Off-grid Solar Powered Water Treatment System for a Swimming Pool

Graham Aikenhead, Christina Cholkan, Ryan Lacharity, and Dan Roth

Abstract. A water treatment system was designed for an existing pool structure at the Cambodian Children’s Fund Kids Camp in Cambodia. The system is cost effective and reduces the use of chlorine and providing a safe and enjoyable environment. High rate sand filtration and copper/silver ionization were selected as the methods of water treatment. The disinfection system combines of copper and silver ions and low levels of chlorine to eliminate bacteria and algae. To satisfy the need for running the system off-grid, solar panels were employed as the sole power source for the design. Proposed modifications to the existing pool structure reduced pool water volume, resulting in a lower estimated capital project cost of $52,900.

Key words: Copper/Silver Ionization, pool water treatment, solar power

1 Introduction

The Cambodian Children’s Fund (CCF) is a non-profit organization, which is developing a facility in the Kampong Cham province called the “Kids Camp” that will serve as an educational and retreat center. This site is the location of an existing concrete pool structure in need of a water treatment system, designed by the project team. The major contraints for the project include off-grid power production, maximum occupancy of 50 people, and ensuring pool water quality complies with World Health Organization (WHO) guidelines for Safe Recreational Water Environments standards [1]. The criteria to optimize the water treatment system consists of reducing chlorine, minimizing system cost, sourcing equipment locally to Cambodia, minimizing difficulty and frequency of system maintenance, reducing adverse environmental impacts, and maximizing the safety and function of the design. The major assumptions for the final design include a pool volume of 210,000 US Gallons, sufficient sourcewater quality for use in pumps and treatment systems, modification of existing pool and gazebo structure is viable pending approval of a Structural Engineer, and the proposed site plan is an adequate representation of the site (see Figure 2). In order to meet the constraints and criteria, four different treatment systems, three different pool structure changes, and three different filtration systems were considered. Cost, local availability, and equipment performance determined the final selection of equipment.

2 Conceptual Design/Methodology

The water treatment system design consists of a filtration and disinfection system powered by solar energy. Solar pumps provide circulation through sand filters and copper-silver ionizers in order to treat the pool water. The creation of a modular pool system was selected base on a series of design iterations which allows for two separate treatment and power systems in case of failure or low solar input. This also creates a safer environment for children who are not able to swim well which is shown in the process diagram Figure [1].

3 Detailed Design

3.1 Structural Design

Modifications were designed to the existing 210,000 US gallon structure to reduce the volume of water to be treated. Two concrete dividing walls are to be constructed, eliminating the middle section of the pool. These modifications resulted in one shallow 23,000 US gallon pool and one deep 74,000 US gallon pool.

![Fig. 1. Pool Piping Diagram](image)

3.2 Pool Water Circulation

An 8 hour turnover period and a flow rate of 12 m3/s is required for the pool water to meet WHO guidelines.
For the shallow pool one Lorentz PS600 Badu pump was selected to meet the above specification with a head loss of 5.4 ft through the circulation system. For the deep pool three of the Lorentz pumps were needed in parallel to get the required flow rate with a head loss of 28.7 ft.

The main piping lines for the circulation system of the deep pool measure 2.5” in diameter while the main lines for the shallow pool measure 2” in diameter. Both pool systems contain 1.5” diameter piping for the skimmer and jet branches. Due to reconstruction and safety concerns in placing floor drains in both pools, 10 skimmers and jets in the deep pool and 8 skimmers and jets in the shallow pool will provide adequate circulation (Figure 2).

3.3 Powering System

The total power requirement is 2500 Watts, with the shallow and deep pools at 650 Watts and 1850 Watts, respectively. The total power at peak irradiation of the sun is 5600 Watts at 57 V, using 26 ND-216 Sharp panels. Battery modules will be used to keep the pumps and treatment systems operating while providing a one day energy backup for the system. Inadequate power will result in closure of the deep pool allowing the shallow pool to remain operational.

3.4 System Filtration

A Hayward S220T sand filter rated at 52gpm is required for the shallow pool, while two S310T sand filters rated at 98gpm are required for the deep pool which provides extra flow capacity. Backwash lines are provided for cleaning each filter and adjusting circulation pressure which drains the effluent to a holding tank for dechlorination (Figure 2).

3.5 System Water Treatment

The Aquabrite Mark 9 and Mark 10 copper-silver ionization systems were chosen for the deep and shallow pools, respectively. Copper-silver ionization treatment is listed by the WHO as an adequate pool disinfectant in conjunction with chlorine. An Aquamatic chlorine doser is incorporated into the treatment system. Chlorine levels will be maintained at 0.4ppm which will provide proper disinfection for the pool water.

4 Discussion

Designing a water treatment system for an existing pool created unique challenges for the CCF Kids Camp given their constrained budget and site specific conditions. Creating a piping and system layout, working without grid power, and designing without the availability of an accurate site plan were key challenges for the project.

The capital cost was minimized to $52,900 USD; annual operating and maintenance costs are estimated to be $7,300 USD. The creation of a dual pool will allow the camp to phase in one pool at a time, pending budgetary constraints.

Some recommendations to increase the life and optimization of the water treatment system include: creating a detailed model of circulation and treatment systems, and conduct a solar survey of the site for more detailed solar insolation data. In addition, extensions to the integration of the water treatment system with the services offered by the CCF Kid’s Camp such as power-producing playground equipment would be beneficial. Proper training in the operation of the system for on site staff to ensure longevity of the system. Realize, approval of a licensed engineer or professional is required before implementation of this design.

Acknowledgement

We would like to acknowledge the assistance of Rick Petersen and the CCF, and Green Grid Solution

References