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AquaHeat

Aquaponics Water Heater System

University Of Washington Mecnahical Engineering Department sponsored by Farmer Frog

Introduction

An Aquaponics system is a system in which plants and fish share nutrients to each other. While fish are eating and gaining nutrients from plants, the fish discharge feces which provide nutrients for the plants. The heater system plays a big roll to help fish and plants year round to act more lively rather than in a dormant state to increase productivity for the whole system. To address this problem we created a "AquaHeat" aquaponics water heater system for the fish and plants to reach maximum productivity even in the coldest months of the year.

Project Outcome

Our teams intended design was to devolop a fully functional working system for farmer frog. But due to coronavirus we decided to design the system with a manual and installation instructions for farmer frog and similarly with other aquaponics systems.

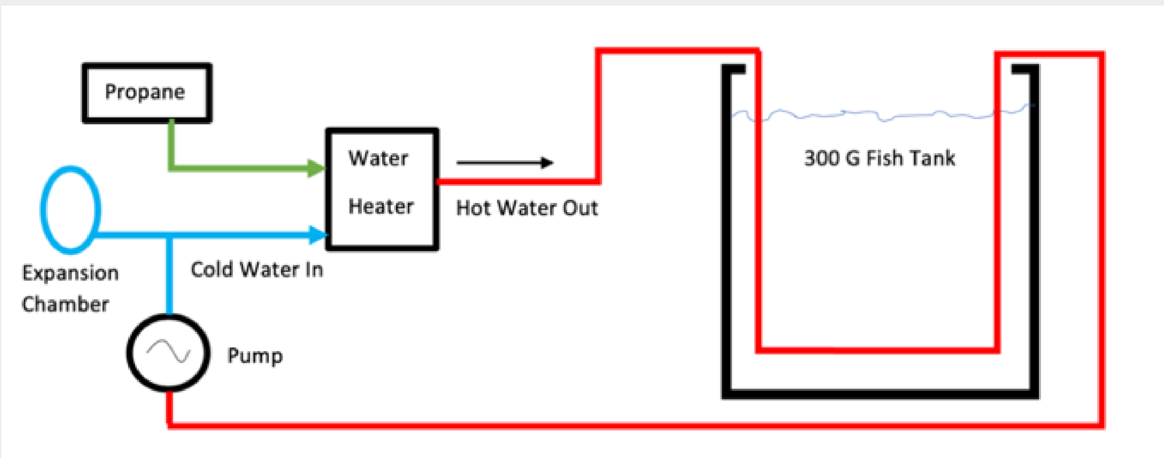
Problems

1. A Complex system to Build
2. Cost efficient/off grid style system
3. Space to install system
4. Low maintenance system

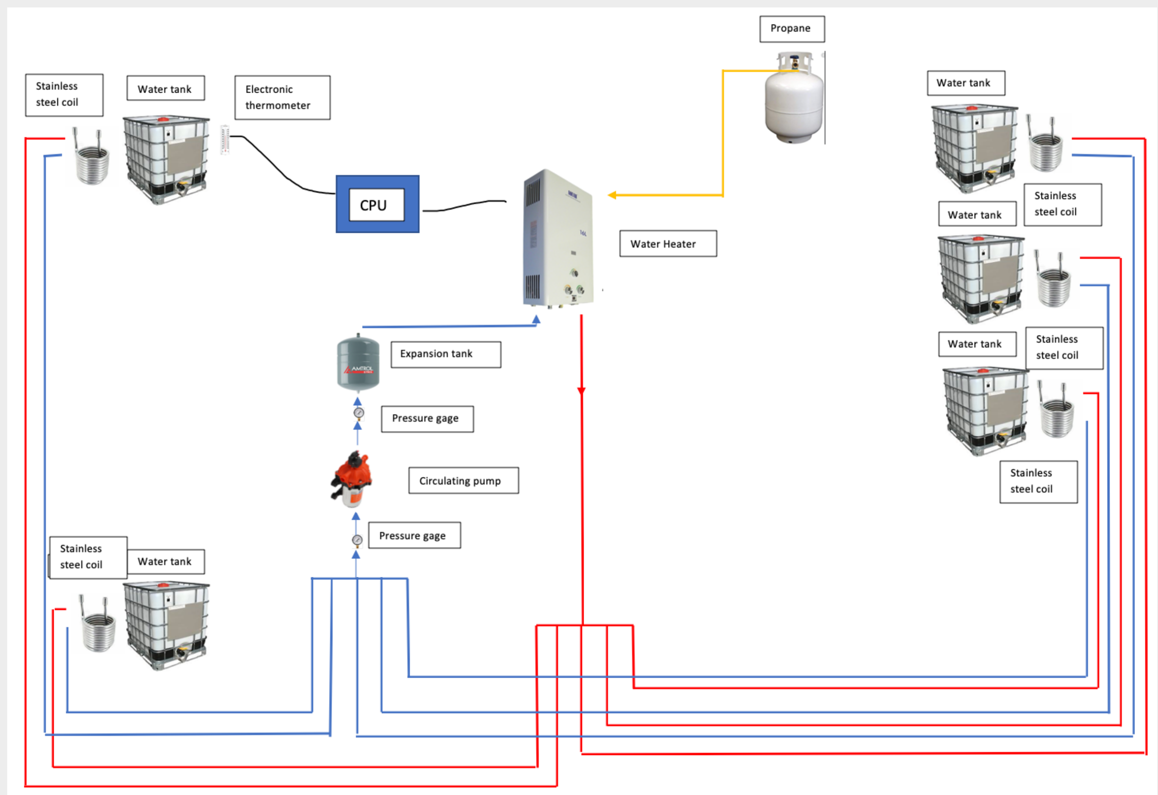
Solution

1. Design a instantaneous water heater system
2. Instead of pricey inefficient electrical systems we created a propane and natural gas system
3. Make a system that is installed on a fire proof free standing wall panel and underground pipes
4. Self temperature regulating system that is to be designed by electrical engineers

