Plymouth State University

Geothermal System

The PSU **geothermal heat pump** system is a vertical closed loop system that actively pumps liquid to or from 260 wells drilled approximately 180 ft below the parking lot. This design takes advantage of moderate temperatures in the shallow ground to boost efficiency and reduce operational costs.

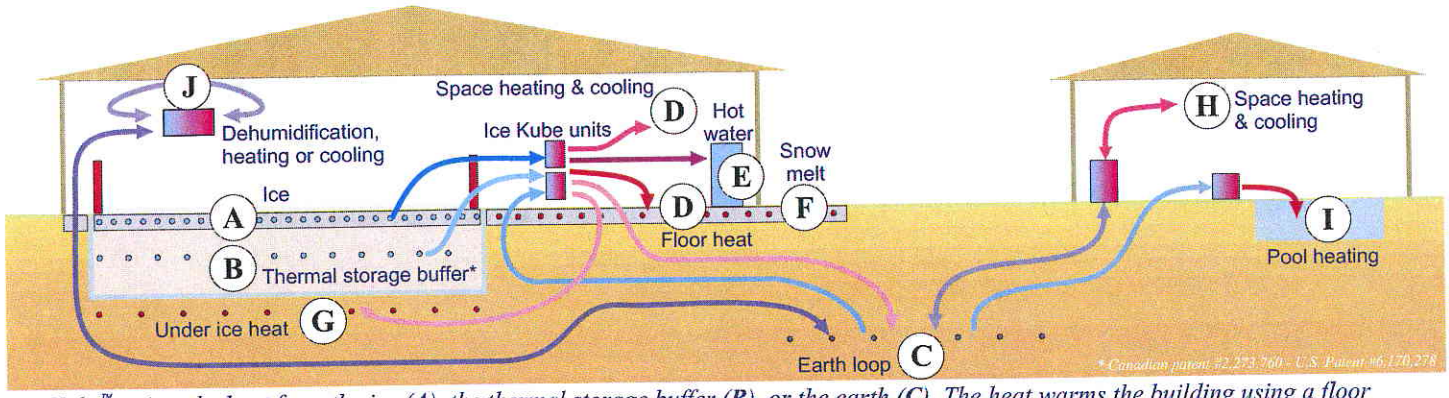
Like a refrigerator or air conditioner, this system uses a heat pump to force the transfer of heat. Heat pumps can capture heat from a cool area and transfer it to a warm area, against the natural direction of flow, or they can enhance the natural flow of heat from a warm area to a cool one. The core of the heat pump is a loop of refrigerant pumped through a vapor-compression refrigeration cycle that moves heat. Heat pumps are always more efficient than pure electric heating, even when extracting heat from air.

But unlike an air-source heat pump, which extracts or exhausts heat to or from the outside air, a ground-source heat pump exchanges heat with the ground. This is much more efficient because underground temperatures are relatively stable through the year. Seasonal variations drop off with depth and disappear below 10 m due to thermal inertia. Like a cave, the shallow ground temperature is warmer than the air above during the winter and cooler than the air in the summer. A ground-source heat pump extracts that ground heat in the winter (heating) and exhausts heat back into the ground in the summer (cooling).

Geothermal heat pumps are also known by a variety of other names, including **geoexchange, earth-coupled, earth energy, ground-source** or **water-source heat pump**. The engineering and scientific community tend to prefer the terms "geoexchange" or "ground-source heat pumps" because very little of the heat originates from true geological sources. Instead, these pumps draw energy from shallow ground heated by the sun in the summer. Genuine geothermal energy from the core of Earth is available only in places where volcanic activity comes close to the surface, and can usually be extracted without the help of a heat pump.

www.icekubeheat.com

Take your heat right out of the ice!



*Ice Kube™ units take heat from the ice (**A**), the thermal storage buffer (**B**), or the earth (**C**). The heat warms the building using a floor heating system (**D**) or a forced air system. It also makes hot water (**E**), melts snow scraped off the ice or from the sidewalks around the building (**F**) and prevents penetration of frost under the rink floor(G). Heat pumps in nearby buildings draw heat from the earth loop for space heating and air conditioning (H) or to warm a pool (I). The Thermal Storage Buffer (**B**) is chilled at off-peak times to provide heat for the building, while at the same time building refrigeration capacity for peak times the next day. Heat pumps designed to dehumidify the ice area (J) also heat and cool the arena by drawing heat from the earth loop (**C**) or rejecting heat to the earth loop.*

Simple to operate: Modular system design builds redundancy into the system. If a compressor or pump fails, the other units maintain the ice. "Off-the-shelf" components are easily replaced by local refrigeration mechanics supplied by local refrigeration distributors. Trained technicians are not needed to start up and shut down the system, and regular compressor rebuilds are not required. Oil does not have to be drained from the chiller regularly. In many jurisdictions, less highly trained operators can legally operate these systems.

Great ice quality: The mass of the patented "Thermal Storage Buffer" built into the ice rink floor maintains the ice in the event of a power failure. It helps create very consistent, even ice temperatures even during heavy use. It is a heat source for the building at "off peak" times, and reduces peak electrical demand at peak times. It almost eliminates "emergency" service calls and enhances the reliability of the system.

Six or eight Ice Kube units make ice in average full size hockey arena year round. Equipment is easily serviced by local refrigeration mechanics using "off-the-shelf" components supplied by local refrigeration equipment distributors.

Good for the Environment: Reduced energy consumption means lower operating cost. It also means reduced greenhouse gas emissions. In fact, depending on how electricity is generated, greenhouse gas emissions can be virtually eliminated. The equipment uses R404A refrigerant, a non-toxic, non-ozone depleting refrigerant. Each heat pump contains only 6 kg (13 lbs) of refrigerant. (A conventional ice plant requires 300-600 kg (650-1,300 lbs) of refrigerant.

Safety: The potential liability of toxic ammonia leaks is totally eliminated, and the potential danger of carbon monoxide and other dangers associated with burning fossil fuels to heat the building is gone.

Other applications: Ice Kube™ Systems manufactures heavy-duty, reliable water to water heat pumps that operates under a wide temperature range. Because of the extreme temperature range they operate under they are used in many different applications, including refrigeration for hockey and curling arenas, thermal ice storage applications, systems to maintain permafrost in northern buildings and process cooling and heat recovery. The large temperature range capability makes them very suitable in ground-source, or GeoExchange heat pump systems in many different types of facilities, including schools, office buildings, apartment buildings and condominiums, etc.