Energy Conservation with Hydrogel

Landen Conway,

Department of Aerospace & Mechanical Energy, University of California, San Diego, 9500 Gilman Drive, La Jolla, California

ABSTRACT

Life cannot exist without energy. In our modern day and age, energy has become an increasingly growing factor to our everyday lives, affecting everything we do from driving a car to using our phones. From this, we are advancing our knowledge and application in energy and trying to improve it as much as we can. Energy emitted from buildings in residential and commercial areas accounted for 40% of energy consumption during 2013 in the United States. Researchers have found a way to reduce the amount of energy consumption by diminishing the amount of heat and irradiation the sun acts upon buildings. A major consideration to this problem is a material known as hydrogel.

Hydrogel is a material that can absorb water extremely well and has the ability to "sweat" it away when temperatures increase. With this tactic, buildings are able to be covered with hydrogel, allowing the hydrogel to absorb water from rain, humidity, and moisture; then releasing the water as temperature increases in order to cool off the structure. Hydrogel, when soaked with 84.0 % water weight, is able to sustain a temperature of 35^{o} C while under 60^{o} C of sunlight for 3 hours. After those three hours, in which all the water is typically released, the temperature rises to a constant 70^{o} C. Along with this great cooling ability, hydrogel has the competence to easily regenerate and recover lost water. When put under four cycles of 90 minutes of sunlight then 10 minutes of a 2mL sprinkle of water, the hydrogel was able to keep cool at around 35^{o} C for more than 4 hours. Along with this great cooling capability, when hydrogel is used on a building, it is expected to reduce CO2 emission by 60% for the average user by reducing the amount of air conditioning systems the building has to use. A major concern in outdoor use is deteriorating and aging due to UV radiation, requiring a change in the existing plan.

With further knowledge and testing, hydrogel can be used as a major product in the upcoming future as a way to conserve energy and reduce CO2 emissions.

What is Hydrogel?

Figure 1 – An example of what a typical piece of hydrogel looks like

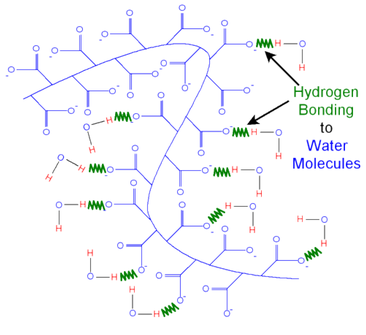

Figure 2 – Diagram explaining hydrogels ability to retain water easily

Hydrogel is a material that is known for its ability to absorb and retain water very efficiently. Hydrogel is made up of polymers that are hydrophilic, allowing it to contain about 90% water. Along with that, hydrogel is very flexible, allowing to be placed and put into use in many different applications. When various changes occur with the hydrogel, such as temperature, the hydrogel will release its water. Hydrogel has many applications including: tissue engineering, implants, contact lenses, glue, pharmaceutical needs, dressings, and cooling substances.

Using Hydrogel on Buildings to Conserve Energy

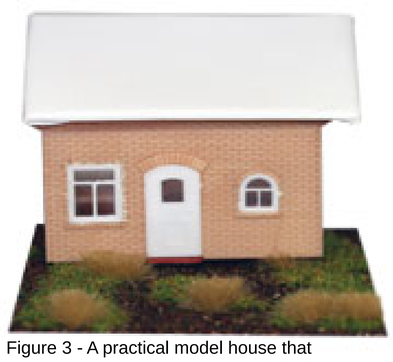

Figure 3 - A practical model house that could be used as a scale model to test effectiveness of hydrogel on constructions.

Due to the increase in energy awareness, we have found that 40% of energy consumption can be traced back to the cooling off of buildings and structures. The idea has risen of using hydrogel to help cool off buildings and structures. The idea is simple, coat the roofs and other surfaces of structures with hydrogel, an the cooling will be completely autonomous. Humidity and rain will be absorbed into the hydrogel and stored, when temperatures increase, the hydrogel will then release the water and will then act as a sweating mechanism to cool off buildings. It has been predicted that using this simple idea can reduce the temperature of a building by 20^{0} C and an annual savings of 220 kilowatt hours for the typical house.

