# Heat Recovery with Compressed Air Systems

**Compressed Air Systems Fact Sheet #10**

As much as 80-93% of the electrical energy used by an industrial air compressor is converted into heat. In many cases, a properly designed heat recovery unit can recover anywhere from 50-90% of this available thermal energy and put it to useful work heating air or water.

Typical uses for recovered heat include supplemental space heating, industrial process heating, water heating, makeup air heating, and boiler makeup water preheating. Recoverable heat from a compressed air system is not, however, normally hot enough to be used to produce steam directly.

Heat recovery systems are available for both air- and water-cooled compressors.

## Heat Recovery with Air-Cooled Rotary Screw Compressors

***Heating Air.*** Air-cooled packaged rotary screw compressors are very amenable to heat recovery for space heating or other hot air uses. Ambient atmospheric air is heated by passing it across the system's aftercooler and lubricant cooler, where it extracts heat from both the compressed air and the lubricant that is used to lubricate and cool the compressor.

Since packaged compressors are typically enclosed in cabinets and already include heat exchangers and fans, the only system modifications needed are the addition of ducting and another fan to handle the duct loading and to eliminate any back pressure on the compressor cooling fan. These heat recovery systems can be modulated with a simple thermostatically-controlled hinged vent. When heating is not required -- such as in the summer months -- the hot air can be ducted outside the building. The vent can also be thermostatically regulated to provide a constant temperature for a heated area.

Hot air can be used for space heating, industrial drying, preheating aspirated air for oil burners, or any other application requiring warm air. As a rule of thumb, approximately 50,000 Btu/hour of energy is available for each 100 cfm of capacity (at full-load). Air temperatures of 30 to 40$^{o}$F above the cooling air inlet temperature can be obtained. Recovery efficiencies of 80-90% are common.

Caution should be applied because if the supply air for the compressor is not from outside, and the recovered heat is used in another space, you can decrease the static pressure in the cabinet and reduce the efficiency of the compressor. If outside air is used, some return air may be required to avoid damaging the compressor with below freezing air.

***Heating Water.***Using a heat exchanger, it is also possible to extract waste heat from the lubricant coolers found in packaged water-cooled reciprocating or rotary screw compressors and produce hot water. Depending on design, heat exchangers can produce non-potable (gray) or potable water. When hot water is not required, the lubricant is routed to the standard lubricant cooler.

Hot water can be used in central heating or boiler systems, industrial cleaning processes, plating operations, heat pumps, laundries, or any other application where hot water is required. Heat exchangers also offer an opportunity to produce hot air and hot water, and allow the operator some ability to vary the hot air/hot water ratio.

## Heat Recovery with Water-Cooled

## Compressors

Heat recovery for space heating is not as common with water-cooled compressors because an extra stage of heat exchange is required and the temperature of the available heat is lower. Since many water-cooled compressors are quite large, however, heat recovery for space heating can be an attractive opportunity. Recovery efficiencies of 50-60% are typical.

## Calculating Energy Savings

When calculating energy savings and payback periods for heat recovery units, it is important to compare heat recovery with the current source of energy for generating thermal energy, which may be a low-price fossil fuel such as natural gas. The equations in the text box below illustrate the annual energy and costs savings available by recovering heat for space heating from an air-cooled rotary screw compressor. Applications where the existing heater is less than 85% efficient will see proportionally higher savings.

## Energy Savings Calculations

**Energy Savings (Btu/yr)** = 0.80 x Compressor bhp x 2,545 Btu/bhp-hour x hours of operation
**Example:** A 100 hp compressor running two shifts, 5 days per week
(0.80) x (100 bhp) x (2,545 Btu/bhp-hour) x (4,160 hours per year) =
**846,976,000 Btu per year**

where: 0.80 is the recoverable heat as a percentage of the unit's output
2,545 is a conversion factor

**Cost Savings ($/yr)** = ((Energy Savings in Btu/yr)/(Btu/unit of fuel) x ($/unit fuel))/ Primary Heater Efficiency
**Example:** Waste heat will be displacing heat produced by a natural gas forced-air system with an efficiency of 85%
((846,976,000 Btu per year)/(100,000 Btu/therm)x($0.40/therm))/0.85 =
**$3,986 per year**

* Cost of operating an additional fan for duct loading has not been included