CHEMICAL PROCESSING
LEADERSHIP | EXPERTISE | INNOVATION

BANK ON ENERGY EFFICIENCY SAVINGS

PutmanMedia®

TABLE OF CONTENTS

AD INDEX

Justify Condensate Recovery

Consider some potential opportunities for achieving energy savings

By Earl Clark, Energy Columnist

Jake had conducted many energy conservation surveys in his career and condensate recovery often came up. Depending on the plant, it could be a money-making-or-saving move. But, in some cases, depending on the age and the type of equipment used on the site, it could be a dead-end evaluation. Jake prepared to visit the plant to help with the evaluation.

The plant was one of the older ones on Jake's list. It had been built when energy was inexpensive, reciprocating steam engines were the predominant power source, and the primary purpose was production. It also had been built in a hurry; the window for the products was fairly short. As a result, the designers had ignored many energy-saving features.

Elaine met Jack at the gate with the enthusiasm Jake would expect from a young engineer. She had been in charge of the survey and developed a number of excellent ideas for energy savings. Many already had been implemented, with the plant reaping energy and cash savings. However, management resisted when Elaine introduced the idea to recover condensate. Many objections centered on the cost of putting in a piping system to recover the liquid. Others concerned the quality and suitability of using a "dirty" stream.

Elaine already had split the plant into target zones and surveyed how much condensate was available in each zone. She had narrowed her work down to one area with the most condensate available. She identified the streams based on saturation

Energy savings are usually small incremental steps.

temperatures to enable quick determination of the streams' heat content. She asked Jake what to do next.

Jake said, "The first thing to do is determine if there is a need for the heat content in the condensate. We can survey the heat sinks in the process area to see if we can displace some primary steam." Elaine and Jake reviewed the process diagrams and quickly discovered several low-temperature inputs that currently were heated with high-temperature and high-pressure steam. Jake noted that because the plant was built fast, the designers would have minimized the numbers of levels of steam coming in to the area and used the available high-pressure steam. Elaine analyzed each potential application and noted two worth further evaluation.

The evaluation showed the condensate heat recovery was financially justified, so, Elaine set about developing a project to install two new heat exchangers to capture the savings. The area was able to save about $30,000 for each stream and the project had approximately 30% return on investment. Energy savings are usually small incremental steps as this example showed.

Elaine also asked Jake about recovering the condensate liquid and sending it back to the central powerhouse to displace some of the high-pressure boiler makeup water. Jake indicated they would have to do some chemical analysis of the condensate first. The area Elaine first targeted previously had contained steam-engine-driven process compressors. Most of these had been replaced with electric motor and steam turbine drives. Elaine arranged to have condensate samples collected from various point sources in the process area. The condensate would have to meet very high purity standards due to the stringent feedwater requirements for the site's high-pressure boilers.

Elaine had the lab analyze the condensate for high oil content, pH, carbonic acid and the other usual water analyses. Unfortunately, the residual oil in the system precluded the use of this process area's condensate for feedwater makeup. Elaine next evaluated whether the condensate could be used as make up to the area's large cooling towers. This proved feasible and a line was run to the cooling tower. (For details about cooling tower fill, see "Understand the Importance of Correct Cooling Tower Fill").

Elaine then started evaluating other areas to see which were candidates for condensate reuse. All in all, Elaine identified nearly $200,000 per year in site energy and water savings.

Have you looked around your site for condensate that could be put to good use? Make sure it meets the requirements of your equipment before dumping it into makeup streams. Happy energy hunting!

EARL M. CLARK, P.E., is engineering manager, Global Energy Services. Clark retired from DuPont after a career of 39 years and 11 months and joined Hudson's Global Energy Systems Group as Engineering Manager. During his over 43 years in the industry, he has worked in nearly all aspects of the energy field; building, operating and troubleshooting energy facilities for DuPont. He began his energy career with Duke Power and Clemson University during the energy crisis in the 1970s.

Active in both, the American Society of Mechanical Engineers and the American Society of Heating, Ventilating, Refrigerating, and Air-Conditioning Engineers (ASHRAE), Clark was chairman of ASHRAE's task group on Halocarbon Emissions and served on the committee that created ASHRAE SPG3 - Guideline for Reducing Halocarbon Emissions. He has written numerous papers on CFC alternatives and retrofitting CFC chillers. He was awarded a U.S. patent on a method for reducing emissions from refrigeration equipment. He has served as technical resource for several others.

Do You Understand Partial Pressures?

