Seasonal Energy Storage: Thermal Energy Storage in Lakes

Student

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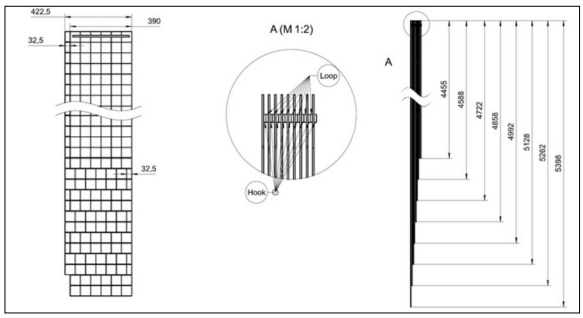
Introduction: Studies show 50% of the energy use in Europe is attributed to heating and hot water demands. In Switzerland, this demand is still largely filled by fossil fuels. One of the greatest challenges in switching to renewable energy sources is the cyclical nature of renewable energy production. Thermal energy storage can bridge the gap between warm summer months with high energy production rates and cold winter months with high heating demands. In Switzerland, traditional methods of thermal energy storage with heated water are limited by land use restrictions. The Bubble in the Lake Storage (BILS) project proposes underwater thermal energy storage in a flexible tank to address the land use restrictions and enable thermal energy storage in Switzerland.

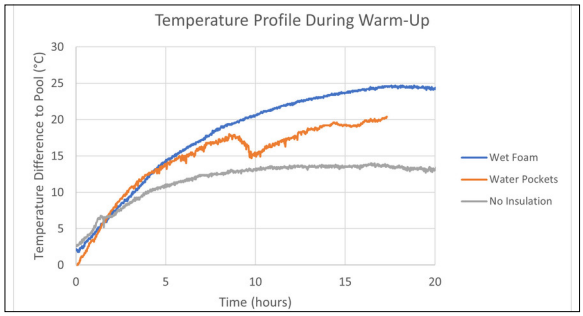
Approach: The goal of this study is to investigate the feasibility of an underwater thermal energy storage design through research, analysis and testing in support of the Bubble In the Lake Storage (BILS) project. Four designs are proposed and analyzed. The critical factors affecting feasibility include thermal conductivity, density, flexibility and center of gravity. The proposed designs were analyzed and ranked. The best design from this process uses “water pocket” insulation, which contain a superabsorbent polymer to immobilize water and limit heat transfer. This concept was designed, built, tested and analyzed on a pilot-scale water reservoir. Installation and heat loss tests were performed at a swimming pool in Zurich during the winter. The ease of installation, stability in the water and heat loss characteristics of the chosen design are tested and analyzed in this project.

Result: The water pocket design provides a stable structure and is easy to handle above ground and underwater. It proved through tests to be a structurally sound construction. Heat transfer characteristics were worse than expected due to flow of ambient pool water into the test article. Integrated insulation or a water-tight attachment method is needed to prevent water flow and improve performance in future designs.

Drawing of insulation concept "water pockets"
Own presentment



Temperature profile of water reservoir while heated up compared to no insulation and a previous design
Own presentment



Testing of design and water reservoir in winter at a local pool
Own presentment

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Subject Area
Energy and Environment