Energy Innovators Initiative

Technical
Fact Sheet

Reducing Water Use by Installing a Closed-Loop Compressor Cooling System

Description

Some water-cooled air compressors use domestic cold water to cool the air between compression stages, and sometimes after the final compression stage. In urban areas, using cold municipal water for cooling purposes in an *open loop* (in which water passes through only once) is costly and wasteful. This type of cooling is common in many systems because it is simple to set up and cold water is readily available. However, installing a *closed-loop* fan-coil system, as shown in Figure 1, can nearly eliminate domestic water usage during winter and shoulder seasons.

Figure 1 – Fan Coil, Pumps and Three-Way Valve

Technical Specifications

As illustrated in the schematic in Figure 2, the alternative compressor cooling system consists of a bank of fans that draw outside air through a heat exchanger fed from a closed glycol loop. When the fan-cooled heat exchanger cannot provide the required cooling, domestic cold water is brought in through a heat exchanger (Figure 3, overleaf). If the cooling water temperature rises above the setpoint temperature, the domestic water control valve opens to bring the temperature down. A three-way mixing valve controls the flow of water through the fan-cooled heat exchanger to the compressors. The system operates with a solution of 20 percent propylene glycol and 80 percent water to prevent freezing. Each compressor has a solenoid valve installed in the cooling water supply lines upstream of the compressors to control flow. These valves can be interlocked with the cooling circuit so that the fans and pump are shut off when the compressors are not running.

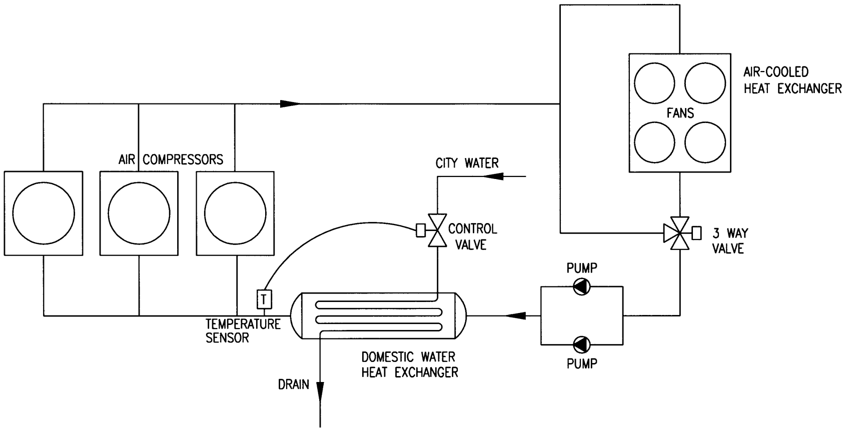

Figure 2 – Schematic of Air-Cooled System

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Figure 3 – Domestic Cold Water Heat Exchanger

Water-cooled air compressors consume water almost constantly, and therefore the amount of water they require depends on equipment operating times. As mentioned above, domestic water use drops significantly (in some cases to nearly zero) when using an air-cooled system. Only during the summer, when the cooling requirements are high, is domestic water required to supplement the air cooling. The cost of the electricity required to operate an air-cooled system is 4 to 6 percent of the cost of water at typical municipal rates. The only drawback of the system is that the cooling water inlet temperature needs to be kept as low as possible. Manufacturers specify an inlet temperature of 12°C for a water-cooled system. However, it is difficult to achieve such a low glycol temperature year-round. If an average inlet temperature is 20°C, a two-stage system with inter-cooling and after-cooling would require a 2–3 percent higher input of energy. One side benefit of the air-glycol system is that it preheats ventilation or combustion air from the fan system heat exchanger in the winter.

Case Study

Simon Fraser University in Burnaby, British Columbia, has implemented a program to reduce domestic cold water use. The compressed air system consists of three permanently installed Atlas Copco ZR series two-stage rotary compressors, one of which is used for standby capacity. The two remaining compressors operate 24 hours a day, year-round. The existing cooling system for the compressors was modified to include a new glycol loop, an air-glycol heat exchanger and a supplemental municipal water heat exchanger for peak periods. The maximum heat rejection of the compressors is 130.6 kW during standard operation. The cooling loop was designed with a maximum inlet temperature of 30°C, a maximum temperature rise of 15°C and a glycol mixture flow rate of 2.14 litres per second. A bank of four 1-hp (0.746 kW) fans draws outside air through the air-glycol heat exchanger, and a pair of 2-hp (1.492 kW) circulation pumps each rated at 2.33 L/s (37 U.S. gallons per minute), provides flow through the heat exchanger and to the compressors. The pumps are set to run in a lead/lag configuration, with the second pump running only if the first pump fails. The four fans are configured in pairs and are cycled to maintain the cooling loop temperature setpoint. Table 1 analyses the project cost and savings, and shows that the project will yield a 2.3-year simple payback. Water savings values are based on meter readings performed before the project was implemented.

Table 1 – Project Cost and Savings Analysis

Before	
Estimated Annual Water Use (m^3)	44 570
Annual Cost (@ \$0.84/m^3)	\$37,439
After	
Annual Electrical for Fans and Pump (kWh)	24 300
Penalty for Higher Cooling Temperature (kWh)	18 500
Annual Electricity Cost (average \$0.05/kWh)	\$2,140
Annual Project Savings	\$35,300
Total Project Cost	\$81,000
Payback Period (years)	2.3

For more information, contact

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