow	$10,000/yr
Steam	Improve Boiler Efficiency (2 boilers)	$120,000/yr
	Replace cracking unit off-gas compresssor steam turbine with electric motor	$500,000/yr
Insulation	Main steam line, 8″ at 365°F	$139/yr per LF
	97 LF of ducting, 30″ at 320°F	$37,000/yr
	Top of 80,000-barrel storage tank at 225°F	$148,000/yr
	Reactor head, 44″	$8,600/yr
	Crude Unit exchanger, 24″	$4,000/yr
	Condensate receiver at 210°F	$1,800/yr
	Flanged valve, 10″ at 600°F	$1,900/yr
Compressed Air	Modify control valves	$8,600/yr
	Repair leaks	$5,900/yr
	Excessive operating pressure	$2,400/yr
	Implement central drying	$3.700/yr

To establish a connection between unit operating conditions and energy consumption, the process unit consultant tracked a selection of key energy indicators. Some of these included heater efficiencies, reflux to feed ratios, and steam stripping rates. These indicators were used to help identify why a unit's energy consumption changes within a specified timeframe.

Findings

Efforts by the utility systems, plant operations and process unit assessment teams resulted in a number of recommendations for Flying J to consider. First, the technical experts who analyzed utility systems made a number of recommendations, which are summarized in the table above.

Plant Operations Assessment

Second, the plant operations assessment team from Texas A&M identified potential annual savings of $261,000 based on eight recommendations. These are summarized in the table below.

Process Energy Usage Study

Third, the process unit analysis spearheaded by UOP identified 33 energy improvement projects with a combined potential savings of over $1.22 million.

During the 4-month evaluation period, the total energy consumed by the process units at Flying J's Salt Lake City refinery averaged 230 MMBtu/hr. This included steam, fuel, and electricity consumption, and had an equivalent energy cost of $22,000/day. The target energy consumption was found to be 219 MMBtu/ hr, or $21,000/day, representing a potential refinery-wide cost savings of $1,000/day for normal operating periods.

The summation of energy consumed in each process unit was compared to the summation of refinery target energy consumption for each unit. The graphs on page 9 show the energy and cost variance between the two.

A key characteristic identified was that as energy rates varied, several process units showed little change in total energy consumption. This effect was quantified to demonstrate the increase in per-barrel energy costs resulting from underutilizing the equipment. The consultant's findings suggested where improved controls and instrumentation would help minimize efficiency loss at low throughputs.

Flying J Implementation

Flying J has implemented a majority of the savings opportunities suggested by the utility plant system experts. In the area of process heating, oxygen control for flue gases has been implemented. All of the pump system recommendations were seen as favorable and have been implemented, with the exception of a recommendation for a 250 hp pump, which was still under evaluation. Boiler efficiency is being improved as recommended by the steam expert. All of the insulation recommendations have been implemented with the exception of the 80,000-barrel storage tank. This project was scheduled to take place during the next tank inspection. Flying J has repaired compressed air leaks and partially implemented a central compressed air drying system.

Of the eight recommendations that came from the Texas A&M plant operations assessment, Flying J implemented four. The remaining projects are still under consideration for future implementation. Flying J has proceeded with repairing leaking steam traps, insulating reformer unit piping and heat exchanger, rescheduling butane isomerization unit regeneration, and repairing steam leaks.

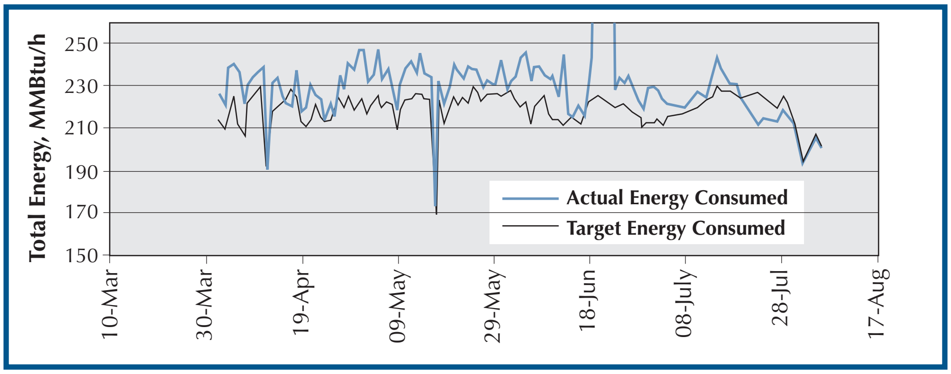
In the year following receipt of the UOP energy analysis, Flying J implemented eight of the 33 recommended projects and