Non-azeotropic mixtures can cause problems in ancillary equipment.

By Earl Clark, Energy Columnist

As we work on various refining trains and columns, we oftentimes take for granted how and where they work. Partial pressures are one of the basic facts in separations. However, what happens when a partial pressure causes poor performance in ancillary equipment? Many of us have performed binary separation column calculations and compared the saturation curves for two components to try to optimize how we design and run our columns. A third component or non-condensable gas can wreak havoc with both types of calculations.

JAKE'S STORY

Jake had been asked to assist with analyzing a new refrigerant to solve a short-term supply issue with a chlorofluorocarbon (CFC) that was to be phased out. On the surface, the refrigerant looked good. The three-part mixture promised similar performance to one of the primary three refrigerants used in centrifugal chillers. In the process, Jake learned to two new terms, non-azeotropic and glide. He understood azeotropic, i.e., two substances when combined acting as a single gas. The plant used the technique for columns with extraordinary levels of water as a way to finesse partial separation. It also had been used with several previous refrigerants.

Non-azeotropic substances, as he learned, due to their different saturation curves could serve to simulate performance of a single refrigerant. This would work as long as there was a constant flow with no residence place that could cause the gases to separate. The initial analysis looked good.

Without warning, the familiar sound of a full-blown surge echoed through the warehouse.

Based on the refrigerant holding together, Jake's calculations indicated it would be a suitable replacement.

He also learned that for non-azeotropic mixtures, at any given temperature, the liquid has the mixture composition at the bubble point while the vapor has the composition at the dew point — and that "glide" reflects how the gap between the boiling and dew points changes with temperature and represents the composition shift across the saturation dome.

Jake began calculating based on the evaporator side that acted like a reboiler with one composition coming in and another composition exiting in the gas phase. That meant the low boilers in the mixture were vaporized and the higher boilers were only partially boiled off so most would remain in the evaporator. Jake moved through several iterations and concluded the mixture eventually would not be compressible by the centrifugal compressor and the unit would surge and probably trip. This lead to the decision to limit the use of slug-flow-type systems such as direct-expansion refrigeration where no liquid gas residence interface could be established.

However, Jake's good friend Gavin challenged Jake's theory and set up a test at a vendor shop. The shop hooked a refrigeration unit to a test loop and filled the unit with the refrigerant mixture. Gavin invited Jake to witness the test; he was present from the start. After checking everything, Gavin gave the operator the go-ahead to start the unit. Jake held his breath. The compressor started with the usual snarl as it passed through the surge line and on up to operating conditions. The unit held and started to work down the evaporator pressure. Then, almost without warning, the familiar sound of a full-blown surge echoed through the warehouse. Several similar rounds followed as the compressor worked to regain the head required to condense the mixture. It then shut down on a low evaporator pressure trip. Gavin looked disheartened.

Jake asked, "Well, what did we learn from this?"

Gavin quipped, "Not to challenge Jake's theories."

Jake replied, "No, you had the guts to do that and now we have confirmation!"

So, what happened? The mixture contained the major high-pressure gas, HCFC22. As the compressor lowered the evaporator pressure, the HCFC22 preferentially boiled off along with small quantities of the other two gases; the compressor drew away the gases and pushed them into the condenser. Unfortunately, the condenser needed the sum of the partial pressures and resultant temperature to start condensing the vapor. Because the compressor didn't have the capability to compress the HCFC22 to its saturation pressure, flow was reduced and the compressor crossed the surge line, setting up the instability. As a result, the compressor tripped.

There are many situations where you can use partial pressures to investigate system faults or design systems for energy optimization. Brush up on your understanding of the partial pressure calculations and begin optimizing or troubleshooting. Happy energy hunting!

EARL M. CLARK, P.E., is engineering manager, Global Energy Services. Clark retired from DuPont after a career of 39 years and 11 months and joined Hudson's Global Energy Systems Group as Engineering Manager. During his over 43 years in the industry, he has worked in nearly all aspects of the energy field; building, operating and troubleshooting energy facilities for DuPont. He began his energy career with Duke Power and Clemson University during the energy crisis in the 1970s.

Active in both, the American Society of Mechanical Engineers and the American Society of Heating, Ventilating, Refrigerating, and Air-Conditioning Engineers (ASHRAE), Clark was chairman of ASHRAE's task group on Halocarbon Emissions and served on the committee that created ASHRAE SPG3 - Guideline for Reducing Halocarbon Emissions. He has written numerous papers on CFC alternatives and retrofitting CFC chillers. He was awarded a U.S. patent on a method for reducing emissions from refrigeration equipment. He has served as technical resource for several others.

