Drain Water Heat Recovery at the University of Guelph

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Abstract. In this paper we present the design of a heat recovery system for the University of Guelph's Athletic Centre pools that will increase energy efficiency and save the University money. Counter-flow heat exchangers will be installed on the overflow system of the pools and direct recovered heat into the water heaters that provide hot water for the building. The design incorporates several new components into the existing pool plumbing system in the Athletic Centre mechanical room.

Key words: Drain water heat recovery (DWHR), $Power - Pipe^{TM}$, Energy Efficiency

1 Introduction

High energy costs and an increasing awareness of the environmental consequences of our actions have prompted many institutions to increase the efficiency with which they use energy. The University of Guelph uses large amounts of energy to heat its Athletic Centre's two large swimming pools. While the pools are in use, some of the water overflows and is replaced with new city water. The warm water removed from the pool is discarded to the sewers along with the heat energy it contains. Recovering a portion of the heat energy in this effluent water would allow the University of Guelph to save money and decrease its greenhouse gas emissions which are inherent to energy production on the campus.

A system to recover waste energy from the pool overflow would interface with the existing plumbing of the Athletic Centre. It is necessary that the integrity of the potable water systems in the Athletic Centre be considered and protected. The implementation of an energy recovery system should not disrupt the regular operation of the Athletic Centre and should require little upkeep. Considering one of the reasons for installing such an energy recovery system is to save money, any system installed should have a payback period well within its useful life so that there would be confidence that money will not be lost on the project.

A plan for the implementation of a drain water heat recovery (DWHR) system has been created which would allow for the recovery of 40% to 50% of the waste energy which is currently lost to the sewer system. The system would attach to the pool water drain pipe and, through the use of counter-flow heat exchangers, preheat city water entering the building as it goes to the water heaters which service the building's showers and faucets.

2 Overall Design

The energy recovery system that has been designed incorporates several new components into the existing plumbing system in the Athletic Centre's pool mechanical room. These new components include four counter-flow heat exchangers, pipe extensions for fresh water, and new piping to convey the heated water from the heat exchangers to the two water heaters. The additions to this system will pre-heat otherwise cold city water, using heated pool water effluent, before it enters the existing water heaters. This will reduce the amount of energy required by the water heaters to heat the incoming water.

3 Detailed Design

3.1 Existing Pool Overflow System

The Athletic Centre has two pools, the Red Pool and the Gold Pool, with capacities of 605 m^3 and 943 m^3, respectively. The Red Pool is maintained at $\sim 30^o$C while the Gold Pool is maintained at $\sim 27^o$C. Each pool has its own water filtration system. While the pools are in use, this system removes a portion of the pool water to be recycled. The overflow from each pool is collected via troughs, along the edges of the pools, and is piped to large concrete reservoirs located in the mechanical room where the water is filtered.

As the water is being filtered, a portion of it is discarded through an overflow pipe in each concrete reservoir and replaced with fresh water. This overflow pipe leads to a sump. Approximately 27 m^3/day overflows from each pool's filtration reservoir. The overflow is then pumped, using sump pumps, into the City of Guelph sewer system.

3.2 Heat Exchanger Units

Energy recovery in the system will be facilitated through the use of RenewABILITY Energy Inc.'s counter flow heat exchangers ($Power - Pipe^{TM}$), shown in Figure 1. The system will use 4, 60 inch long $Power - Pipe^{TM}$ units. Two units will be used for the Red Pool, and two for the Gold Pool. They will be attached to the effluent pipes leaving the pools' filtration reservoirs as the discarded water drops into the sumps.

3.3 City Water

Water to be heated and used in the Athletic Centre's showers and faucets enters the building and passes through the two hot water heaters in the mechanical room. The water temperature prior to reaching the hot water heaters is $\sim 10^oC$. This water will be redirected through the $Power - Pipe^{TM}$ heat exchangers connected to the concrete reservoirs. The preheated water will then be sent to the water heaters. This will reduce the amount of energy required by the water heaters to heat the influent water.

3.4 Water Heaters

There are two water heaters in the mechanical room. These water heaters supply hot water to the showers and bathrooms in both the men's and women's change rooms. Water passing through these water heaters is heated using steam which is generated on site at the University of Guelph. The preheated water coming from the $Power - Pipe^{TM}$ units will reduce the amount of energy needed to heat incoming city water.

3.5 New Pipe Installation

PVC and cast iron piping will be installed to accommodate the transfer of the preheated water from the $Power - Pipe^{TM}$ units to the water heaters. The piping will be added for both the Red Pool and Gold Pool overflows. These pipes will be installed near the ceiling level next to existing pipes in the mechanical room.

4 Discussion

The proposed design effectively addresses the University of Guelph's need to reduce its energy costs while maintaining present services and decreasing greenhouse gas emissions. Due to the method which is used to keep the pool water clean, a great deal of energy is wasted in the form of heat which has been imparted to the pool water. The Athletic Centre pool heating system discards 3.6 cubic meters of warm water per hour for approximately 4000 hours each year. Considering that heating the water costs $0.0453/kWh, the University loses almost $14 000 in wasted energy every year.

The main goal of the system is to save the University money. The system must have a rate of return on investment well within its useful life. It is estimated that the total capital cost of the complete $Power - Pipe^{TM}$ system, including installation, would be $15,000. Based on an analysis of the proposed system, it is estimated that 35 kW of energy can be recoverd from the discarded pool water during hours of operation. On an annual basis, this works out to approximately 138,000 kWh, for a total savings of $6,700. The total savings over the useful life of 30 years are $200,000. Since the system has no moving parts, the maintenance requirements are very low. When considering the annual cost savings of the system along with its capital cost, a 2.2 year payback period is obtained. This is well within the expected useful life of the system. Additionally, the system indirectly reduces the University of Guelph's greenhouse gas emissions by improving energy efficiency, therefore decreasing energy production needs and the emissions inherent to them. These energy savings are all provided without decreasing the temperature at which the pool water is maintained, or changing the operating hours, and does not sacrifice any services.

The $Power - Pipe^{TM}$ drain water heat recovery system is an ideal candidate to help address the University of Guelph's need to reduce operating costs by improving energy efficiency as well as reducing greenhouse gas emissions without sacrificing services.

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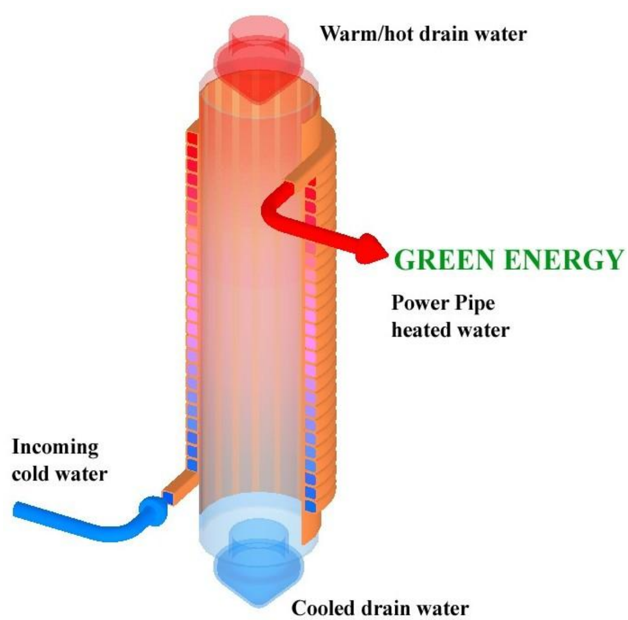

Fig. 1. $Power - Pipe^{TM}$ DWHR System [1]