ENERGY RECOVERY SIMPLIFIES PROCESS AIR DRYING

Warm, dry air is critical for many manufacturing processes. The traditional method of drying compressed air typically includes an aftercooler and a refrigerated dryer as shown in Figure 1. This arrangement, although effective, can be expensive to operate and maintain. As a result, many plants are now turning to a Reheat System, Figure 2, to perform this function because of its energy savings, low capital equipment cost, and maintenance free operation. This packaged system cools compressed air in an aftercooler, removes the moisture using a separator, then reheats the air using a regenerative heat exchanger for use in the manufacturing process without the need for an external energy source. In effect, a reheat system supplies free heat to your process while significantly reducing plant operating expenses.

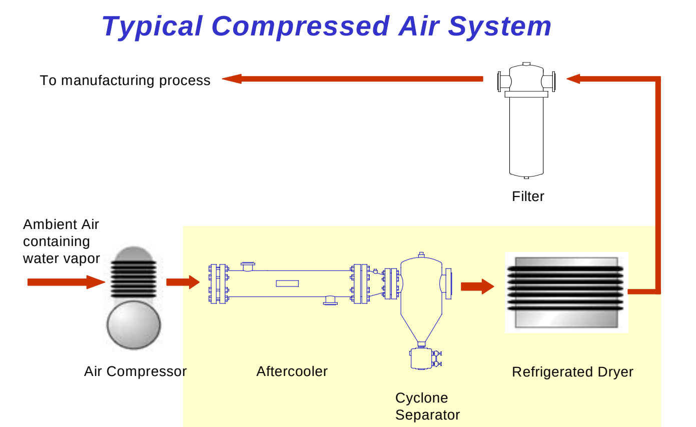

Figure 1 Compressed Air System using a Refrigerated Dryer.

Cooling compressed air is an essential method to condense moisture that is present in the stream. However, it robs the energy or volume from the compressor system. While the amount can vary, it is not unusual to lose thirty percent of the energy available from the total compressed air system.

The purpose of a Reheat System is to add this energy or volume back into the compressed air system using the heat of compression from the air compressor. One particular advantage of the Reheat System is that it does not require the use of any external energy to reheat the air. This results in significant savings in plant operating expenses. In fact the system is efficient enough to take the place of a refrigerated dryer, depending upon pressure dew point desired and coolant available. Typical dew point temperatures achieved range from 35°F to 90°F. The system can reheat the process air to temperatures as high as 300°F, depending on the heat coming from the compressor discharge, however, 90°F to 120°F is more common for most applications.

The Reheat System replaces the traditional equipment in the shaded area in Figure 1 with the system shown in Figure 2. The Reheat System consists of an air to air regenerative tubular exchanger, aftercooler(s), cyclone separator, automatic moisture trap, interconnecting piping and controls all mounted on a support rack.

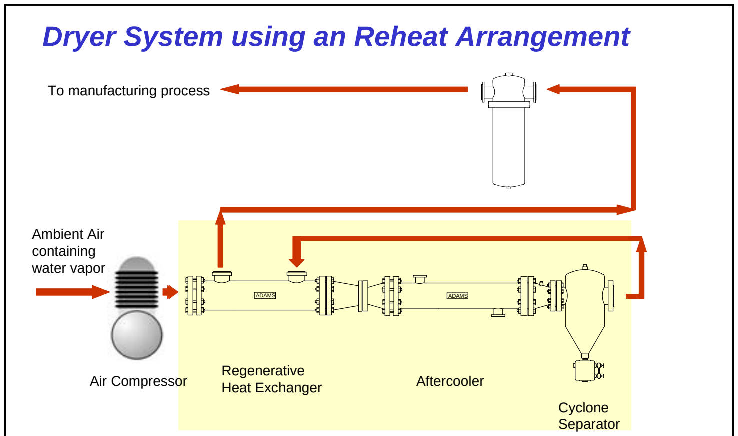

Figure 2. A Reheat System

A key component to the Reheat system is the air to air regenerative tubular heat exchanger.

Regeneration is a method of exchanging heat between the same fluid at different intervals in the process. For example, compressed air from the compressor must be cooled to condense the moisture present and then should be reheated once the moisture is removed. Instead of performing the entire cooling load in an aftercooler, a Reheat System uses a regenerative heat exchanger upstream of the aftercooler to reduce the cooling load on the aftercooler. The regenerative heat exchanger's cooling source is the same compressed air that has already been cooled by the Reheat System aftercooler. A cyclone separator is used to efficiently remove up to 99% of the condensed liquid present in the air stream prior to returning to the regenerative heat exchanger.

