Research AND Development of a Polycarbonate Solar Water Heater

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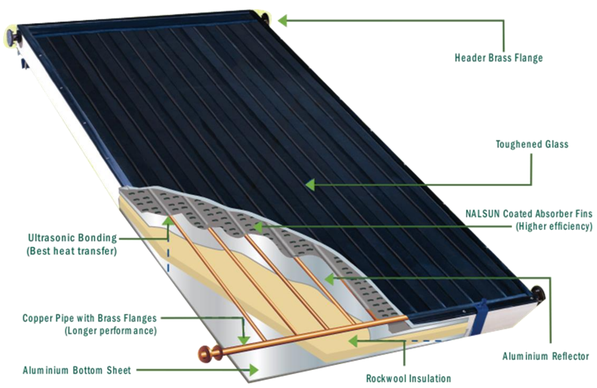
Purpose

Currently, a vast amount of the world's energy is used for creating heat for various industrial processes and for heating buildings. The goal of our research is to create an ecofriendly solution for heat production. Our panel will be:

- Developed with light weight inexpensive materials
- Combining heating methods using both a ground source heat pump and a solar water heater
- Twice as efficient as a natural gas water heater

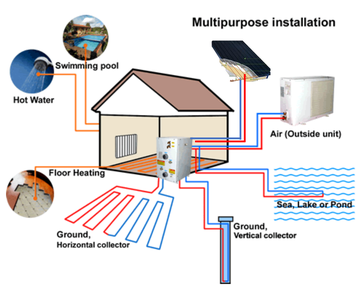
Solar Water Heater Systems

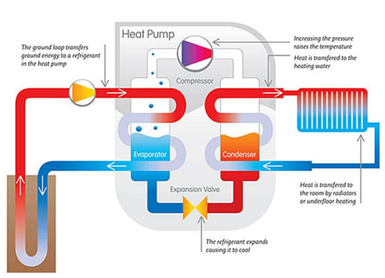
Current commercial designs use copper fins to absorb and transfer heat energy to water within the panel. The heat energy travels along the fin to a pipe which contains water which gets heated. The polycarbonate design utilizes a polycarbonate honeycomb panel. Sunlight hits this panel and transfers energy to the panel which then transfers energy to the water that is flowing through the panel.



Coupling with Heat Pump

The following figures show how a polycarbonate solar water heater could be incorporated into a heat pump system. Heat pump systems gather thermal energy (heat) from the air or by pumping cold water into the ground to absorb heat. Instead for our system, cold water flows out of the heat pump and into the solar water heater. The water moves through the panel and absorbs the Sun's energy and warms up. Our system was specifically designed to produce a large volume of warm water that is sent back into the heat pump and turned into a smaller volume of hot water. This hot water is then used directly or used with a radiant heating system to heat homes. The water is then sent back to the solar water heater to repeat the process.





Testing the Solar Water Heater

Motivation & Efficiency Calculations

The motivation for this project came from the theoretical efficiency calculations comparing current commercial copper fin solar water heaters to polycarbonate solar water heaters. The theoretical calculations show that the polycarbonate solar water heater design is over three times more efficient than the copper fin design being used today. Despite having a much lower thermal conductivity, the shorter distance that the heat has to transfer causes the polycarbonate design to be more efficient. This led us to design and construct a prototype that we could test.

Copper Fin

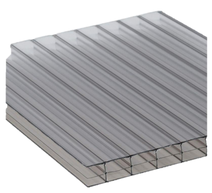
$$K_{copper} = 400\ \frac{W}{m^{\circ}C}\quad L_{copper} = 0.038m\quad A = 0.01951m^2$$

$$\frac{\frac{Q}{t}}{\Delta T} = \frac{KA}{L} = \frac{(400\ \frac{W}{m^{\circ}C})(0.01951m^2)}{(0.038m)} = 205\ W/^{\circ}C$$

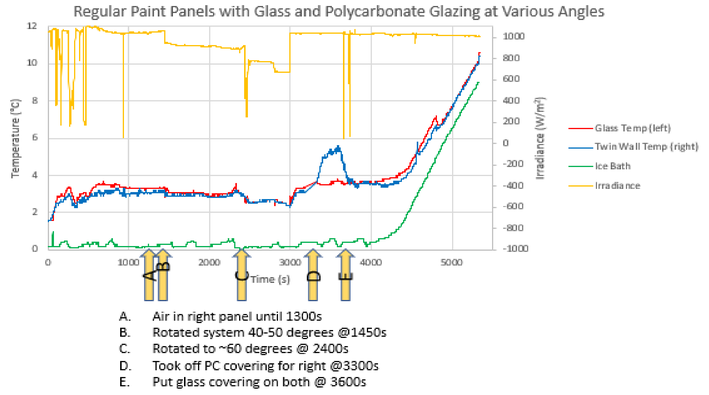
Polycarbonate Sheet

$$K_{poly} = 0.22\ \frac{W}{m^{\circ}C}\ L_{poly} = 0.0005m\quad A = 1.49m^2$$

$$\frac{\frac{Q}{t}}{\Delta T} = \frac{KA}{L} = \frac{(0.22\ \frac{W}{m^{\circ}C})(1.49m^2)}{(0.0005m)} = 656\ W/^{\circ}C$$



Previous Results



A. Air in right panel until 1300s
B. Rotated system 40-50 degrees @1450s
C. Rotated to ~60 degrees @ 2400s
D. Took off PC covering for right @3300s
E. Put glass covering on both @ 3600s

Applications

The solar powered water heater will have various implementations that could be used for various forms of industrial uses. One possible use for the solar water heater is for dairy farms (mainly in Wisconsin). Much of there energy costs go towards heating, which has recently led to the failure of some farms.

Continuation of Research

New panels will be developed to the test parameters of the system and how they affect the overall efficiency of the panel. Variables that will be tested include:

- Designing new panels with similar materials as previously used, as well as using the same testing system.
- Using both polycarbonate twin wall and glass as the front panel
- Making the panels twice as long to, in theory, yield results of a greater temperature change of the water.
- Painting the housing unit white to achieve a more accurate reading of the temperature difference due to only the panels.

This will accentuate the temperature difference of the specific variable that we will be testing, keeping it a controlled experiment. The ultimate goal of this research project is to produce a low-cost, yet efficient renewable energy heating system available to consumers.

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