Heat Recovery For Your Ice Rink - Asked & Answered

On technical feasibility:

For a condenser replacement project, what can be incorporated into our existing refrigeration system/project for additional energy reduction? For example: We already have a VFD on the condenser fan as well as "fan first" switch over on our Cimco 6000E...what else can be implemented into our system? What would the approximate cost be to incorporate such a system?
The 6000E feature is generally used to maintain a certain discharge pressure for optimal refrigeration operation. Ultimately, you want to upgrade to the next level by operating under a discharge floating head mode. This means that you want to focus on having the lowest condensing pressure base on outside temperature to improve compressor COP without compromising the refrigeration system. Sometimes we could be limited on the decrease of condensing pressure by the required lubrication of compressors by differential pressure or also by some limitation in velocity into the oil separator. The cost to incorporate such a system would be approximately $20,000 – $30,000.

Can an existing plant be retrofitted with a plate and frame if you already have a shell and tube for underfloor and snow melt heating?
The Smart heat will do that, but if you have a brine underfloor vs a glycol floor, then we need to keep it separate from the shell and tube.

Can heat recovery projects be expanded on in the future?
Absolutely. The main point is to have the reclaim condenser (Ammonia to glycol P&F) and the water to glycol P&F in place with a cooling tower. If heat is not used in the rink building, it would be rejected to the cooling tower.
a. For example, if we were to implement a heat recovery project in the arena, could it be expanded to a pool in the same facility?
Yes. We have completed pool heat reclaim projects. When the time is right, you would just need to bring the warm glycol loop close to your pool and add another P&F glycol to the pool water.

How many recovery projects have been done to heat pools? Have there been any case studies completed?
We have done at least two that I have personally been involved in – one in Pointe Claire, Montreal and the other in O’Fallon, IL. We do not have any case studies and no monitoring, but from what we understand, the actual heating requirement seems to be lower than what we had anticipated. That indicates that pools are a great dump for all the waste heat generated that would otherwise be expelled into the atmosphere.

What are the options for waste heat for rinks that operate through the summer (where there isn't a pool)?
Sometimes heat is required in the summertime, for instance in the underfloor, the snow melt and to reheat the air that comes out of the mechanical dehumidifier (Ecodry). Other than that, the heat will be rejected to the cooling tower.

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Could this work with a partial geothermal set up?
Yes - that was done at Upper Canada College in Ontario. We have published a fact sheet on this, please don't hesitate to ask for it.

How much heat can be recovered from a 100hp compressor? And how much of it useful?
A 100 HP compressor in rink application is about 70 Tr of refrigeration load. Taking into account the motor power, we will end up with approximately 90 TR of heat rejection, which equates to about 1 million of BTU or 292 KW of heat. Approximately 7 to 12% of this could be used as high grade reclaim (hot water heating). The rest would be to warm glycol at 95°F - 100°F and circulate it within the building mechanical system as the air handler unit (to warm fresh air intake, for example).

What do we do with the heat when it is not needed?
When it is not needed, it is rejected outside to the cooling tower. It could also be stored into a radiant infloor or concrete stand as a bank and reused later.

When using CO2, do you use transcritical or subcritical? Has CIMCO used direct CO2 to the pad (instead of glycol)?
Depending on the region and season, we might be able to be in subcritical mode all the time, but heat for reclaim is minimal. Normally we design for transcritical operation, and we can then use it on longer seasons, a southern location or when heat is needed. We have installed many CO2 rink systems, over 50 now in North America, from Alaska to California, Nova Scotia to Vancouver. We have done many direct floors in Qc, On, ND and Alaska.

Does Floating Head Controls minimize the amount of heat that is available for recovery?
Yes it does. It's a compromise – you get more efficiency, higher COP and use less energy consumption for refrigeration, but not as much heat reclaim. Or you get a more stable COP, with higher energy consumption for refrigeration, but free heat.

