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Energy Efficiency eHandbook

Use Energy Effectively





TABLE OF CONTENTS

Manage Your Energy Management Program	3
Understand Energy Management Basics	6
Heat of Compression Dryers: Low Energy Consumption, Optimal Air Quality	9

AD INDEX

Pick Heaters www.pickheaters.com/energy_efficiency.cfm	5
Emerson Rosemount www.rosemount.com/stopsteamloss	8
Atlas Copco www.atlascopco.us/usus	13



Manage Your Energy Management Program

Learn what roles make up a successful energy management program

By Ven V. Venkatesan, Energy Columnist

ENERGY MANAGEMENT involves managing people, costs and technology, and creating energy cost awareness among plant personnel. Successful energy-management programs require three functional roles, namely, an energy manager, an energy consultant, and an energy auditor. If the energy system isn't large it's very common to see the same person perform all three roles.

An energy-management program should draw upon both internal and external resources, as appropriate. For the program to succeed, an experienced process engineer should lead all activities as an energy manager. The energy manager generally should:

- Initiate and monitor the energy database or energy accounting system — including costs — and report periodically to top management.
- Develop energy consumption targets for the processes within the plant based on best-in-class levels.
- Observe all phases of operation, including production and utilities, to optimize energy consumption.
- Involve all personnel, encouraging energy conservation by developing awareness campaigns, motivational awards and publicity materials.
- Conduct brainstorming sessions to identify energy cost-reduction measures, and review and prioritize them for all units within the plant.
- Coordinate with experienced energy consultants to set realistic energy-consumption targets.
- Establish energy efficiency programs that inspire personnel to ensure management's commitment to achieving energy efficiency targets.
- Utilize an energy accounting system to identify and develop measures to minimize deviations from target.
- Investigate and estimate the initial investment, operating costs and environmental impact of all proposed energy cost-reduction measures (ECMs).
- Determine high-priority ECMs and present these to management for capital approval.
- Coordinate implementation of ECMs with project management and monitor the results once implemented.



"Continuous support from top management is key to a program's success."

- Participate in relevant associations and professional bodies, liaise with research institutes and equipment manufacturers for regular updating of targets.
- Assume responsibility for all energy-management activities within the plant.

Although an energy manager plays the lead role, many companies also rely on external energy consultants to achieve energy cost reductions. Competent energy consultants share their vast experiences across several process industries, with unbiased thinking focused on reducing energy losses. The energy consultant typically helps the energy manager to:

- Develop a suitable energy cost-reduction strategy for the plant.
- Perform a systematic energy use analysis and set benchmark levels.
- Determine best practices and set progressive target milestones.
- Evaluate and prioritize possible energy cost-reduction measures.
- Provide case-study references on relevant ECMs and train operating personnel.
- Evaluate vendors and detailed engineering relevant to prioritized ECMs.
- Provide technical assistance and clarifications during ECM implementations.

An energy auditor reviews energy flows within the plant and evaluates the supplied and wasted energy. Typically, energy auditors are external

specialists; however, some large companies with multi-site operations maintain their own group of energy auditors. The expected functions of an energy auditor include to:

- Collect and validate plant's energy consumption and costs data.
- Correlate the production or service activity related to the energy use.
- Review the energy procurement processes and available alternatives.
- Gather the relevant process data and make necessary measurements to perform heat and mass balances.
- Identify and classify energy uses as controllable or uncontrollable losses.
- Suggest remedial measures to minimize or eliminate controllable losses.
- Indicate cost benefits of controlling the energy losses to feasible levels.
- Provide simplified methodologies to monitor and report key parameters that correlate to energy use/controllable energy losses.

Successful energy-management programs have an enlightened energy manager who obtains periodic support from external energy consultants and energy auditors. But one undeniable fact in those programs is the continuous support energy managers received from top management.

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Understand Energy Management Basics

Five key activities can help reduce energy use

By Ven V. Venkatesan, Energy Columnist

EFFECTIVE ENERGY management can help achieve more efficient use of energy without reducing production levels, product quality or employee morale, and without compromising safety and environmental standards. It should not only address higher-efficiency generation, energy conversion, distribution and utilization, but also explore lower-cost energy alternatives. Simply put, energy management is optimizing the energy cost per unit of product output.

