Extracting Water and Energy from the Air: A Quantitative Study
Mark Herde and Can Aktas, Ph.D.
Tagliatella College of Engineering

Condensation is a method of extracting water from the air which involves pressure or temperature changes to the air which causes water vapor to stick to a surface. As the temperature and/or pressure of the air increases, the likelihood that water will condense on a surface increases. This physical phenomena can be exploited by developing a system which either increases the temperature or pressure of the air. In this case, a box with a transparent roof that will allow the sun to heat the inside (Fig. 1). A lot of charge is contained within this water, and this project aims to tap into that (Fig. 2).

The main goal of the study is to design, prototype, and test an effective water collection system that will condense humidity in the atmosphere and convert it into liquid water. This has dual benefits. The stored water can be used for drinking or other purposes especially in water-poor regions or in developing countries. Another potential benefit which will be tested and quantified is that the stored water could be turned into electricity in combination with a fuel cell, therefore using all or part of the collected water to generate electricity (Fig. 3).

A prototype condensate collector was successfully built and tested under many different conditions to provoke condensation. This prototype was engineered to ensure efficient air circulation and plentiful sun exposure to the inside (Fig. 1). As of yet, it has been determined that over an 8 hour period during the course of the night, this prototype can collect 2.8 g/ft² of water. Figure 4 shows the prototype at night after it has collected some condensation. The hydrogen in this water contains a little over 3 times the amount of charge held in an iPhone 6 battery (Fig. 5). After experimenting with the fuel cell to figure out properties such as its hydrogen production rate and output current, it was calculated that using this water could power a 60W light bulb for about 2hrs using the water collected. These calculations are shown in Figure 6.

Further studying of the prototype is necessary to come up with an optimal system for the collection of condensation. Future tests could include:

- Use of an adsorbent material to trap more water,
- Using stones or concrete as a source of heat for the night
- Finding an easily reversible endothermic reaction to continuously cool down the acrylic panels
- More frequent water collection to find the maximum amount of condensation this prototype can collect

This prototype was successful in its purpose of a proof of concept. If this were to be commercialized, it would need to be much bigger and made out of different material. More surface area means more condensation, and more insulating materials would mean even higher temperatures and therefore more likelihood of condensation.

Further study of the prototype is necessary to come up with an optimal system for the collection of condensation. Future tests could include:

- Use of an adsorbent material to trap more water,
- Using stones or concrete as a source of heat for the night
- Finding an easily reversible endothermic reaction to continuously cool down the acrylic panels
- More frequent water collection to find the maximum amount of condensation this prototype can collect

Figure 2 – Calculation to see how long you can power lights of average room with condensation
Figure 3 – System for collecting condensate and converting that water into electricity.
Figure 4 – Prototype condensate collector with condensation
Figure 5 – This is data of water collected by the condensate collector after 8 hours overnight. The calculation shows the total amount of charge stored in the hydrogen from that water.
Figure 6 – Calculations and data based on the output of the hydrogen fuel cell. With the water collected, we could power a 60W light bulb for about 2 hours.
Figure 7 – Graphs which show the basis of the design of the prototype.
Figure 8 – Graphs which show the basis of the design of the prototype.