Save money with the energy efficiency advantages of a Pick Direct Steam Injection Heating System!

With Direct Steam Injection, steam is instantly blended into the process fluid, resulting in 100% heat transfer with full use of both the latent and sensible heat.

Let Pick Heaters show you how we can reduce not only your energy bills, but your total operating costs.

Additional Benefits:

- Low Liquid Pressure Drop - Less than 2 PSI
- Low Sound Level - Typically Less than 85 dB(A)
- Accurate Temperature Control +/- 3°F
- Steam is Absorbed Instantly and Quietly
- Compact Design

pick® heaters inc.
Phone: 262-338-1191
E-mail: info1@pickheaters.com

Visit www.pickheaters.com to learn more about Pick Direct Steam Injection Systems

Energy Hog Restricts Plant Production Rates

A seemingly minor change causes a major problem

By Earl Clark, Energy Columnist

The plant was operating at less than 30% production, but the refrigeration system still was at capacity and barely keeping up. What was going on?

When product demand dropped, the East Plant was shut down and the West Plant began operating at reduced rates. Yet, the massive refrigeration plant was having a hard time meeting the lower refrigeration demand, partially due to equipment failures; however, there was more to it than that. Jake had been called to the plant to help with troubleshooting the situation.

Jake met with Joe, the staff engineer responsible for the refrigeration plant. Its available capacity was more than required but still the plant couldn't keep up with production demands. The refrigeration system consisted of a batch process used to supercool the -18°C brine in the off-batch times but it was getting close. The three largest units were available but something seemed to be holding their capacity back.

Looking at the round charts from the day before, Jake noted that No. 26 was producing only about 40 % of its nameplate rating. In addition, the outlet brine temperature seemed to be close to the maximum. Jake found fouling in many of the 26 other refrigeration machines previously, and so thought that might be a good place to start. He also observed the power consumption per ton was about double design requirements.

Jake and Joe headed to the operations control room to review with the lead operator what might be happening. Doug appeared

Fouling could not explain this very poor performance.

very tired and confirmed it with Joe and Jake. "We are just barely keeping our heads above water and spending lots of time just getting units back online as they seem to be tripping out every hour or so. I hope demand does not pick up as we would not be able to meet their refrigeration loads."

No. 26 was a 2,500-ton -18°C brine machine with a 6,000-hp motor. While steam turbines drove most of the plant, the last three units contained motor drives to help the site's steam balance.

Joe and Jake headed out to take a look at No. 26. The first observation: the motor amps were already at the maximum. Checking the pneumatic controls showed the motor override had activated and the suction vanes were restricting flow to the compressor. Jake calculated the load on the machine to be only about 1,200 tons. Fouling could not explain this very poor performance.

No. 26 was fitted with a split-range capacity control, meaning the pneumatic controller would try to open up the inlet vanes when the outlet brine temperature increased, putting more load on the machine. If the temperature decreased, it would pinch back on the vanes to restrict flow to match the load. If the load dropped below a minimum, the hot gas bypass would open, causing the flow to keep the compressor from going into surge. Careful testing and data logging determined this point. Excessive surge could damage the machine.

Joe and Jake tested the control. They attempted to override temperature control to put more load on the machine. Nothing happened; something was wrong with the controls. They put the machine in manual and attempted to cut back on the hot gas bypass. Still nothing happened. An operator wandered by and said they were having trouble with the controls, so had put the hot gas bypass in manual at the valve controller. The valve had been set nearly wide open.

The team placed the main controller in manual and set in a safe load position. Then they switched the hot gas bypass controller to auto and returned to master control by the main system. The valve immediately cut back on the flow, the motor unloaded and the outlet brine temperature returned to the set point. They then set the main load controller; other machines in the system began unloading and overall brine temperature returned to standard operating conditions.

Joe and Jake sat down with operations to reinforce standard operating procedures and emphasized the need to report to engineering when a machine was having problems. They determined the cost of the off-standard operation to be about $150,000 per year on just that machine. Other units were checked with similar results but not nearly as large an impact on costs.

So, many of you out there may still have pneumatic controls on old process refriger-ation machines. Or you may have upgraded to single loop electronic controllers. Do you know how those controls are operating? Do you know if off-standard operations are costing you energy dollars? It might be time to check. Happy energy hunting!

