Low-Cost Water Pump Design/Testing to Serve Rural Villages

IPRO 323

Team

Project Timeline

- Studied Components
  - Ordered Test Components
  - Testing Model
- Full Model Scale
  - Farm in Kankakee
- Large Scale Project
  - Understanding the Requirements
  - Ordering Components

Methodology

- Design a renewable solar power based water pump
- Four subteams
  - Pump
  - Solar Panels
  - Pipes
  - Storage

Pump Subgroup

Katty Davila, Erick Leong, Joshua Sullivan

Pump Test System

- A small test pump was selected to aid in understanding its working mechanisms
- Size, GPM, DC Powered, Submersible

Pump Test Selection

- Testing on Farr Hall Apparatus
  - Understanding Electricity Requirements
  - Possible Factors of Flow Rate
  - Physical Constraints

Pump Design Requirements

- Functional Requirements:
  - 6gpm @ 36m
  - Must be no-maintenance.
  - Operate off of DC current (Solar Panel)
  - Submersible
  - Groundwater temperature between 20-25 Celsius
  - Positive Displacement Pump

Pump Selection (Mexico)

- Suitable Candidates
  - 1) Grundfos 11 SQF-2
  - 2) Lorentz PS200 HR
  - 3) Lorentz PS600 HR
- Candidate Selected: Lorentz PS600
- HR-14 Class 2 (HR-14-2)
- Reasons:
  - Lower Cost (About $1700 total)
  - Efficiency and Low Maintence
  - Scalable to increases in village size or water consumption

Solar Panel Subgroup

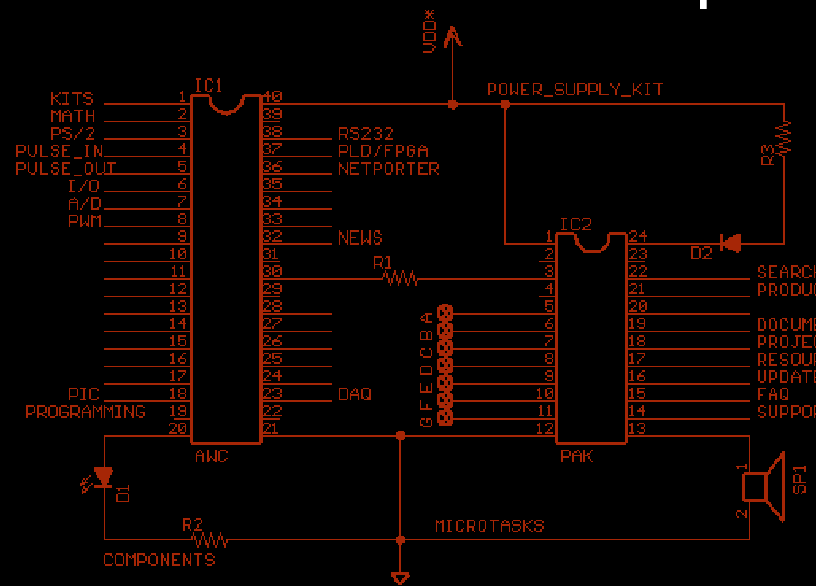
Ellen Rohde, Ryan Yarzak, Nicholas Bailey, and Jaucinta Burt

Test Solar Panel

- To gain an understanding of expected pump performance when powered by solar energy
- Purchased a small solar panel to evaluate panel performance relative to given ratings
- Determine size of solar panel needed in Monterrey

Solar Panel Test Circuit

- Purchased to obtain panel test data
- Connects to computer via USB
- Comes with software to interpret data



Accomplishments

- Previous research data states that Solar Panels achieve maximum performance in Chicago when mounted at 67 degrees during the winter
- Mounting bracket has been constructed
- All testing equipment has been procured

Next Steps

- Collect data over two 1 day periods
- Correlate solar panel performance data to expected performance in Mexico
- Determine size of solar panel array necessary to provide required flow rate from pump
- Monterrey receives 98% of the solar radiation available at the equator therefore, performance will be better than in Chicago.