The reasons for this type of system arrangement are twofold. First it conserves the amount of coolant needed in the aftercooler because the regenerative heat exchanger is performing part of the cooling load. Second, compressed air is reheated using its own energy from the heat of compression of the air compressor. Therefore no external energy source is required to reduce the dew point of the process air. Instead the "free" heat of compression increases the air temperature well above the dew point at the aftercooler. In essence, the Reheat System provides free heat to your compressed air process.

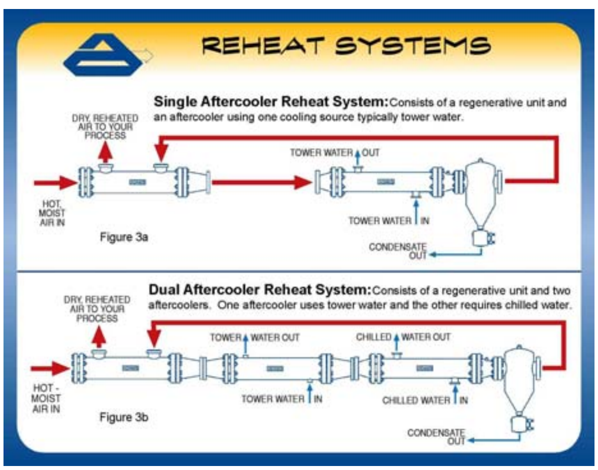

Figure 3 Reheat System Configurations

The Economat Reheat system configuration can vary as seen in Figure 3. Figure 3a shows a Reheat System that uses one aftercooler. The aftercooler cooling medium can be cooling tower water, chilled water, river water, lake water, or city water.

When chilled water is needed to further dry the air, adding a secondary aftercooler as shown in Figure 3b can minimize water consumption. The primary aftercooler uses tower, river or lake water to handle part of the cooling load, while the secondary chilled water aftercooler performs the final cooling. This reduces chilled water consumption and operating expenses.

In the food industry, ammonia refrigerant is commonly used as a cooling source in the Reheat System in place of the chilled water.

It should be noted that a significant amount of moisture could be condensed using chilled water or ammonia refrigerant. In those cases where 33°F to 45°F coolant is readily available, the Reheat System can take the place of a refrigerated dryer. This saves on system capital equipment costs and annual operating expense since the refrigerated dryer requires electricity to operate. In situations where desiccant dryers are being used, the Reheat system can dramatically improve its performance.

Figure 4 illustrates the Reheat Systems performance and shows what happens when air is compressed, cooled, and reheated. The example involves 7,100 SCFM of atmospheric air at 14.7 PSIA and 70°F entering a two stage compressor and discharging at 125 PSIG. The resulting volume represents 1,000 CFM of air at 125 PSIG and 250°F. It takes 1,200 horsepower to compress the air. When the air is cooled to 70°F in the aftercooler, its volume shrinks to 748 CFM resulting in a 25% reduction. This represents a loss of 302 horsepower of work that could have been performed if the air temperature was at 250°F. By heating the air to 200°F, using the waste heat of compression from the compressor, there will be a gain in air volume of 182 CFM. This translates into a 24% increase in air volume and 291 horsepower of work has been reclaimed using the Reheat Systems. In addition, by reheating the air the chance for additional condensation in the air distribution system is eliminated.