Energy management is a proven tool; during challenging economic times, this competitive edge can help plants survive. When economic conditions are favorable, energy management can further boost the plant's profitability. The best energy management programs essentially cover the following five activities:

1. *Analysis of continuous energy supply (its cost, alternatives and flexibilities to energy supply) and an energy-efficient layout.* Both long- and short-term use of continuous energy should be evaluated. Consider the infrastructure costs of large-scale transportation of fuels. Selection of fuels should also be based on long-term sustenance.

In addition, a compact layout and optimized manufacturing processes can reduce material handling, energy costs, and in some cases, capital needs. Evaluate and install energy sources closer to energy "users." For example, in a power-intensive process such as graphite manufacturing, furnace bases are located as close as possible to the rectoformer housing. In a steam-intensive units, like ammonia plants, all process equipment and steam generating boilers are located in a compact manner to minimize distribution losses.

2. *Identify and incorporate energy-efficient process technologies and devices.* Evaluating the energy cost per unit of product output has a significant impact on a plant's operability. For example, membrane cell technology for chlor-alkali plants is significantly more energy efficient than earlier diaphragm-type electrolytic cells. Membrane cell technology uses lower voltage across the electrodes of the cell, consuming 20% less electricity — about 2,800 kWh/ton of chlorine production, while the diaphragm cells consume nearly 3,500 kWh/ton of chlorine. Also, steam use to evaporate the caustic lye is substantially lower in membrane cells compared to diaphragm cells. Hence,



“Effective management can help lower the energy cost per unit of product output.”

many chlor-alkali manufacturers have modernized their units, replacing the diaphragm cells with cells using the membrane technology.

3. Identify and incorporate energy-efficient operating practices and methods. Where applicable, energy-efficient retrofits may be necessary to take advantage of technological developments. Installing economizers and combustion air preheaters to fuel-fired furnaces and boilers, and adding blowdown heat recovery systems to medium-sized boilers are common retrofits. In addition, providing additional energy-efficient operating guidelines is an effective way to reduce energy costs.

It's also necessary to evaluate and compare the energy efficiency of actual operating conditions to design efficiency conditions. Market conditions always dictate load factors, and partial load operations may have become the norm for some operations. In such situations, significant energy-efficiency losses can be eliminated with retrofits like variable frequency drives for electric motors.

4. Add metering, control and automation features for improved energy productivity. Metering of critical parameters and energy use may not result in energy savings directly, but it helps save energy when combined with process control and automation. Automation and

control features ensure higher efficiency by avoiding over-heating, excessive compressing and cooling.

5. Evaluate the “lifecycle costing” of technical processes and equipment. Be sure to review the lifecycle cost instead of looking only at the first cost. I have seen plants that choose less-expensive electric motors, less-efficient transformers and low-cost steam traps. A steam trap worth \$150 can leak steam worth \$1,000/year. Similarly, a \$900 electric motor can consume \$3,000/year worth of electricity. Even marginally higher-efficiency electric motors and transformers can save enough electricity to justify their increased first cost within the first couple of years. The same goes for an incorrectly selected steam trap that could leak steam and condensate worth more than its purchase price within a few months. Hence, lifecycle costing is an essential energy management activity.

Remember, the objective of energy management isn't to simply reduce variable energy costs without compromising productivity and product quality, but also to increase the involvement and awareness of all team members associated with the activity and the relevant manufacturing process.

VEN V. VENKATESAN is Chemical Processing's Energy Columnist. You can e-mail him at Wenkatesan@putman.net



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Heat of Compression Dryers: Low Energy Consumption, Optimal Air Quality

SUPERB QUALITY compressed air is an essential ingredient for an efficient and productive plant, but air that is inadequately treated can cause extensive damage to equipment, processes and products. One crucial air treatment process is drying. When air is compressed, the moisture naturally present in ambient air is concentrated. A dryer eliminates this moisture before it can get into the air network, where it is extremely difficult to remove.