Design



Our design includes two major components, a water heater, and a circulating pump. We plan to have a propane powered water heater that outputs hot water into the circulating pump. The water then flows through piping and into a set of coils that lays at the bottom of a fish tank.



The Design we created on the left figure was specifically for the Farma frog aquaponics system. In this system we have a AQUAH instantaneous water heater that runs at 100,000 BTU. A SEAFLO 51 series circulation pump. A AMTROL EX-30 expansion tank. We also have Premade stainless steel coils that are dropped down in the 500 gallon tanks warming up the water. All piping will either be insulated by dirt if subgrade or foam insulated if above grade. And finally a CPU system that regulates temperature of water autonomously.

System Components


AQUAH water heater


SEAFLO 51 Series circulation pump


AMTROL EX-30 Expansion Tank


Stainless Steel Water cool


Poly-Pipe for water travel


pressure gage


expansion valve

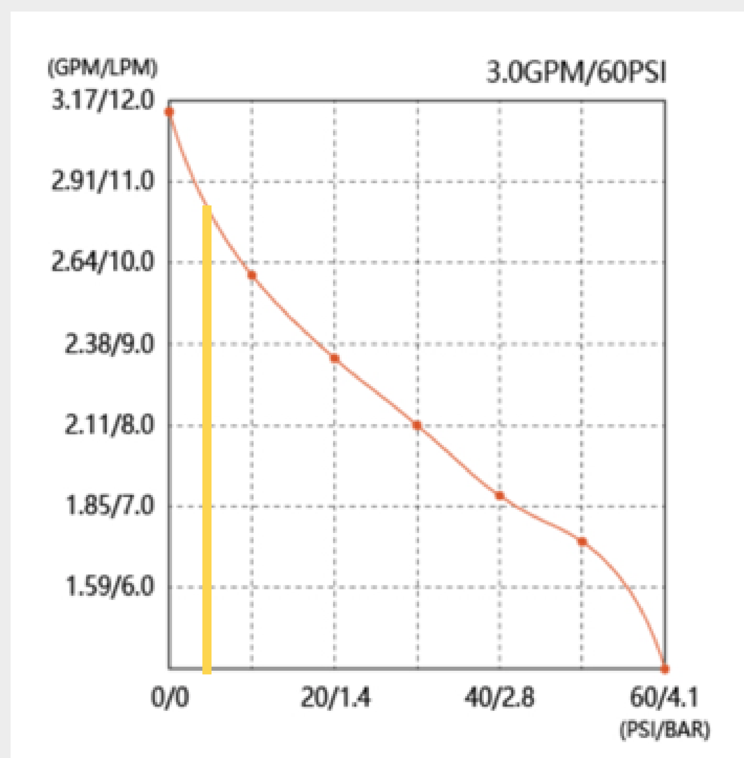
Testing/Analysis

Sizing the System

Step 1: We need to calculate the temperature increase that we want the desired temperature:
Goal Temperature – Start Temperature = Increase in Temperature
Our goal is between 60-75 degrees and the Start temperature on average in winter is 40 degrees
75 – 40= 35 degrees
Step 2: Now we have to calculate the Energy in BTUs for the heater.
Temperature Increase x Tank Volume x 8.34 = Energy of heater
35 degrees x 300 gallons x 8.34 = 87,570 BTU
Step 3: Calculate the volume for propane and natural gas to heat the heater tank.91,333 Propane BTU and 85,250 Natural Gas BTU. Since we will use propane we get 87,570/91,333= .96 gallons of propane.
Step 4: To size the circulating pump we need estimate how much head we need
20% * pipe feet + the vertical positive head= total head
.2 * 60ft + 4 ft = 16 feet of head = 6.9 psi and flow rate at 2.8 GPM
Step 5: We sized the expansion tank on Amtrol sizing website for 100 KBTU

Pump Curve

To pick the pump we had to look at various different pumps and see the pump curve they operated in. We were aiming to reach our desired head amount of 6.9 psi. And we needed to hit our minimum requirements of water above 2.6GPM. This chart on the right is the SEAFLO 51 Series pump we have picked for the farmafrog project.



Conclusion and Future Work

In conclusion, the system we developed over the span of two quarters only works for farmafrog. But when sizing any system you can use the same criteria and sources to devolp a different system. We have created a manual which shows how we have created and devolped the system for farma frog and can be universal to any open air tanked water heaters. For future work we want to build and test the system on job site also design a CPU system at which the heater and pump can operate when needed to conserve energy. We would also like to design an air duct system to dispose the CO2 from the instantaneous water heater.