EARL M. CLARK, P.E., is engineering manager, Global Energy Services. Clark retired from DuPont after a career of 39 years and 11 months and joined Hudson's Global Energy Systems Group as Engineering Manager. During his over 43 years in the industry, he has worked in nearly all aspects of the energy field; building, operat-ing and troubleshooting energy facilities for DuPont. He began his energy career with Duke Power and Clemson University during the energy crisis in the 1970s.

Active in both, the American Society of Mechanical Engineers and the American Society of Heating, Ven-tilating, Refrigerating, and Air-Conditioning Engineers (ASHRAE), Clark was chairman of ASHRAE's task group on Halocarbon Emissions and served on the committee that created ASHRAE SPG3 - Guideline for Reducing Halocarbon Emissions. He has written numerous papers on CFC alternatives and retrofitting CFC chillers. He was awarded a U.S. patent on a method for reducing emis-sions from refrigeration equipment. He has served as technical resource for several others.

Corrosive environments.

Costly blowdowns.

Hidden costs.

Don't let your efficiency evaporate.

This is why level matters.

Steam production is responsible for up to 60% of your total energy consumption. Which means any inefficiency can cost you a small fortune. That's why Magnetrol® matters. We'll help you identify hidden costs, improve production and reduce downtime. And we have the broadest portfolio of level instruments to optimize your entire steam generation and condensate recovery process. That's critical. Because at your plant, level matters.

MAGNETROL®
LEVEL MATTERS

Download the Steam Generation Optimization Kit
at **steamgen.magnetrol.com**

Deftly Deal with Distillation Performance

Several issues contribute to water hammer and leakage of condensate

By Earl Clark, Energy Columnist

Jake recently had graduated college and started his first job. His new company assigned him to one of its large sites. There, Jack, a senior engineer who had been at the site his entire career, would mentor Jake.

One of the areas both were responsible for was a methanol distillation or finishing process. Methanol, created in previous steps, was pumped to this final refining area to produce product for customers. Because it was a very low-pressure distillation process, the temperature of the steam and condensate in the reboiler also were low. Earlier in the process, heat recovered from the reformers generated steam. Then, the steam was let down through several stages of power generation to provide the boil-up for the distillation operation. Condensate from the process then was sent to the process sewer.

WINTER WOES

The small amount of flash steam created hazards during winter weather. In light of a national energy crisis at the time, an energy conservation push closely targeted any losses. Installing a flash cooler on the line to the sewer resolved the hazard issue. Engineers put in a used heat exchanger at ground level with the condensate line piped to the exchanger. And, then, problems started.

When the heat exchanger began banging and jumping, Jack was called to the site. Eventually, the movement caused the inlet piping to fail; the condensate spilled into the area, resulting in even more problems

It was a great learning experience for a young engineer.

on that cold day. Jack had the condensate diverted back through the original sewer dump while he began to deal with the water hammer issue. Because Jake had just graduated, Jack asked him to do a little research on water hammer and directed him to some of the company's resources on the subject.

In the meantime, Jack went back to finding a quick solution. He installed a sparger into the inlet line and piped cooled condensate to the sparger. Weld repairs were made and the heat exchanger returned to service. Jack gradually introduced condensate into the sparger and reached an equilibrium point where the banging and shaking stopped. It was temporary — but it solved the problem for the time being.

MULTIPLE ISSUES DISCOVERED

Jake had begun researching the water hammer issue. Jack had sent him to one of the corporate experts who showed Jake where to find the information as well as how to begin the manual calculation and modelling process. Jake began the calculations but ran into a problem due to lack of information for the model; Jack filled in the missing data. Together, they worked through the complex analysis until they had a clear picture of what was happening. Through this experience, Jake learned not only how to perform the analysis but also how to be a mentor to a younger engineer.

So, what did they discover? First, the heat exchanger was oversized. It was bought cheap but resulted in too much capacity, causing flash steam in the condensate to quickly condense leading to the severe water hammer. Second, the piping to the heat exchanger had been sized according to the inlet to the exchanger rather than for the actual flow of condensate. This led to a large cross section with the pipe operating much like a drain with only partially filled conditions. As it entered the heat exchanger, a rise in elevation then closed off the pipe, capturing flash steam in a bubble that then collapsed, further aggravating the water hammer problem. Third, river water was used as condensing medium. The water was fairly warm in the summer but when winter rolled in the temperature difference along with the oversized heat exchanger resulted in major bubble collapses within the heat exchanger. And finally, while the sparger could mitigate the problem, it required constant modulation based on multiple variables including process rate, river temperature, ambient temperature, etc.