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On design:

It is a well-known fact that the evaporative condenser offers the highest efficiency for a refrigeration system. Your proposal is a PHE. It has lower efficiency, requires cooling tower, pumps and requires much more maintenance. Please explain.
A cooling tower requires less initial investment, weighs less, offers similar water circulation and similar water consumption as an evaporative condenser. However, there is no steel ammonia coil inside that would eventually scale, rust and deteriorate. This means a cooling tower requires less maintenance and lasts longer. You are correct that we are adding another set of heat exchangers, which means we need to slightly increase the condensing temperature and add an additional glycol pump. We size the plate heat exchanger with a very close approach, so we condense at 100°F (vs the normal 95°F with the evaporative condenser). Overall, the gain in heat reclaim significantly outweighs the increase in compressor energy and pump. Unless, of course, the price of oil barrel is negative J**What's the typical COP in the heat recovery configuration?**
With our standard Ecochill configuration, screw compressors and P&F we achieve a COP of 3.42 on the cold side with heat reclaim mode functioning. This would produce a COP of 4.44 in heat.

What type of heat exchanger do you use to reclaim 4kW of heat from the refrigeration plant?
Plate and frame as the condenser to warm up glycol at 35°C.

Is there a CO2 version of ecochill? If so, how do you deal with the low critical pressure?
Yes, it called the ECO2CHILL. The discharge side and heat reclaim exchanger (including piping) are designed for 1500 PSI.

Do the Smart Dry dehumidifiers systems use NG/Dessicant wheels or are they all electric?
We have a mechanical dehumidifier called the Ecodry. It includes a cooling coil connected to the refrigeration plant for dehumidification and air conditioning requirements, in addition to a heating coil connected to the heat reclaim side for reheating after dehumidification and heating of the incoming fresh air. There is also an option to have an independent NG or electrical dehumidifier.

What is a Smart Compressor? What is the difference with the typical reciprocating? It is only the control system with VFD? Which compressor brand do you offer?
The main feature is the control system that constantly monitors the operation, efficiency and maintenance of the compressors. We typically use the Mycom M series, newly developed and with higher energy efficiency than the older A or B model. The manufacturer requires less overhauls or longer operating hours before overhauls, in the range of 15 000 to 25 000 hours before maintenance.

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How invasive is it to the facility?
Taking a team approach is crucial with the mechanical designer and HVAC system contractor. If the design is fully coordinated, the requirement is a hydronic warm glycol loop serving the various air and heating elements in the building.

What expertise would we need to bring in to help us with the project?
At CIMCO, we can bring our experience and ideas to the table and build a business case with the owners and operators. The team approach with the mechanical system designer is also crucial to fully integrate all systems.

On implementation:

What are the technical challenges, limitations and solutions for using waste heat in retrofit situations - particularly heating of bleachers and dressing rooms? What are the economics typically like for this type of scenario? Any detailed case studies, including economic analysis would be appreciated.
The biggest challenge in existing facilities are hydronic heating systems that were designed for 130°F water temperature from the boilers. Ecochill produce 95 to 100 glycol. Generally speaking, existing systems may not be efficient with lower glycol infeed temperature. Canmet, the Energy Mines and Resources Canada technical laboratory has done many cases studies and published literature about these types of retrofits. Those are available online on the CNRC sites and we could built a case study for your specific project.

Did I hear that business case right? $4M cost, $2M incentives, and $50k annual savings? 40-year simple payback?
Yes. We have done over 200 projects in Canada. Normally, the initial increase in our price needs to take into consideration the savings on the mechanical side, as boilers are no longer necessary for examples. Our full Ecochill approach includes the entire building control system, heat production and rink space air handling and dehumidification system. Generally, independent companies demonstrate that simple payback would be between 8 to 15 years, depending on the price of electricity and gas.

What is the added cost of all these options as compared to replacing ‘like for like’? And what is the average payback period/ROI in energy savings for a single sheet facility?
Each case is different - it could be in the range of 30% more than a ‘like for like’ replacement, excluding savings on the boiler side. ROI varies between 8 to 15 years, depending on energy price and location.

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What are some lessons learned when implementing, commissioning and operating these systems?
We need to monitor and make necessary adjustments to the system for full-year operation. If we don't supply the entire control system of the building, communication with another control system for the building could be a challenge if both systems do not work and communicate together.
As an example, a system may produce heat but the building doesn't require heat, so it rejects it outside. When the building needs heat but the system is not running, boilers are used. Our system would force the building to take heat when it is produced for future need, and for the refrigeration to run when heat is required and store the cold for dehumidification or air conditioning.

Can you share from experience any challenges with other heat recovery projects that we could anticipate?
The biggest challenge is our system producing 95°F warm glycol, when the mechanical designer has (for example) configured his system to use 130°F. In this example, all the produced heat is too low and ends up being wasted.