There are three general types of dryers in the market: refrigerant, desiccant, and heat of compression. Most people who work with compressed air are familiar with desiccant and refrigerant dryer technologies. Though they are well established, many superior advantages are offered by today's most advanced dryer technology, heat of compression dryers.

REFRIGERANT DRYERS

A refrigerant dryer uses a refrigerant circuit and heat exchanger(s) to pre-cool air, refrigerate it to remove moisture vapor via condensation, and then reheat the air to prevent pipe sweating downstream. Refrigerant dryers can lead to a pressure dew point (PDP) as low as +37.4°F/+3°C for many applications where there is a need for dry air. They can be used at different pressures and consume no processed compressed air. The main types of refrigerant dryers on the market include:

- Direct expansion dryers.
- Fixed speed non-cycling dryers that run continuously regardless of varying load conditions.

- Fixed speed cycling dryers that shut down at lower loads to save energy and restart when required.
- Variable speed dryers that cycle automatically according to demand.

DESICCANT DRYERS

A desiccant dryer consists of two towers filled with desiccant such as activated alumina, silica gel or molecular sieve. While one tower is drying compressed air, the other is being regenerated. Desiccant dryers can achieve dew points as low as -40°F/-40°C and -100°F/-70°C. Three types of desiccant dryer are widely used throughout industry:

- Heatless purge dryers use a small portion of the dried compressed air for regeneration.
- Heated purge dryers use a small and heated portion of the dried compressed air for regeneration.
- Heated blower purge dryers use heated ambient air for regeneration.

HEAT OF COMPRESSION (HOC) DRYERS

Compressing any gas, including air, produces heat. Heat of compression drying recycles heat energy from the compressor to regenerate the desiccant. An HOC dryer requires only a very small amount of electric power for regeneration, and operation is continuous and fully automatic. When used in place of a refrigerant or desiccant dryer, it also eliminates the related power consumption (direct or purge). Atlas Copco's unique zero purge technology consumes no compressed air due to purge, so there is no need to oversize



the compressor installation to compensate for purge losses.

WHICH DRYER IS RIGHT FOR ME?

To find out, consider this simple formula: ACE, which stands for applications, customers and environments.

Applications: What dew point do you need to achieve? Do you have very low temperatures in the winter and very high temperatures in the summer? Refrigerant dryers are not compatible with freezing temperatures, so if the equipment is located outside or has compressed air piping that is exposed to outside air (which is very common), being able to cope with a negative dew point will be required and desiccant dryers will be required.

Customer: What quality of air is demanded for the customer's application and their end products? For general applications where only protection against corrosion is needed, a refrigerant dryer is enough. However, an HOC dryer — even if it requires a higher initial investment — can pay for itself through lower operating costs and provide similar or better dew points. Applications with more stringent requirements, such as when compressed air is in contact with food,

will require dew point of at least $-40^{\circ}\text{F}/-40^{\circ}\text{C}$ to remove sufficient moisture content. Guaranteed dew point HOC or desiccant dryers, sized to take into account the maximum operating conditions, will then be the right choice. Even more demanding applications, such as electronics manufacturing, may require $-100^{\circ}\text{F}/-70^{\circ}\text{C}$ special versions with molecular sieve of HOC or desiccant dryers.

Environment: Does the compressed air system run 24/7? What size compressors are running? Can higher investment costs easily be recovered through smaller energy bills?

Blower purge desiccant, zero purge, and HOC dryers employ more sophisticated designs and, not surprisingly, are more expensive to purchase. However, these technologies benefit customers in the long term because energy savings can pay back the extra initial investment. Additionally, reducing or eliminating purge loss brings higher outlet flow, so in most cases a smaller combination of compressor and dryer can be used. That can save even more.

Atlas Copco offers an industry leading, energy efficient range of compressed air dryers with options for technology, size and configuration to suit any application.

