Engine Drives Are Fueling the Future of Ice Rink Economics

Engine Refrigeration Compressor Drive with Heat Recovery Demonstrates Peak Shaving Benefits

Demonstration Finds Natural Gas Engines will be an Essential Element in Utility Restructuring

"This engine-driven compressor set is predictable and understandable. In fact, it operates with minimal hand holding. I feel quite comfortable with our engine-driven compressor and look forward to avoiding future peak price increases." John Berndt, Facilities Manager, Schwan's Super Rink.

The National Sports Center (NSC), located in Blaine, MN, is the host facility for the USA CUP. Built in 1990, the NSC is a $30 million, 132-acre sports complex with more than 70 grass fields, making it the world's largest soccer complex. The NSC opened its new Schwan's Super Rink in October 1998. This arena holds four Olympic-sized ice sheets, making it one of the largest ice facilities in the USA.

Each of the four Olympic-sized rinks is identical. The refrigeration system consists of two electric motor-driven 8-cylinder reciprocating compressors, one electric motor-driven 16-cylinder reciprocating compressor, and one natural gas engine-driven 16-cylinder reciprocating compressor. The R22 refrigeration compressors work in conjunction with an evaporator supplying calcium chloride brine at 14.4 °F to the rinks. Heat from the engine is recovered to preheat boiler water for space heating and domestic hot water, and to regenerate four desiccant units that dehumidify and heat the rink areas.

Each 16-cylinder compressor is capable of maintaining all four sheets of ice throughout most of the year. The Engine-driven compressor currently operates during peak electric rate times (about 9 hours each weekday) and the electric compressors operate during off-peak times, giving the rink $13,500 in potential operating savings annually.

Economics

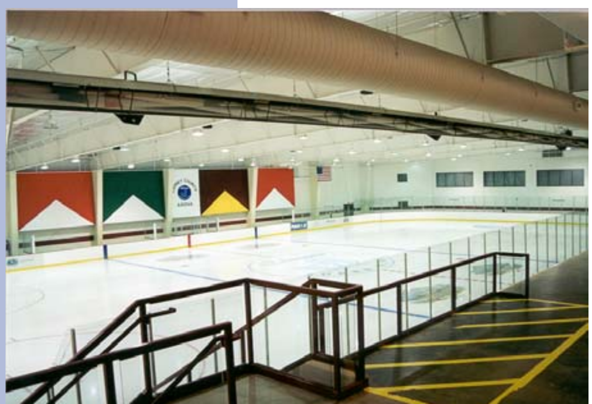
Operating the engine-driven compressor during the peak tariff time – about nine hours per weekday – provides operating cost savings of $13,492 (including maintenance cost differential for the engine) versus the all-electric option. With a drive line cost differential of $73,000, this yields a payback of 7.2 years under the current rate tariff. Adding heat reclaim equipment at a cost of $15,209 increases the savings from $10,196 to $13,492. This yields a payback of 6.5 years.

A six and one-half-year pay back does not tell the whole story. The municipal utility providing electric service to the facility charges 2.9¢ per kWh and $5.2 winter / $7.25 summer demand. Looking out to the future, both on-peak commodity and demand charges in Minnesota appear to be headed higher. This is especially true in the ten-year time frame, when several nuclear power plants apply to be re-licensed.

Moving the same facility to the New York area changes the story dramatically and may be a harbinger of things to come elsewhere. Running the engine-driven compressor on-peak (14-hours on weekdays) energy savings are $33,491 annually, yielding a simple payback of 2.2 years. Adding heat recovery improves the simple payback to 2.1 years.

Schwan's Super Rink

"This engine-driven compressor set is predictable and understandable. In fact, it operates with minimal hand holding. I feel quite comfortable with our engine-driven compressor and look forward to avoiding future peak price increases," John Berndt, Facilities Manager, Schwan's Super Rink. Berndt continued, "[w]e have had a few design issues to work out, like replacing a turbocharger, under warranty, after 18 months of operation because of a shutdown sequence needing modification, and a radiator leak. But, on one electric motor-compressor set, we had to change out three control mother boards."