They developed a solution but, unfortunately, the cost was not in the budget. The plant had been scheduled for shutdown three years before Jake arrived; however, operation continued because the facility set to replace it experienced start-up delays, forcing the older plant to continuing operating at low rates. Nevertheless, it was a great learning experience for a young engineer both from a technical perspective as well as forming one of the bases for future mentoring. (For more on mentoring and sound advice from the field, visit www.ChemicalProcessing.com/voices/field-notes/.)

EARL M. CLARK, P.E., is engineering manager, Global Energy Services. Clark retired from DuPont after a career of 39 years and 11 months and joined Hudson's Global Energy Systems Group as Engineering Manager. During his over 43 years in the industry, he has worked in nearly all aspects of the energy field; building, operating and troubleshooting energy facilities for DuPont. He began his energy career with Duke Power and Clemson University during the energy crisis in the 1970s.

Active in both, the American Society of Mechanical Engineers and the American Society of Heating, Ventilating, Refrigerating, and Air-Conditioning Engineers (ASHRAE), Clark was chairman of ASHRAE's task group on Halocarbon Emissions and served on the committee that created ASHRAE SPG3 - Guideline for Reducing Halocarbon Emissions. He has written numerous papers on CFC alternatives and retrofitting CFC chillers. He was awarded a U.S. patent on a method for reducing emissions from refrigeration equipment. He has served as technical resource for several others.

ADDITIONAL RESOURCES

EHANDBOOKS

Check out our vast library of past eHandbooks that offer a wealth of information on a single topic, aimed at providing best practices, key trends, developments and successful applications to help make your facilities as efficient, safe, environmentally friendly and economically competitive as possible.

UPCOMING AND ON DEMAND WEBINARS

Tap into expert knowledge. Chemical Processing editors and industry experts delve into hot topics challenging the chemical processing industry today while providing insights and practical guidance. Each of these free webinars feature a live Q&A session and lasts 60 minutes.

WHITE PAPERS

Check out our library of white papers covering myriad topics and offering valuable insight into products and solutions important to chemical processing professionals. From automation to fluid handling, separations technologies and utilities, this white paper library has it all.

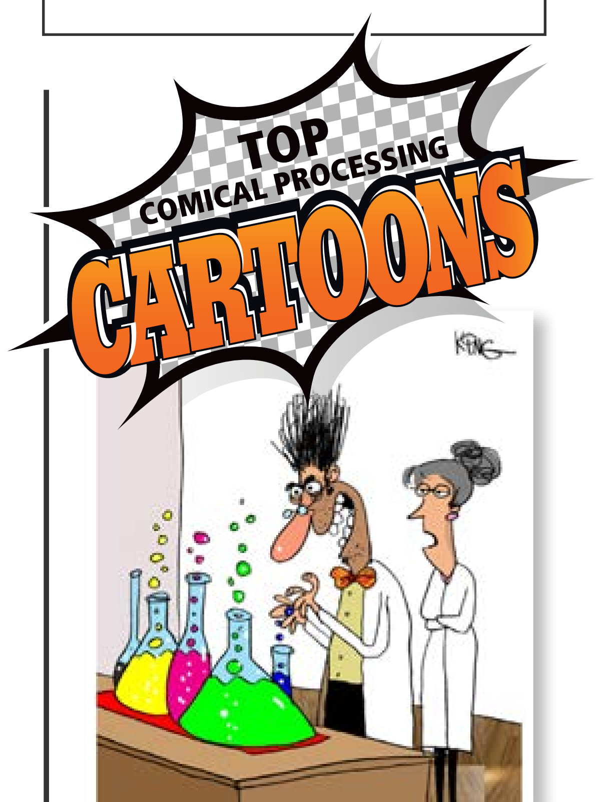
MINUTE CLINIC

Chemical Processing's Minute Clinic podcast series is designed to tackle one critical issue at a time — giving you hard-hitting information in just minutes.

ASK THE EXPERTS

Have a question on a technical issue that needs to be addressed? Visit our Ask the Experts forum. Covering topics from combustion to steam systems, our roster of leading subject matter experts, as well as other forum members, can help you tackle plant issues.

JOIN US ON SOCIAL MEDIA!



Visit the lighter side, featuring drawings by award-winning cartoonist Jerry King. Click on an image and you will arrive at a page with the winning caption and all submissions for that particular cartoon.