Alternate Public Pool Design: UV Treatment and Arena Heat Recovery

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Abstract --This paper presents a half size Olympic pool system focusing on renewable energy and alternatives to chemical treatment. The aim of this design is to reduce the harmful chemical effects on swimmers as well as to minimize the pool’s energy requirements from a utility source. As a means of primary pool water treatment, a low pressure low intensity ultraviolet (UV) water treatment system is used with a contact time of 1.8 s. This system includes 3 light banks containing 16 bulbs each which can reduce chlorine levels from 2.0 ppm to 0.5 ppm. A chlorine residual of 0.5 ppm must be maintained in the pool at all times as required by the Ontario Ministry of Health [1]. Calculations were conducted on the design to ensure that the UV treatment and heating systems are both suitable alternatives to the current standards in Ontario pool treatment and heating methods. The proposed system design also includes a complete and integrated circulation system including; drainage, filters, pump requirements, pH and chlorine controls, in addition to the UV treatment and heating unit. The overall cost of this project has been estimated at $1.5 million, with an approximated $300,000 in annual operation costs.

Index Terms --UV treatment, pool disinfection, heat recovery, public pool design, chlorine reduction

I. INTRODUCTION

The primary goal of this design is to provide a half Olympic sized, outdoor pool to be located adjacent to the existing arena facility. The pool must incorporate both non-chemical treatment and renewable energy sources. The design consists of water recirculation, treatment and heating systems. Currently in Ontario the only method of treatment permitted in public pools is that of chemical disinfection [2]. By incorporating new UV technology as the primary method of treatment, we will successfully reduce chemical usage to the lowest permitted Ontario standard, 0.5 ppm [1]. Recovering waste heat from ice rink operations is also a new, yet successful, method of pool heating. A heat recovery pump installed inline with the current arena cooling system will transfer waste heat from the arena’s cooling system into the pool’s water. This will maintain a temperature of 25°C.

The pool recirculation system is designed to meet typical treatment turn over rates for Ontario public pools as well as accommodating required contact time for the in-line UV treatment. The pre-determined recirculation flow rates were the basis behind both the pool drainage and water treatment designs.

The milestone for this project focuses on the circulation of pool water and associated water quality parameters under normal operating conditions. By modeling the pool’s water circulation and quality fluctuations using EPAnet, the system controls are optimized for maximum chlorination performance.

II. OVERALL DESIGN AND MAJOR COMPONENTS

The pool has been designed with a total volume of 625m³. The deepest point within the pool is 3m in depth, while the shallowest point is 1m. A main drain will act as the primary drainage device, operating in unison with an overflow gutter/skimmer system. Both drainage units will flow to a surge tank within a treatment building, built onto the south eastern most part of the arena.

Pool disinfection and water heating will occur within the treatment building before the water is returned, and evenly distributed, to the pool. Disinfection treatment includes strainers, dual media sand/anthracite filtration, pH control, UV and chlorination treatment. A network of pumps and PVC piping connects these systems into one unified operating unit. Figure 1 illustrates the pool and complete treatment system.

All Ontario Regulations must be adhered to before opening the pool to public use, despite being excluded from this report.

III. DISCUSSION OF DETAILED DESIGN

Drainage - To achieve the required turn over rate of 6 hrs, the pool’s main drain is sized to provide 2.9E-2 m³/s [3]. To fall below the max velocity of 0.45m/s, for public pool drains, the pipe diameter was set at 0.30m which provided a constant velocity of 0.40m/s [3]. The surge tank volume is determined based on maximum loading of the pool, as to regulate water level fluctuations within the pool. The volume of the surge tank was set to 9m³ with a constant pool of 1m³. The additional 8m³ volume in the surge tank is reserved for overflow purposes.

Water is drawn from the surge tank through the treatment loop of 0.30m PVC pipe at a rate of 2.9x10^-2 m³/s.

Filtration - The treatment begins with passage through granular filtration. Two dual media, sand/anthracite filters are used with dimensions 2.1m x 2.1 m and a backwash velocity of 0.013 m/s. Designed in accordance to standard practices [4].

Heat Exchanger - The amount of heat energy lost from the pool due to evaporation, conduction and radiation during the typical coldest day in May, 5°C, is 5.33kW [5]. The heat available from the arena during the same weather conditions is 543.02 kW [2]. Hence; the arena heat exchanger is more than sufficient to compensate for maximum heat losses during normal operating weather conditions. A heat pump is installed online with the current arena cooling system to provide the circulating pool water with a constant temperature of 25°C.
UV Treatment - Based on a low pressure low intensity UV treatment system, a contact time of 1.8s is required to provide adequate disinfection [4]. The designed system contains 3 banks of bulbs, each bank containing 16 bulbs. Each bank is 0.3m in length and has diameter the same as the inflow and outflow pipe (0.3m). This system yields a retention time of 2.17s.

Chlorination - Abiding by the Ontario Ministry of Health standards, a chlorine residual of 0.5 ppm is required in all public swimming facilities [1]. A liquid feed system is used to inject sodium hypochlorite into the system. This system contains a sensor and monitors the level of chlorine residual present in the pool and adjusts release rates accordingly. In the event of a required shock treatment 1.17E-2m³ of liquid sodium hypochlorite will be required [6].

pH adjustment - The Ontario Ministry of Health requires that the pH of swimming pools must be maintained within the range of 7.2 - 7.8. The pH adjustment monitor is coupled with the chlorination system. A pH of 7.5 is maintained with the addition of either muriatic acid or soda ash [7].

System controls will be in place to measure and adjust water parameters in real time. By placing feedback controls on the treatment system, the disinfection and heating may be regulated at all times, while being checked daily by maintenance staff to ensure accuracy.

IV. CONCLUSIONS

The design of this pool system focuses on alternate methods for pool water treatment. After researching pool designs, it is evident that treatment choice is merely one facet in the design of a pool. Chemical treatment is not completely removed from the treatment process, as residual within the pool is a factor which must be included at all times [1]. In future designs the layout of treatment system should be altered to maximize pump efficiency in transporting water through the system. Perlite filtration media can also be substituted within the sand filters to reduce the overall size of the system. For the design to be feasible, the pool location must be in close proximity to an arena with sufficient heat output.

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REFERENCES