

## Energy Analysis of Geothermal Heat Pump for Indoor Aquatic Facilities

*Rama Ponnaiah Murugan, Amornvadee Veawab and Adisorn Aroonwilas  
Faculty of Engineering and Applied Science, University of Regina, Canada*

### Summary

The heat pump technology is known for its efficient energy conversion delivering heat more than work input to the compressor. As such, the integration of heat pumps into community heating systems would allow an upgrade of low-quality to high-quality heat, thus increasing energy efficiency of the entire heating system. This study evaluates the feasibility of using a geothermal heat pump system for clean heating of an indoor aquatic facility with an aim to support the City of Regina's commitment to net-zero greenhouse gas emissions by the year 2050. A comprehensive energy audit of an indoor aquatic facility was carried out using our in-house energy model to determine heating load and optimize for an energy-efficient heating system. The performance of the integrated geothermal heat pump and indoor-aquatic heating system was determined with the help of the process simulator Aspen Plus.

### Method

An energy flow model was developed for both pool water and air space of a standard indoor swimming pool with the dimension of 25 m × 12.5 m × 2 m. As shown in Figures 1-2, the analysis of heating load accounted for: 1) evaporation-, convection- and radiation-types of heat transfer between pool water and indoor ambient air, 2) heat requirement for water refilling, 3) transmission heat loss through wall, roof, door and windows, and 4) heat loss due to air ventilation. The ASHRAE standard 62.1 was used for defining values of important indoor air and pool water parameters associated with HVAC. The data of monthly outdoor air temperature and relative humidity of Regina were obtained from the Environment Canada. The heat recovery unit was incorporated in the heating system to recover heat from the hot and moist indoor air before releasing it to the outdoor environment.

### Results

The heating load for the indoor aquatic facility varies by season. The highest heating load is supplied in winter months, followed by fall, spring and summer. The air space of the swimming pool requires a much greater heating load than the pool water. The majority of heating load for the air space is used for air ventilation and for compensating the transmission heat loss from the building, both of which greatly depend on outdoor ambient temperatures. The heating load for maintaining the pool water temperature is primarily attributed to the heat loss due to water evaporation and the heat required for water refilling. The heat loss due to convection and radiation from pool water as well as the heat loss due to air infiltration plays a minor role in the heating requirement of the indoor aquatic facility. To accommodate the high heating load, a ground-source heat pump system with vertical group loops is recommended.

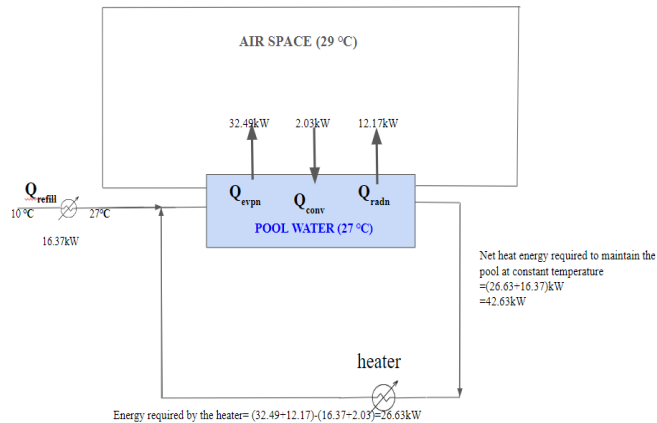


Figure 1: Heat components for the pool water.

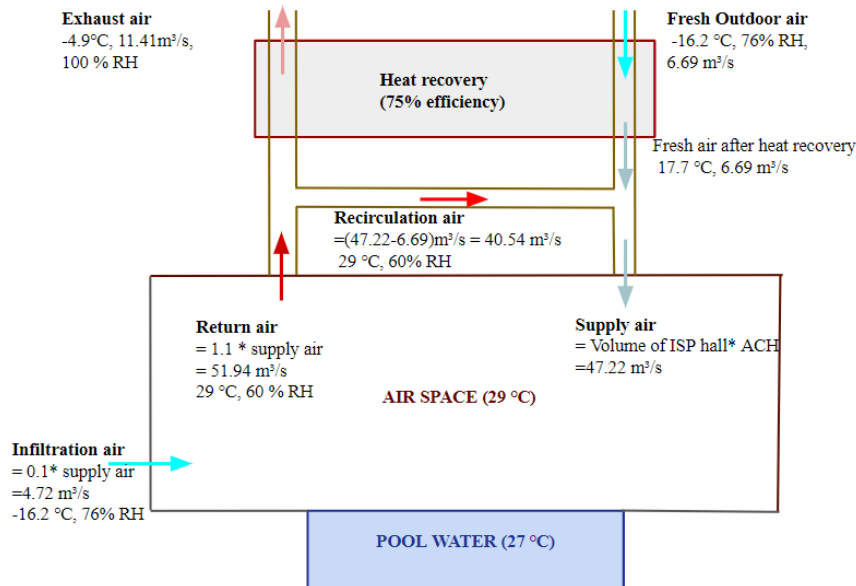


Figure 2: Heat components for the air space.

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