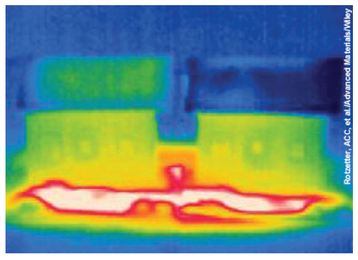

Figure 4 – A thermal view showing the difference of a model house without hydrogel on it's roof(left) and the same model house with hydrogel on it's roof(right) under going the same amount of heat.

Hydrogels Autonomous System

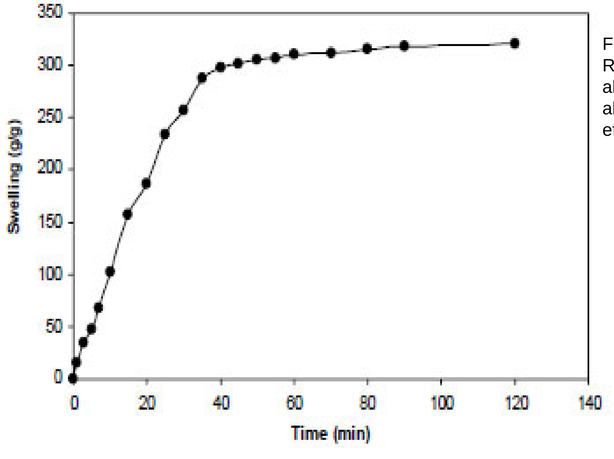

Figure 5 – Graph Representing hydrogel's ability to swell and absorb water very effectively.

With applying hydrogel to buildings, it is very important for it to be autonomous, allowing it to regenerate and sweat water by itself. With this ability, hydrogel is able to attain a grand amount of water in little time, and able to sweat it off very efficiently.

Our Experimental Setup

In our lab, we created three different house models each with different specifications. The first is our control, the typical house with a black roof too it. The second is the same house with a black roof, but with hydrogel attached to its roof. The third is the same house but just with a white roof, resembling a new common product known as White Roof which is also designing a way of cooling buildings down using a white roof instead of black. The three model house's will then be place in a controlled environment and be provided with equal amount of heat, and the samples of hydrogel will be soaked in the same amount of water for equal amount of time. All three roofs have thermo couples attached to the inside and outside parts of the roof, which will then be hooked up to a computer to record the various temperature readings of each.

Experimental Predictions

Although I was not here long enough to run the experiment and collect the data, I have predictions of what type of data will return.

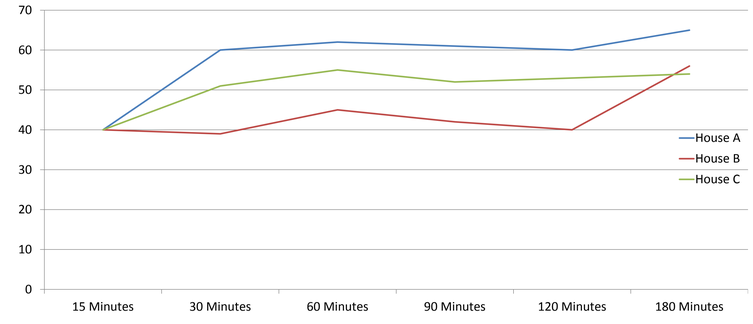

Figure 6 – My predictions on what will happen to the three houses. House A is just plain black roof. House B is black house with hydrogel. House C is white roof. The temperature is measured in Celsius.

CONCLUSIONS AND FUTURE DIRECTIONS

Unfortunately I was not able to be here long enough to see through with the experiment and see the results. Although here are some future expectations and applications of hydrogel that could be implemented if hydrogel does prove to be a good energy conserver.

- Hydrogel can be proved to be able to cool down buildings with efficiency and be able to be applied to buildings.
- Have buildings began to use hydrogel to cool down there temperature and decrease energy consumption
- If hydrogel can be worthy, then in the future it could be used as a world wide used product to decrease energy.

References

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Figure 5 - http://www.scielo.br/img/revistas/bjce/v30n2/a15fig08.jpg