(continues) ►

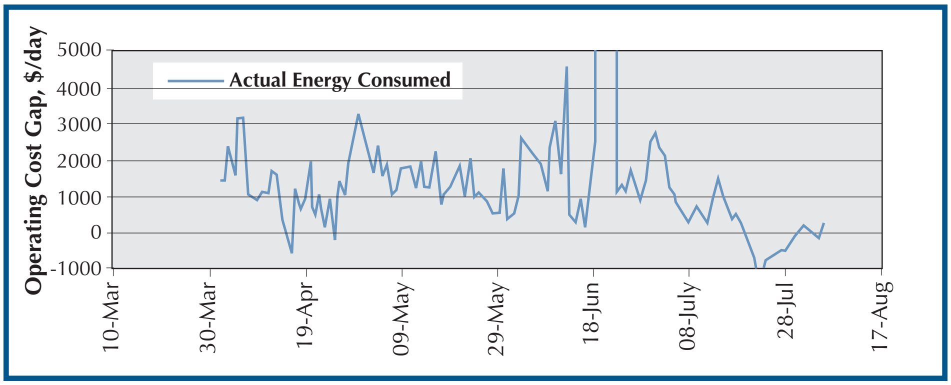
TABLE 2. POTENTIAL SAVINGS FROM RECOMMENDATIONS

Recommendation	Potential Savings
Repair leaking steam traps	$147,000/yr
Install/repair insulation on piping and heat exchanger in Reformer Unit	$47,000/yr
Use premium efficient motors	$27,000/yr
Install fixed capacitance to increase power factor	$13,000/yr
Reschedule operation of Butane Isomerization Unit drier regenerations to avoid high demand times	$12,000/yr
Use synthetic lubricants on all electric motors	$10,000/yr
Repair steam leaks	$3,400/yr
Retrofit exit sign lamps	$1,200/yr

 continued from page 8



Refinery-wide energy performance graph comparing actual to target energy use.



Potential refinery-wide cost savings graph based on the cost gap between actual and target energy use.

eliminated another 10 for process reasons unique to Flying J. The remaining projects were still under consideration.

The eight process unit recommendations that Flying J has currently implemented are :

- Optimized crude unit pre-flash operation
- Optimized crude unit stripping steam rates
- Bypassed heavy diesel run-down coolers.
- Produced nitrogen on-site
- Insulated hydrotreater reactor piping
- Reduced reformer unit reactor circuit pressure drop
- Reduced carryover of water to the sulfur recovery unit
- Checked for leaking relief.

Implementing the recommendations benefited Flying J by reducing electrical consumption by 5% to 6% and by reducing purchased natural gas use by 35% to 40%, resulting in cost savings of approximately $900,000 in the first year.

Learn more about energy efficiency projects by attending the Texas Technology Showcase in Houston, March 17-19. The showcase will offer the latest in processing and combustion technologies, and best energy management practices that can result in improved environmental performance, increased energy efficiency and reduced costs at refineries and chemical plants. For more information on the Texas Showcase, including registration details, visit **www.showcasetexas.org**, or call toll-free 877-648-7967. ●

Retrofit Project Helps Mobil Refinery Avoid a Major Capital Investment

In 1998, the Mobil petroleum distribution facility in Vernon, California, was retooled from a blending plant into a less energy intensive distribution facility. Because the plant was being converted, a compressed air system review was performed by DOE Allied Partner, Scales Air Compressor Corporation. This review led to an improvement project on the plant's compressed air system. The project's implementation substantially reduced the plant's energy and maintenance costs by substituting a new 50 hp rotary screw compressor with load/unload controls for two 200 hp compressors and two aging 50 hp compressors. After the compressor replacement was complete, a leak repair campaign was performed, reducing the plant's load and making its production process more reliable. The total project cost was $23,000 and the annual savings were $20,700, leading to a simple payback of approximately 1 year. The plant also avoided $52,000 in capital equipment costs by implementing a less capital-intensive project.