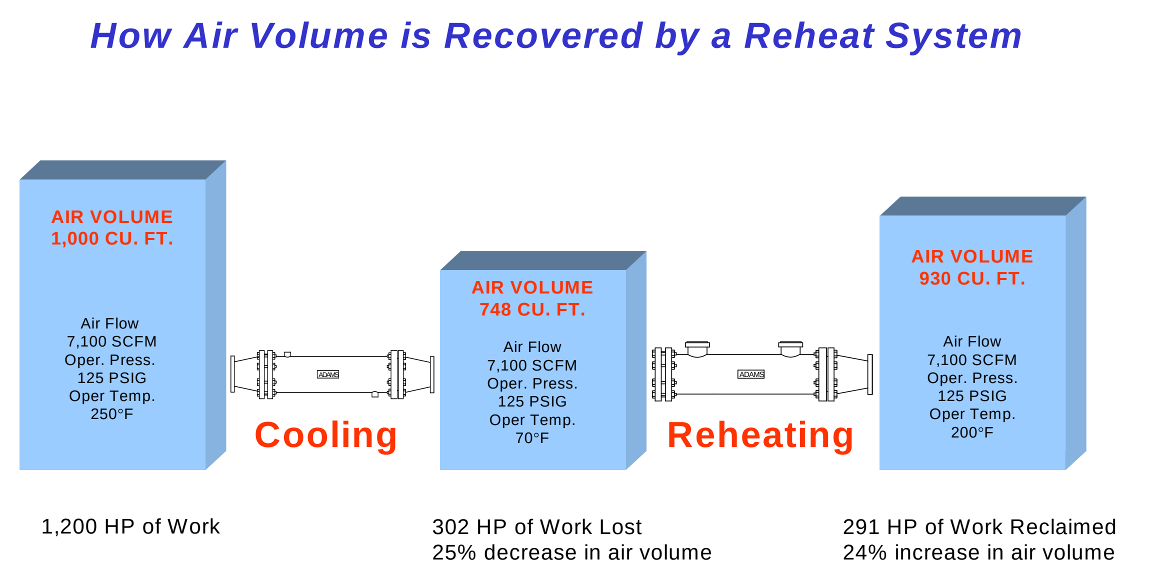

Figure 4 Recovering air volume in a Reheat System

Moisture in any compressed air process represents a major problem because the compressor uses ambient air that contains man made pollutants. Contaminants such as carbon dioxide, sulfur dioxide, chlorine, etc, combine with the moisture to form weak acids that are concentrated and corrosive in the compressed state. In the glass making process, it is especially important to remove moisture because it will affect the quality of the glass being manufactured.

Figure 4 shows the moisture content of compressed air at various pressure dew points. Moisture is significantly reduced by getting the air as cold as possible. How cold the air can get depends upon the coolant source available.

If compressed air is cooled to 47°F using chilled water instead of 85°F using tower water, then the moisture content in the compressed air is 11 gallons of water per day as opposed to 43 gallons per day with tower water as the cooling source. This represents almost a 75% reduction in the total amount of moisture present in the stream.

The aftercooler(s) in the Reheat System should be sized to ensure that moisture in the compressed air is reduced to a minimum. The result is a low dew point of the air that can range from 35°F to 90°F depending upon the cooling source available.

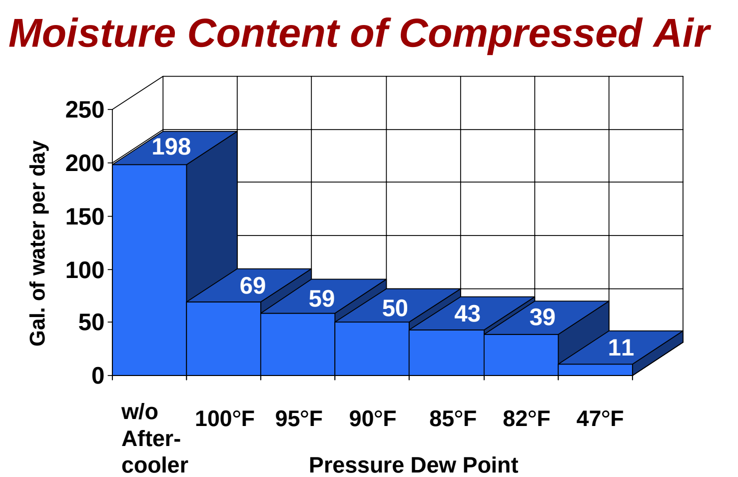

Figure 5. Moisture content of air based on 1,000 SCFM of air at 100 PSIG operating pressure. Ambient conditions being 84°F, 14.7 PSIA, & 60% Relative Humidity

A summary of the advantages of the Reheat System include:

- Dry high temperature compressed air for your production or manufacturing process.
- No external power costs associated with the operation of this system, which saves annual plant operating expenses.
- Increased compressed air volume from a given air compressor. Work done by the compressed air depends on the volume and pressure at the point of use. By keeping the pressure constant and reheating the air the volume increases.
- Low dew points of the compressed air ranging from 35°F to 90°F depending upon the coolant available.
- Elimination of condensate and external line sweating in the air distribution system.
- Virtually maintenance free system with no moving parts or control mechanisms requiring yearly maintenance.

Industries that are benefiting from the Reheat System include automotive, pharmaceutical, food processing, breweries, tire manufacturers, fiber and textiles, glass making, forge shops, and those requiring warm, dry, clean, compressed air for their process.

For more information, please visit our web site at www.rpadams.com. If your need is urgent, then call us at 800-896-8869 and we can put you in touch with your local R. P. Adams Sales Engineer.

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