ISO 8573-1:2010	Dirt			Mass concentration mg/m ³	Water		Oil Total oil (aerosol liquid and vapor) mg/m ³
	Maximum number of particles per m ³				Vapor pressure dewpoint	Liquid g/m ³	
	0.1 - 0.5 micron	0.5 - 1 micron	1 - 5 micron				
0	As specified by the equipment user or supplier and more stringent than Class 1						
1	≤ 20000	≤ 400	≤ 10	-	≤ -70°C/-94°F	-	0.01
2	≤ 400000	≤ 6000	≤ 100	-	≤ -40°C/-40°F	-	0.1
3	-	≤ 90000	≤ 1000	-	≤ -20°C/-4°F	-	1
4	-	-	≤ 10000	-	≤ +3°C/+37.4°F	-	5
5	-	-	≤ 100000	-	≤ +7°C/+44.6°F	-	-
6	-	-	-	≤ 5	≤ +10°C/+50°F	-	-
7	-	-	-	5 - 10	-	≤ 0.5	-
8	-	-	-	-	-	0.5 - 5	-
9	-	-	-	-	-	5 - 10	-
X	-	-	-	> 10	-	> 10	> 10

Figure 1. This graph explains the different ISO classifications.



MD/ND HEAT OF COMPRESSION INTEGRATED DRYERS

- Class 2 and Class 3 dew point performance (see figure 1)
- (Class 2 = -40F and below, Class 3 = -4F and below)
- Instrument quality dry air
- Guaranteed dew point (ND and MD with low load kit)
- Low operating costs
- 104-5,300 scfm

Atlas Copco owns multiple patents for the drum dryer design which makes MD/ND HOC dryers unique. This design re-uses most of the energy consumed during compression and reduces or eliminates purge losses while offering the lowest life cycle cost.

An Atlas Copco MD HOC dryer can be coupled with a low load kit to achieve ISO Class 3 dew point. An ND HOC dryer equipped with a heater can guarantee ISO Class 2 dew point performance.

MD/ND dryers are fully integrated into the Full Feature variant of Atlas Copco's ZR/ZT oil-free compressor range. In cases where HOC drying needs to function as a free-standing solution, MD/ND dryers can be installed downstream of an Atlas Copco oil-free or centrifugal (ZH Turbo) compressor. They also can be used with a competitor's oil-free unit.

XDE/XD HEAT OF COMPRESSION REACTIVATED ADSORPTION DRYERS

- Extremely dry low dew point air
- -40°F/-40°C PDP as standard, -100°F/-70°C PDP is available
- Low operating costs
- 700-14,400 scfm

Atlas Copco's XDE/XD adsorption dryers remove moisture from compressed air to ensure system reliability, maximize productivity, and minimize service and repair costs. They can ad-

dress even the most stringent air quality requirements. One XD dryer can dry the air of several compressors. In fact, Atlas Copco's XD dryer range offers a unique value proposition when coupled with our ZR and ZH compressors or with a competitor's compressor.

Atlas Copco's Adaptive Regeneration Technology actively controls the regeneration parameters, responding to changing working conditions while optimizing the total energy needs. Combined with advanced Elektronikon® controls, the dynamic heating sequence optimizes total energy needs.

Atlas Copco was first to offer an HOC adsorption dryer for extremely low dew points. The XDE330-1100 (700-2,300 scfm) range includes dew point dependent switching, the exclusive Elektronikon® graphic control panel with remote visualization, and filter pressure drop monitoring.

Unlike competitive solutions, the patented XD Zero Purge can use both installed coolers during the complete cycle time, thereby lowering the load on the desiccant and the energy required for regeneration.