Compressed air system optimization projects need to include both the demand and supply sides of the system because a change made in one area will affect the rest of the system. If only one side is improved, the whole system may not operate as expected, and any anticipated energy savings or production improvements may not be realized at all. In the case of the Vernon plant, the absence of a leak repair campaign as part of the initial project caused a new 50 hp compressor to run loaded more often than necessary and the 200 hp compressor to be operated solely to support the leaks. Once the leaks were fixed, the compressed air system was able to operate using only the new 50 hp compressor.

The BestPractices team participates in plant assessments and demonstration projects. Take a look at what others in your industry have done to increase their energy savings by reading their case studies. You can view these documents at **http://www.oit.doe.gov/bestpractices/case_studies.shtml**. Or, order a document from the Industrial Technologies Program's Clearinghouse. You can e-mail the Clearinghouse at Clearinghouse@ee.doe.gov, or call 800-862-2086. ●

Boiler Blowdown Energy Recovery

continued from page 6

Where $\dot{m}_{blowdown}$ is the mass flow rate of blowdown and $\dot{m}_{fuel}$ is the mass flow rate of fuel input to the boiler. The fuel higher heating value (HHV) is required to establish the energy input to the boiler. The energy resident in the blowdown stream is characterized by the enthalpy difference between the blowdown stream and makeup water, ($h_{blowdown} - h_{makeup}$). Makeup water enthalpy is used rather than feedwater enthalpy because the blowdown must be "replaced" to the system by makeup water. This equation provides the loss associated with boiler blowdown as a percent of total energy input with the fuel supplied to the boiler.

Here's how it works. Assume a boiler operates with a blowdown rate determined by boiler water analysis to be 5.0% of feedwater flow. The boiler in this example produces 400 psig, 700°F superheated steam. This blowdown rate is considered typical. Steam production from the boiler is 100,000 lb/hr resulting in a feedwater flow of 105,260 lb/hr. The blowdown flow—5.0% of the feedwater flow—is 5,260 lb/hr. Blowdown and makeup water properties are found in the accompanying table.

TABLE 2. STEAM PROPERTIES

Location	Temperature (°F)	Pressure (psia)	Specific Volume (ft^3/lbm)	Internal Energy (Btu/lbm)	Enthalpy (Btu/lbm)	Entropy (Btu/lbm°R)	Quality (%)
Boiler outlet	700	414.7	1.58945	1,239.90	1,361.88	1.63527	—
Low pressure	277	24.7	17.46640	1,099.38	1,179.21	1.74124	—
Boiler blowdown	448	414.7	0.01939	426.55	428.04	0.62561	0.0
Make-up water	60	14.7	0.01600	28.02	28.07	0.05552	—
Condensate return	200	14.7	0.01663	167.95	168.00	0.29381	—
Deaerator outlet	239	24.7	0.01692	207.67	207.75	0.35234	0.0
Feedpump exit	242	622.1	0.01692	208.47	210.42	0.35615	—

Assume that natural gas is the boiler fuel, supplied at a cost of $3.75/$10^6$Btu. The boiler operates with a combustion efficiency of 85% and a fuel flow rate of 5,896 lb/hr, this equals a fuel expense of $4,515,000 a year. The higher heating value of natural gas equals 23,311 Btu/lbm. A blowdown loss calculation then can be figured as,

$$\lambda_{blowdown} = \frac{5{,}260\ \frac{lb}{hr}\left(428.04\ \frac{Btu}{lb} - 28.07\ \frac{Btu}{lb}\right)}{5{,}896\ \frac{lb}{hr}\left(23{,}311\ \frac{Btu}{lb}\right)}\ (100)$$

$$\lambda_{blowdown} = \frac{2{,}105{,}100\ \frac{Btu}{hr}}{137{,}450{,}000\ \frac{Btu}{hr}}\ (100) = 1.5\%$$

Another way to say this is to note that more than 2.1 10^6Btu/hr (in other words, the numerator of this equation) of input fuel energy is being lost as blowdown. The calculation below approximates the economic loss associated with boiler blowdown for this particular boiler,

$$\lambda_{blowdown} = \text{total fuel cost}\ (\lambda_{blowdown})$$

$$\lambda_{blowdown} = 4{,}515{,}000\ \frac{\$}{yr}\left(\frac{1.5\%}{100}\right) = 67{,}700\ \frac{\$}{yr}$$

Economically attractive projects can stem from thermal energy recovery related to boiler blowdown. There are typically two primary energy recovery activities employed in industry, and both often are incorporated in one system.