The rink currently uses the local municipal utility's general services rate structure until all the operating issues are fully understood and worked out. In the future, the rink will be looking toward hedging its peak load options and taking advantage of its ability to have its peak with the engine-driven compressor set.

The average heat transfer rate for the heat recovery system was 37% of the design heat transfer rate, and at peak operation reached only 70% of the design heat transfer rate. This is because the design values assume a lower return water temperature (and hence a much higher thermal load) than observed. There remains opportunity to improve the heat recovery design to capture higher temperature from the exhaust stream and capture more of this energy.

Looking to the Future

It is clear that engine-driven compressors make sense in ice rinks as peak shavers, especially when considering expected increases in peak electric rate structures. Heat recovery systems can have a powerful economic leverage, and improvements will only make this option more effective.

“We like having the option to control our destiny in the future by running the right equipment to match the energy market place,” concludes Schwan's Berndt. “Overall, it's been very good for us.”

Refrigeration CHP Technology

Increasing electric grid problems and the specter of higher electricity prices in the future are leading companies to hedge their energy bets. Schwan's Super Rink has invested in their energy future by installing the engine-driven compressor and improving today's economics by recovering jacket water and exhaust gas heat to preheat regeneration air for the rink's dehumidification system.

Each rink has a desiccant unit to dehumidify the space air, prevent fogging, eliminate condensation, improve ice surface conditions and avoid water damage to the building. The desiccant units also can provide fresh air ventilation during periods of high occupancy. Each unit operates its supply side fan in low speed continuously, and cycles the regeneration side fan and gas burner as dehumidification is required. When the units operate to provide ventilation air, the process side fan operates at high speed, and the outdoor air dampers on the units open.

Desiccant dehumidification is an essential and powerful tool for the rink designer. The Schwan's desiccant units take rink air, ranging from 16 °F to 40 °F dew point, and deliver dehumidified air to the rink space between 24 °F and -26 °F dew point. The importance of this is that the delivered air is always below the ice surface temperature of 25 °F for hockey and 28 °F for figure skating. This assures that condensation and fog will be minimized or eliminated all year long. Providing 24 °F and -26 °F dew point, air with traditional electric refrigeration equipment, would require enormous amounts of electricity and high operating costs. All four desiccant units combined use about $11,300 of natural gas annually without the heat recovery operating and $8,939 worth of natural gas.

Operation of the desiccant units is automatic and maintenance is simple. The only routine issues are filter changes, fan belt inspections (fans are belt driven to permit two speed operation) and typical burner maintenance.

Gas Technology Fueling the Ice Rink Industry

150 HP standard engine-driven screw compressor product line

Standard brine chillers from 50 to 1,000 HP

Desiccant Dehumidifiers ranging from 1,000 scfm to 50,000 scfm

Natural gas powered ice resurfacers

Fueling the Future of Industry

Energy Efficiency, Emissions and the Future of Energy Decisions

Primary energy use is not an economic factor today, but it directly relates to the amount of air pollution we breathe. It is interesting to note the most energy efficient option is to run the engine-driven compressor 24-hours per day while consuming 10,628 MMbtus annually. But, this is not the most economic choice today. Operating the engine-driven compressor 9-hours per weekday (the most economic choice) uses 12,075 MMbtus annually.

The all-electric option uses 8.5% more primary energy than the economic choice option of running the engine 9-hours each weekday. Many experts agree that emissions will indeed become an issue of import within the next decade and primary energy will become the measure to economically value energy transactions.

Be sure to consult your local gas utility for economics of refrigeration systems in your area as rates vary widely across the nation.

In the future, when peak demand is expected to rise, when improved integrated devices are made and when CO_2 emission reductions are valued, then even with low electric rates gas engine driven compressors with desiccant regenerated heat recovery systems will have vastly improved pay backs.

For further information contact

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