Piping Subgroup

Brian Albee, William Pajak

Piping Objectives

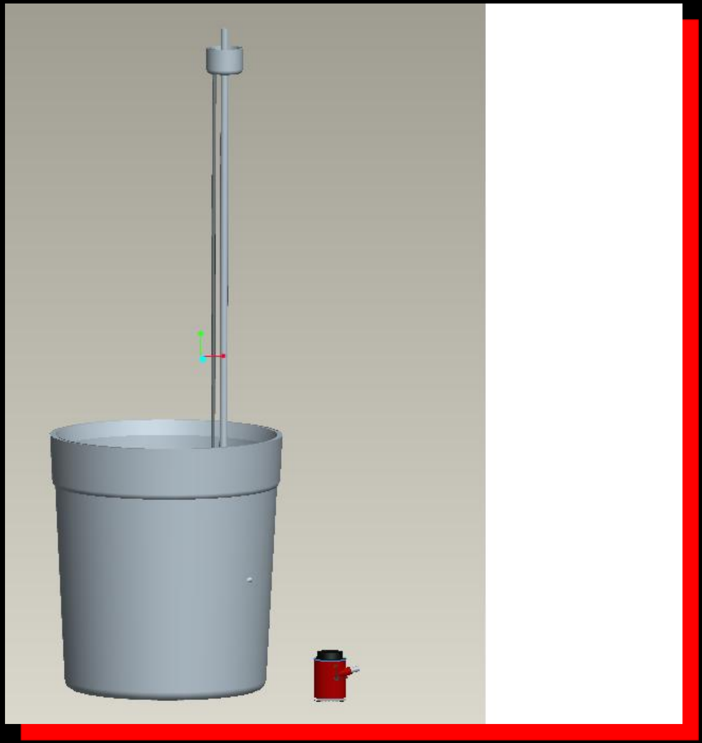
- Determine the piping needs of the test system on Farr Hall
- Purchase the piping for the test system on Farr Hall
- Construct the piping on the test system for Farr Hall
- Determine the piping needs for a large scale test system in Kankakee, IL
- Determine and design the piping needs for the final system in Mexico

Determining the Piping Needs of the Test System

- The piping needs were determined by the Bernoulli Equation: $p + .5\rho V^2 + \rho g h = const.$
- Using the known diameter of the outlet pipe, the equation was solved for the proper diameter of inlet tubing.
- After solving the equation, a sketch of the test system was drawn.

Purchasing and Construction of Piping

Piping material was purchased and then the piping structure was constructed based on the following diagram



Piping Needs for Mexico

- A design will be proposed as to the piping systems of Kankakee, IL and Mexico once the test system has been sufficiently monitored.
- The Bernouli equation will again be used to determine the piping needs.
- Corrections will be made to the design of the piping system for the water wells in Kankakee, IL and Mexico.
- The design for Mexico will hopefully be approved by the Mexican government for installation in the village.

Storage Subgroup

Leon Chan, Nicole Galbraith, Jinting Liu

Objectives

- Design the water storage for Farr Hall test system (IIT solar water pump prototype)
- Obtain a storage container that will meet the needs of the designed test system
- Design the storage tank, according to data obtained from Mexico, for the final system.

Criteria for Storage (Test System)

- Volume
  - 3 GPM pump, continuous water cycle
- Depth
  - submerge pump at all times
- Stability
  - supports pressure of pump and piping
- Temperature
  - water should not freeze

Choice for Storage (Test System)

- Based on the design criteria, a 44 gallon Rubbermaid trash can was selected.
  - capacity is sufficient to maintain the continuous cycle
  - Depth of 24” will keep the pump submerged
  - The material and weight provides adequate stability.

Design of Storage (Mexico)

- Research water usage rate per person per day in Mexico
- Determine size and type of water tank to be used
- Calculate height and placement of water tank
- Design of water flow from storage tank to individual households

Objectives

- Finished a small scale test
- Install a full scale system in Kankakee
- Collect data
- Write a plan to be approved by the Mexico Government for eventual installation in Monterrey, Mexico

Questions?