James J Whalen Academic Symposium Abstract
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Isabelle Sibley and Chase Lurgio
Faculty Sponsor: Professor Paula Turkon
Energy Inputs in Aquaponics: Building a Bell Siphon

The objective of our research is to reduce energy inputs in the aquaponics system at Ithaca College by mitigating the amount of energy needed to pump the water through the system. We have chosen to focus on adding a bell siphon as a means of achieving this goal. By continuing to research this design the hope is to cut the overall dependency on the current electric water pump in the Ithaca College system.

Aquaponics is a system of food production that combines aquaculture (the cultivation of fish) with hydroponics (the process of growing produce without soil). In this system the waste produced by the fish is pumped into the plant beds to act as a natural fertilizer- eliminating the need for added synthetic nutrients. The plants then absorb these vital nutrients from the wastewater.

Aquaponics has several advantages over conventional agriculture practices- making these systems an attractive alternative for food production[1]. Typically, aquaponics systems utilize less water, soil, space, and energy than a conventional farm. These systems are flexible in that they can be designed to fit either an urban or rural environment. Since aquaponics can operate indoors it provides an opportunity for locally sourced year-round food production. Aquaponics systems do not rely on soil and produce little to no runoff or waste. Since the water is filtered, reused, and recirculated through the system, aquaponics also uses significantly less water than the conventional counterparts.

Adding a bell siphon to our current aquaponics setup will allow for the system to use less energy than it does when solely relying on our electric pump to circulate the water. The preliminary goal of this research has been to construct two small-scale aquaponics systems to be placed in the Ithaca College greenhouse. One system, the control, circulates the water using an electric pump. The other system, the test, circulates the water by incorporating a bell siphon. Instead of constantly pumping water into the system, the bell siphon regulates the amount of time and water used to fill the grow bed. The system floods periodically without need for the pump to be on all day. Both systems are connected to a central fishtank below, with identical pumps. The

[1] Goddek, S., Delaide, B., Mankasingh, U., Ragnarsdottir, K., Jijakli, H., Thorarinsdottir, R., … Vala, K. (2015). Challenges of sustainable and commercial Aquaponics. *Sustainability*, *7*(4), 4199–4224. doi:10.3390/su7044199 http://www.mdpi.com/2071-1050/7/4/4199/htm

gravel guard on the bell siphon system is made from a plastic mesh while the gravel guard for the control system is a rigid plastic with slits screwed into the PVC drain pipe.

The bell siphon system and the control system were set up side by side using identical water pumps. Both were plugged into Kill-A-Watt meters plugged into the same outlet. The bell siphon was plugged first into a timer and then plugged into the Kill-A-Watt meter. For the sake of collecting energy and power data the systems are running without plants for the time being. The Kill-A-Watt meters measure kWh, Hertz, Watts, Volts, and Amps. Kilowatts (kW) were calculated:

1 Watt = 0.001 kW

Then, the hours each pump was running were calculated using the equation:

time = energy æ power
or,
h = kWh æ kW[2]

Over a period of roughly 24 hours, the pump for the control system was set to run the entire time. The pump for the bell siphon system was on a timer, turned on for roughly one minute and off for roughly 5. The pump for the control system ran for 24.1 hours and the pump for the bell siphon system ran for 4.64 hours. As seen in Figure 1, the bell siphon system used 0.07 kWh measured over 24 hours, while the control used 0.39 kWh over 24 hours measured with a Kill-A-Watt meter. Figure 1 visualizes the preliminary data collected through the Kill-A-Watt meter test.

We hope to further our studies by running an additional experiment comparing the rate of plant growth between these two test systems. By conducting a growth study we are looking to see if the process of flooding the grow bed with the bell siphon has an impact, either positive or negative, on how the plants develop.

[2] KW and kWh Explained. (n.d.). Retrieved February 25, 2017, from http://www.energylens.com/articles/kw-and-kwh

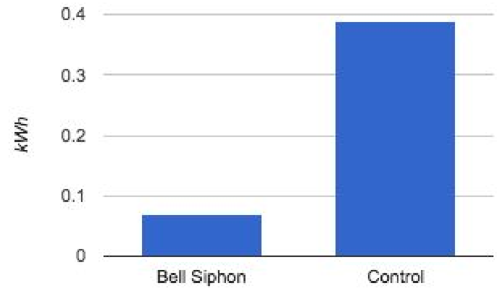

Figure 1. Kilowatt-hour or kWh is a unit of energy[3].

[3] KW and kWh Explained. (n.d.). Retrieved February 25, 2017, from http://www.energylens.com/articles/kw-and-kwh