BD+ LOW ENERGY DRYERS (BLOWER HEATED DESICCANT DRYER)

- Energy savings when HOC dryers are not an option
- Zero Purge variant available
- -40°F/-40°C PDP guaranteed, -100°F/-70°C PDP available
- 200-6,350 scfm

In situations where HOC drying is not an option (for instance, when not enough heat is available or byproduct heat is already recycled for additional energy savings elsewhere), energy savings can still be achieved by minimizing purge consumption. Atlas Copco offers the BD+ 100-3000 range (212-6,350 scfm), a blower heated desiccant dryer that is available in either a purge or a Zero Purge variant (BD+ 350 and up). All BD+ models are equipped with the Elektronikon color graphic controller that



monitors all the operating parameters and offers free remote visualization. The BD+ is also available in a -100°F/-70°C PDP version. Larger BD+ models (350-3000) also have a unique split flow cooling that avoids temperature spikes at tower changeover, and are available in -100°F/-70°C combined with Zero Purge. Up to BD+1100, Zero Purge is based on an air-cooled closed loop (above water cooled). Dry compressed air is not used during the desiccant cooling cycle, eliminating the average 2% loss used by purge models.

In some cases, the difference of purge consumption between a blower purge and heatless desiccant dryer is such that for the same outlet flow, a smaller size of compressor and dryer can be used, contributing to a faster payback of this energy-saving technology.

DRYERS SHOULD BE “ENVIRONMENTALLY FRIENDLY”

Atlas Copco recently introduced a campaign — “STOP Using R22 Refrigerant Dryers” — to raise public awareness of the harmful environmental effects of using R22 refrigerants in industrial and commercial applications, including refrigerant dryers. R22, commonly known by its brand name, Freon, is a halocarbon compound which has the potential to cause depletion of the ozone layer in the atmosphere.

Because Atlas Copco is committed to sustainable productivity, we offer a variety of dryers with refrigerants such as R410A, R404A and R134a that do not deplete the ozone. Our commitment is in line with international conventions that are banning the use of R22 in a phased manner.

DRYERS SHOULD PROTECT THE CUSTOMER’S INVESTMENT

Under the United Nations’ Vienna Convention

for the Protection of the Ozone Layer and the resulting Montreal Protocol, R22 refrigerant is to be phased out by 2020 in order to reduce the abundance of R22 in the atmosphere, thereby protecting the fragile ozone layer. Since 2010, R22 can only be used for service of existing machines in the United States and not for new machines. Beginning in 2020, only recycled R22 will be allowed for service.

DRYERS SHOULD PROTECT THE ENVIRONMENT

The fact that the ozone layer was being depleted was confirmed by international treaty in the mid-1980s. The main cause of this is the release of chlorofluorocarbons (CFCs), a category of chemicals which includes R22 refrigerants.

The importance of the ozone layer is to protect the earth from the sun’s harmful ultraviolet (UV) rays. Overexposure to UV radiation can cause a range of health effects on humans and animals, including skin cancers. In addition, UV rays have been shown to cause eye damage and suppression of the immune system.

CONCLUSION

Drying compressed air is a relatively simple science, until you factor in variants such as energy usage and quality control. After that, the decision can become a more complex puzzle that requires thoughtful analysis. Often, all three of the technologies would do the “simple job” that you need a dryer to perform, but does the purchase “cost” outweigh the “value” that this dryer should add to your energy bill and also help improve your production quality? Atlas Copco’s compressed air experts are trained to find the right solution for you and will provide a payback analysis to which we are committed and indeed proud to stand behind.

Clear the way for quality air



Hi, I'm **Michelle** and I have been working with our customers across the United States for the last 10 years. Products that optimize quality in your air supply are not just accessories we offer; they are a way of life for us at Atlas Copco. That's why we produce such a wide variety of dryers, aftercoolers, filters and oil-mist eliminators just to name a few.

We all perform best when working within our optimum environment, right? And, manufacturing environments are no different. Moisture in your air supply is something that should be avoided at all costs. Water is a by-product of compressing air. But there are ways to ensure this moisture doesn't get downstream and cause equipment malfunction. And more importantly, moisture can lead to contamination of your end products, leading to costly product failures and potentially harming your hard-earned reputation.

Our mission is to continue to bring sustainable productivity through safer, cleaner, more energy-efficient, and cost-effective compressed air technology. Simply log onto www.atlascopco.us/michelleusa or call **866-688-9611** to learn more about us, our products, and how we have earned and will continue to earn our reputation.



Sustainable Productivity

Atlas Copco