Michigan Technological University Student Development Complex Ice Plant

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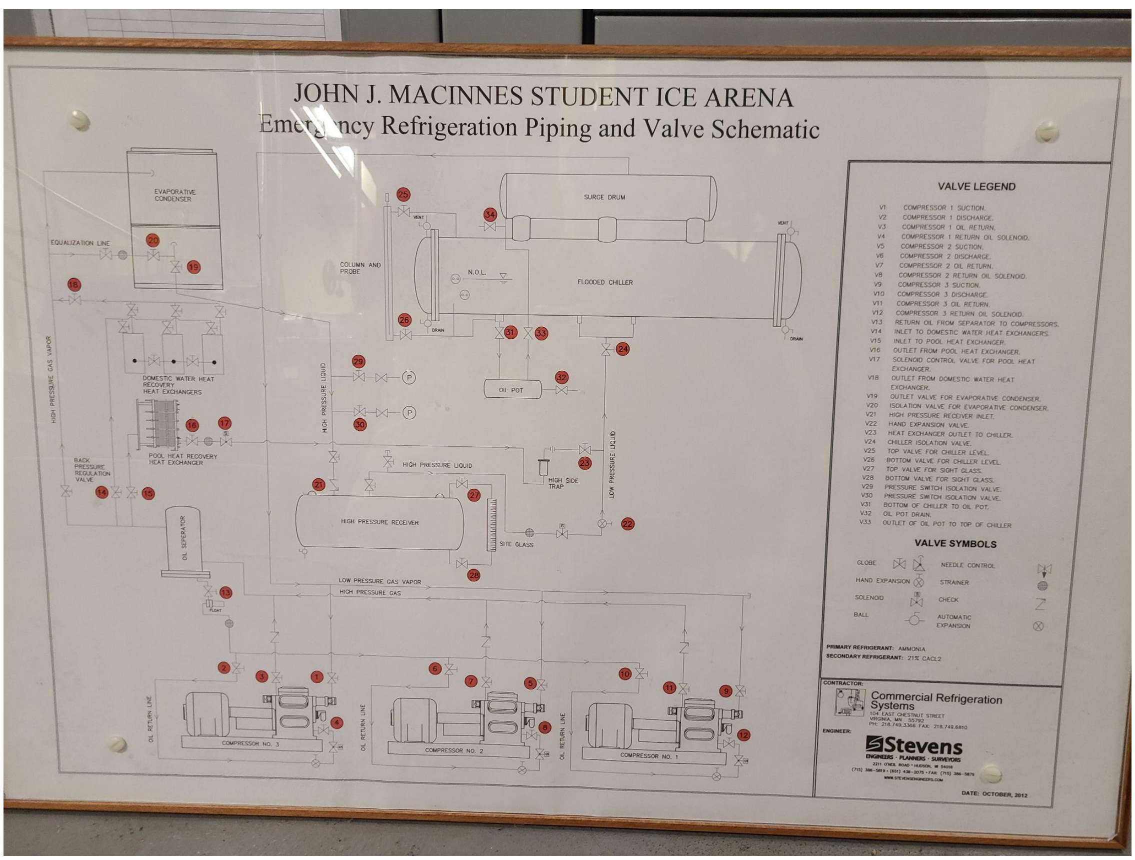
Introduction

The Michigan Technological University Student Development Complex (SDC) Ice Plant was rebuilt in Spring of 2012. This project was completed at a grand total of just over $2 million dollars. This rebuild included the addition of ammonia (R-717) based cooling as opposed to the older R-22 system in an effort to reduce cost, improve safety, and improve efficiency of the ice plant. The SDC also implemented a unique energy savings feature being that waste heat from the compressors is used to heat domestic hot water to the building as well as heat the adjacent swimming pool. It should be noted that the waste heat can not solely heat either system, however, with the implementation of this system the SDC has seen annual savings of roughly $12000-$15000 USD. This report will outline the equipment, functions, maintenance, and general notes for the Michigan Tech SDC Ice Plant.

Equipment

The equipment needed for this operation are 3 compressors, (100hp each) 2 running at a time in the summer, and 1 in the winter. These were set to run in lead, lag, and lap coordination, Heat exchangers are needed for the swimming pool, a defogger (A/C unit) is used to reduce fog and haze indoors , An oil separator is used to help increase life span of the compressors, and an ammonia displacement tank is used as an overflow tank for the currently unused ammonia. A brine is used as the fluid to get pumped through the 12 miles of tubing within the concrete slab. This brine is pumped with two 30hp, 1200 gpm pumps. Some of the heat that is extracted from the ice rink is then used to heat the pool. This requires another ¾ hp pump to pump the pool water to the heat exchanger and back.