As a first energy recovery stage, the saturated liquid high-pressure blowdown is discharged into a relatively low-pressure receiver. As the pressure falls a portion of the liquid flashes to steam. This steam is typically free from impurities carried by the liquid blowdown provided no droplets are carried into the steam exit. As a result this steam is available for use in the steam system.

Properly designed flash vessels reduce the possibility of droplet carryover. (Several references are listed at the end of this article that offer straightforward design strategies for flash

(continues on page 11) ▶

Letters to the Editor

Energy Matters welcomes your typewritten letters and e-mails. Please include your full name, address, organization, and phone number, and limit comments to 200 words. Address correspondence to:

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We publish letters of interest to readers on related topics, comments, or criticisms/corrections of a technical nature. Preference is given to articles that appeared in the previous two issues. Letters may be edited for length, clarity, and style. ●

To the Editor:

I just received the Fall 2002 issue of *Energy Matters* and I feel I have to comment on the comparison of motor rewind vs. new motors in the Ellensburg Wastewater Treatment Plant article.

Based on the most recent Motor Master + data base I see that this example was for a 900 RPM TEFC motor. This should have been indicated because 900 RPM motors usually do cost more. You have also used list prices for both the standard efficient motor and the premium motor. I know of no cases where people pay full list price. Quite often the prices are reduced as much as 30 to 40% or more. This has a great effect in reducing the incremental cost between the standard and premium motors. Furthermore, the data base itself showed a similar motor (based on efficiency) with a list price far below the $12,673 that you quoted. Maybe this motor wasn't exactly the right fit but I'm sure something could have been found for less than the $6,000 differential price you showed.

Richard A. Schondelmeier
Senior Program Administrator
Northeast Utilities

To the Editor:

I read the article on compressed air with great interest ("*Compressed Air's Role in*

(continues) ▶

Productivity," Fall 2002). Overall, the article is good but I do have two points to make.

First, I do not agree with the recommendation to install supply-side pressure regulators. These devices do not solve the real problems: inadequate compressor controls and leaks. The pressure regulator does not provide a stored air volume, the large tank you have to install to make it work provides the volume. This tank is required because the already inadequate compressor controls will not work well when the compressors are isolated from the process. The volume is needed to stabilize the compressors and minimize cycling. Proper compressor controls allow the header pressure, and the compressor discharge pressure, to be reduced and will respond to process demands without needing large volumes. Proper controls will save more energy and cost less than a supply side pressure regulator and volume tank.

Second, the article does not address the extraordinary inefficiency of compressed air systems and the recommendation to eliminate the use of compressed air whenever possible. When calculating the cost of production, facilities should consider the cost of compressed air versus other solutions such as electric actuators, solenoids, low pressure blowers, and hand tools.

Kendall W. White, P.E., CEM
Environmental Engineer
Pollution Prevention Services
Energy and Waste Management Bureau
Iowa Department of Natural Resources

Energy Matters EXTRA

This month on the Energy Matters Extra Web site, we've provided supplementary information on selling energy-saving projects to management. We also show you how to access and order the new CDs: the Chemical Industry of the Future CD and the Motor Market Assessment CD. And there's more! Log on to Energy Matters Extra at **www.oit.doe.gov/bestpractices/energymatters/emextra.** ●

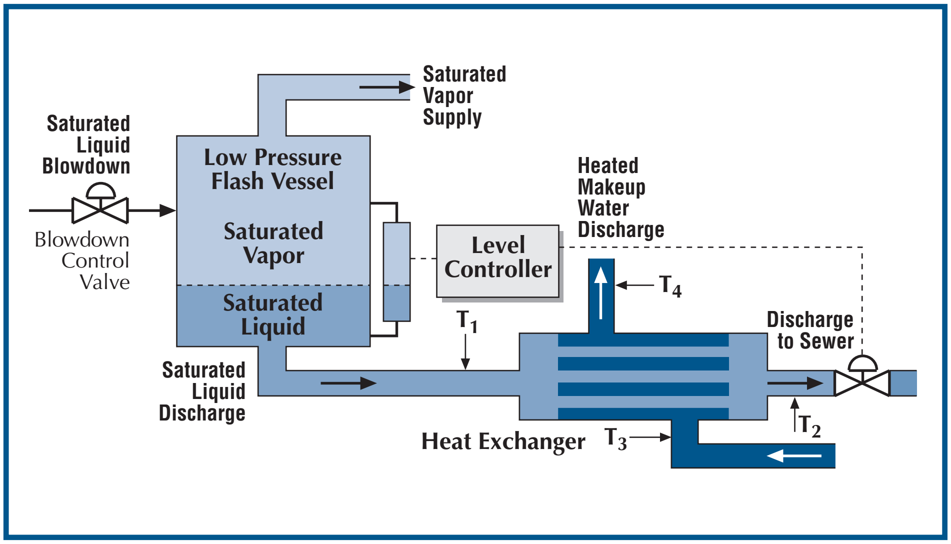
Boiler Blowdown Energy Recovery *continued from page 10*