Functions

The functions of the ice plant and waste heat usage system are designed to heat the swimming pool. This in turn reduces the cost of heating the pool, saving money in the long run. Underneath the ice rink, there is a roughly 6 inch concrete slab in which 12 miles of tubing is laid. A brine mixture is pumped through the tubing via the brine pumps mentioned in the equipment section. This brine is first chilled with the ammonia (R-717 refrigerant). The chilled brine removes the heat in the concrete slab which in turn freezes the ice and creates the ice rink. Some of the excess heat that is extracted from the ice rink is repurposed to heat the adjacent swimming pool and domestic hot water through a series of heat exchanges. The ammonia containing the heat is ran through a heat exchanger transferring heat to a 35% E.G. fluid. This fluid is then pumped into another heat exchanger that transfers the heat into the domestic hot water and heats the pool. The reasoning for using an additional fluid is because of the risk associated with ammonia contaminating the pool water.

Energy Savings - Ice Arena Heat Recovery

Month	Steam Savings (1,000 lbs)	$$ Savings	Cumulative Savings	
Jul-18	203.4	$ 1,516.03	$ 1,516.03	
Aug-18	195.9	$ 1,203.16	$ 2,719.19	
Sep-18	192.4	$ 1,275.14	$ 3,994.33	
Oct-18	192.2	$ 1,386.38	$ 5,380.71	
Nov-18	189.9	$ 1,729.00	$ 7,109.71	
Dec-18	191.3	$ 1,419.46	$ 8,529.17	
Jan-19	194.73	$ 1,676.98	$ 10,206.15	
Feb-19	174.2	$ 1,367.91	$ 11,574.06	
Mar-19	197.2	$ 1,660.65	$ 13,234.71	
Apr-19	50.1	$ 361.99	$ 13,596.70	
May-19	48	$ 217.92	$ 13,814.62	
Jun-19	193.7	$ 1,197.13	**$ 15,011.75**	FY19 Total Savings
Jul-19	203.4	$ 1,458.81	$ 1,458.81	
Aug-19	195.9	$ 1,215.78	$ 2,674.59	
Sep-19	192.4	$ 1,218.19	$ 3,892.78	
Oct-19	192.2	$ 1,135.04	$ 5,027.82	
Nov-19	189.9	$ 1,425.28	$ 6,453.10	
Dec-19	185.3	$ 1,556.59	$ 8,009.69	
Jan-20	194.7	$ 1,926.88	$ 9,936.57	
Feb-20	186.2	$ 1,535.78	$ 11,472.35	
Mar-20	146.3	$ 1,228.72	$ 12,701.07	
Apr-20	0	$ -	$ 12,701.07	
May-20	0	$ -	$ 12,701.07	
Jun-20	45.2	$ 276.71	**$ 12,977.78**	FY20 Total Savings
Jul-20				

Maintenance/Upkeep

The Ice Complex Plant's is a closed loop system, meaning that all the fluids that are in the system stay within the system and no new fluids are introduced. Because it is a closed loop system, the maintenance regime is generally small. The plant is equipped with multiple monitoring systems, since anhydrous ammonia is being used. These systems are in place to notify a leak in the system so it can be stopped and dealt with before any harm is done. As well as preventing the system from hydrolocking. In regards to the equipment maintenance, the electric motors will likely last roughly 20-30 years, however they need to be greased semi-annually. These motors drive the three compressors. The compressors were rebuilt with new piston rings and gaskets at 20,000 hours. This 20,000 hours is typical for these compressors. Other than new piston rings and gaskets, the compressors need little maintenance, but does include checking the oil and greasing bearings. The pumps within the system require their seals to be replaced every 2-4 years, depending on their condition. This is general routine maintenance for all the pumps in the system. The most expensive maintenance piece to this system is the replacing of the oil filters. The oil can contain levels of ammonia from running through the equipment. Due to this, the job must be contracted out to personnel that are adequately trained to handle the chemical. Since running the plant, there have been some unforeseen issues. One issue was that the heat exchangers were building up sediment on the plates. To deal with this issue, the maintenance team modified the heat exchangers so that they are more easily replaced or cleaned without it being a time-consuming task. As mentioned before, the plant has had trouble regulating and equalizing the oil level in the three separate compressors. This became a daily check to ensure that the oil levels have been equalized, especially important when changing over which compressors are currently operating.

General

The new ice plant was implemented in 2012, the expected lifespan of the system is expected to be roughly 50 years. This is realistic so long as regular maintenance is conducted and the system is run under normal operating conditions. There are few special requirements required to work around once the system has been set in place. Aside from special training which is required to work around the anhydrous ammonia, the system is relatively safe. Interesting factoids about the system include the fact that there are over 12 miles of tubing beneath the ice surface, as well as the choice to use ammonia due to it’s normally hazardous nature. Some correlations that were drawn between the ice plant and heat transfer were, the heat loss through the pipe wall on the chilled piping for the ammonia and the brine, this heat loss could be minimized by insulating the pipe. Another correlation was the use of ammonia as the refrigerant for the system due to its ideal insulating properties.