vessel design.) The amount of flash steam produced increases as the difference between the boiler pressure and the flash pressure increase. The flash vessel allows the remaining liquid blowdown to separate from the flash steam. The flash steam then is either piped into the low-pressure steam system or into the deaerator.

A second energy recovery stage may also be applied. Here, a heat exchanger transfers the remaining liquid blowdown energy to makeup water. A significant temperature difference typically exists between the saturated liquid leaving the flash tank and the makeup water supplied to the system, or the water supplied to the deaerator.

Care should be taken in choosing a heat exchanger because the blowdown stream has a significant fouling potential. The heat exchanger must be capable of being mechanically cleaned periodically, especially those surfaces that come into contact with the blowdown. The heat exchanger should also be equipped with temperature-indicating devices on the inlet and outlet blowdown liquid streams as well as on the inlet and outlet makeup water streams. These temperature indications allow the heat exchanger's effectiveness to be determined.

Both the flash tank and the heat exchanger can be used in combination to provide low-pressure steam and to preheat makeup water. In the combined arrangement, blowdown water leaving the flash tank passes through the heat exchanger. A steam system specialist should be contacted to analyze the opportunity associated with these projects, as it often is difficult to implement this type of energy recovery strategy in systems that use intermittent blowdown. A schematic of the blowdown energy recovery system is provided below.



Blowdown energy recovery system.

The type of system discussed in this article can help your plant or facility recover more than 80% of the thermal energy resident in the blowdown stream. The required equipment can generally be bought and installed in such a way that it yields an economically attractive project. Further economic benefit can be attained in systems requiring reduced temperature wastewater discharges. Often cold water is required to be mixed with blowdown entering the sewer system to avoid an elevated temperature within the sewer system. This cold water can result in significant expense.

Resource List

1. *The Nalco Water Handbook, Second Edition*, Frank Kemmer, McGraw Hill, 1988.
2. *Fundamentals of Engineering Thermodynamics, Second Edition*, Michael J. Moran and Howard N. Shapiro, John Wiley and Sons, 1992.
3. *National Board Rules and Recommendations for the Design and Construction of Boiler Blowoff Systems*, 1991. ●

Coming Events

Chemical and Petroleum Showcase, Houston, TX

- Mar 17 - Mar 19, 2003

For more information, contact David Salem, Chemical and Petroleum Team, 202-586-8710

Mining Showcase, Elko, NV

- Aug 25 - Aug 28, 2003

For more information, contact: Mike Canty, Mining Team Lead, 202-586-8119

North American Die Casting Association (NADCA)

- Sep 15 - Sep 18, 2003

For more information, contact Harvey Wong Metal Casting Team Lead, 202-586-9235

To keep up-to-date on Industrial Technologies Program's training and other events, check the calendar regularly on Energy Matters Extra at ***www.oit.doe.gov/bestpractices/energymatters/emextra***.

BestPractices

The Industrial Technologies Program's Best-Practices initiative and its *Energy Matters* newsletter introduce industrial end users to emerging technologies and well-proven, cost-saving opportunities in motor, steam, compressed air, and other plant-wide systems.

Information Clearinghouse

Do you have questions about using energy-efficient process and utility systems in your industrial facility? Call the Industrial Technologies Program's Information Clearinghouse for answers, Monday through Friday 9:00 a.m. to 8:00 p.m. (EST).

HOTLINE: 800-862-2086

Fax: 360-586-8303, or access our homepage at www.oit.doe.gov/clearinghouse.

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