Shuttle Valve Design

Team #17

Date
March 20th, 2014

Group Members
Ryan Laney – Team Leader
Billy Ernst – Team Webmaster
Samantha Zeidel – Team Treasurer

Instructor
Dr. Kamal Amin

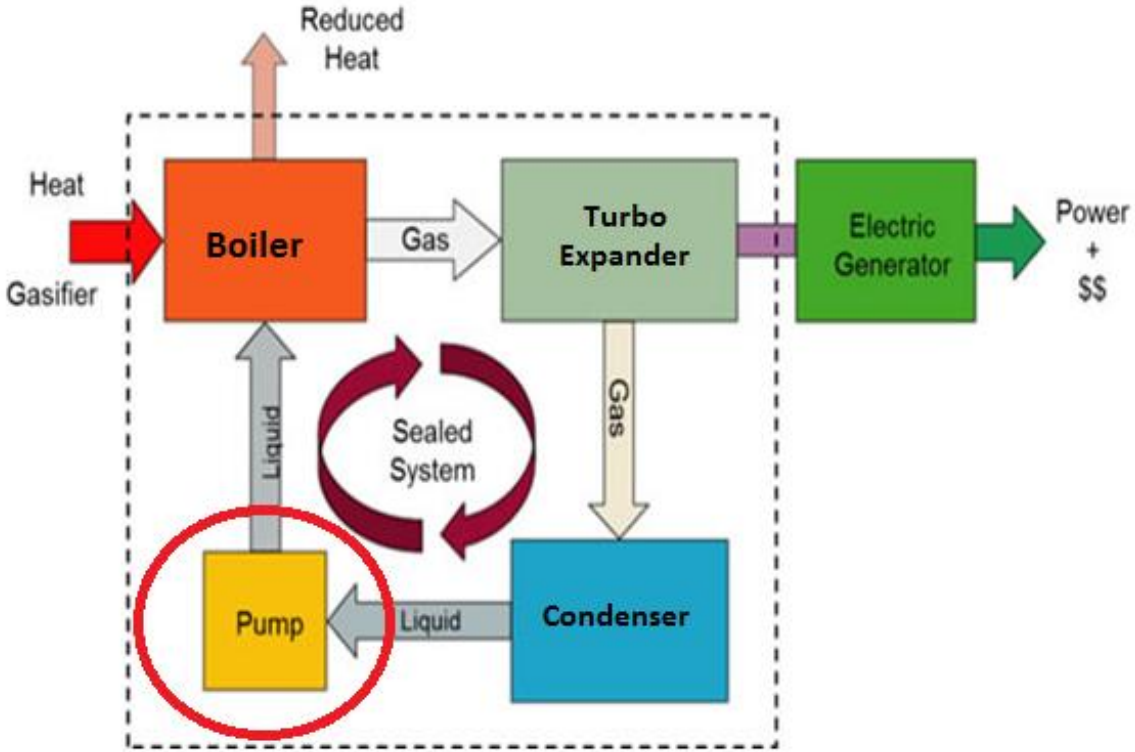
Sponsor
Verdicorp Inc.
Robert Parsons

Verdicorp
ENVIRONMENTAL TECHNOLOGIES

Faculty Advisor
Dr. Steven Van Sciver

Project Overview

- Verdicorp Environmental Technologies has developed a revolutionary Organic Rankine Cycle (ORC)
- ORC uses waste heat from a low grade source and converts it to useful power
- The ORC systems have somewhat low efficiency (~10-14%); Special concern within the company to maximize this efficiency in any way possible
- ORC is cable of producing ~125 kW
- Parasitic losses consume ~20 kW
  - (Pump ~10 kW)
- Senior Design Team 17 has been tasked with increasing the efficiency of the system
  - (Removal and replacement of the pump)



Presented by: Ryan Laney

Fall Accomplishments

- Understand the project and its applications
- Select the final design for the prototype
- Select the components for the prototype
- Procurement of these components
- Modify the final design with input from the sponsor
- Plan the construction and testing of the prototype for this semester

Presented by: Ryan Laney

Current Objectives

- Complete the construction of the prototype
  - Piping and instrumentation
  - Electrical components
  - Wiring and logic

- Test and troubleshoot the prototype upon completion of its individual segments

- Final prototype completion and presentation to MEAC Open House (April 17th, 2014)

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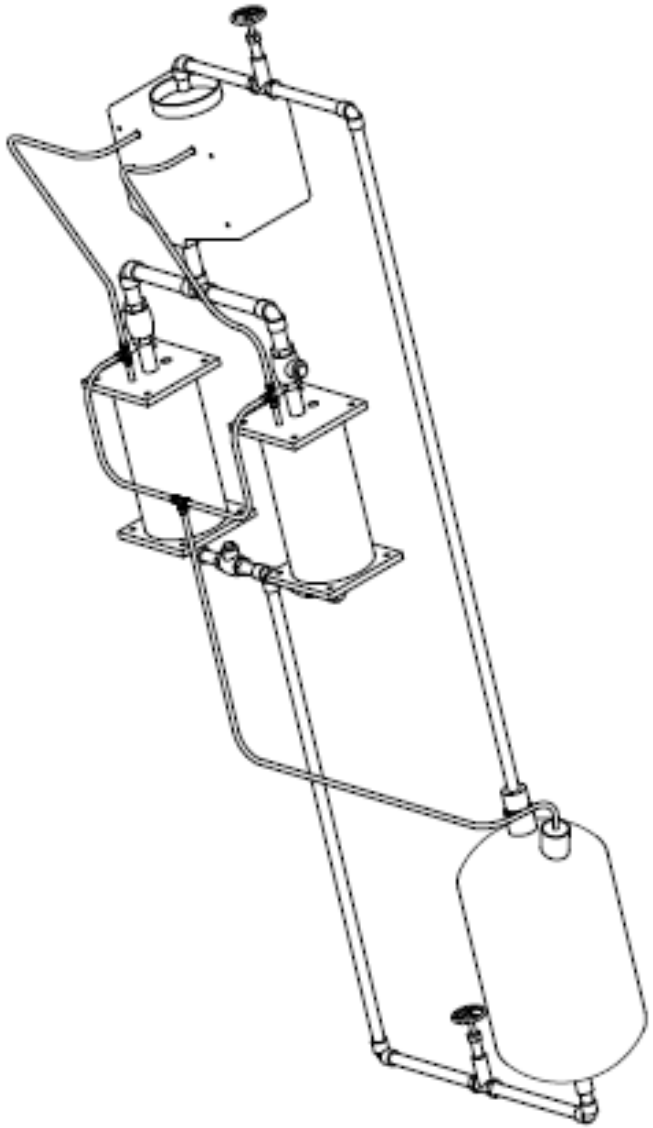
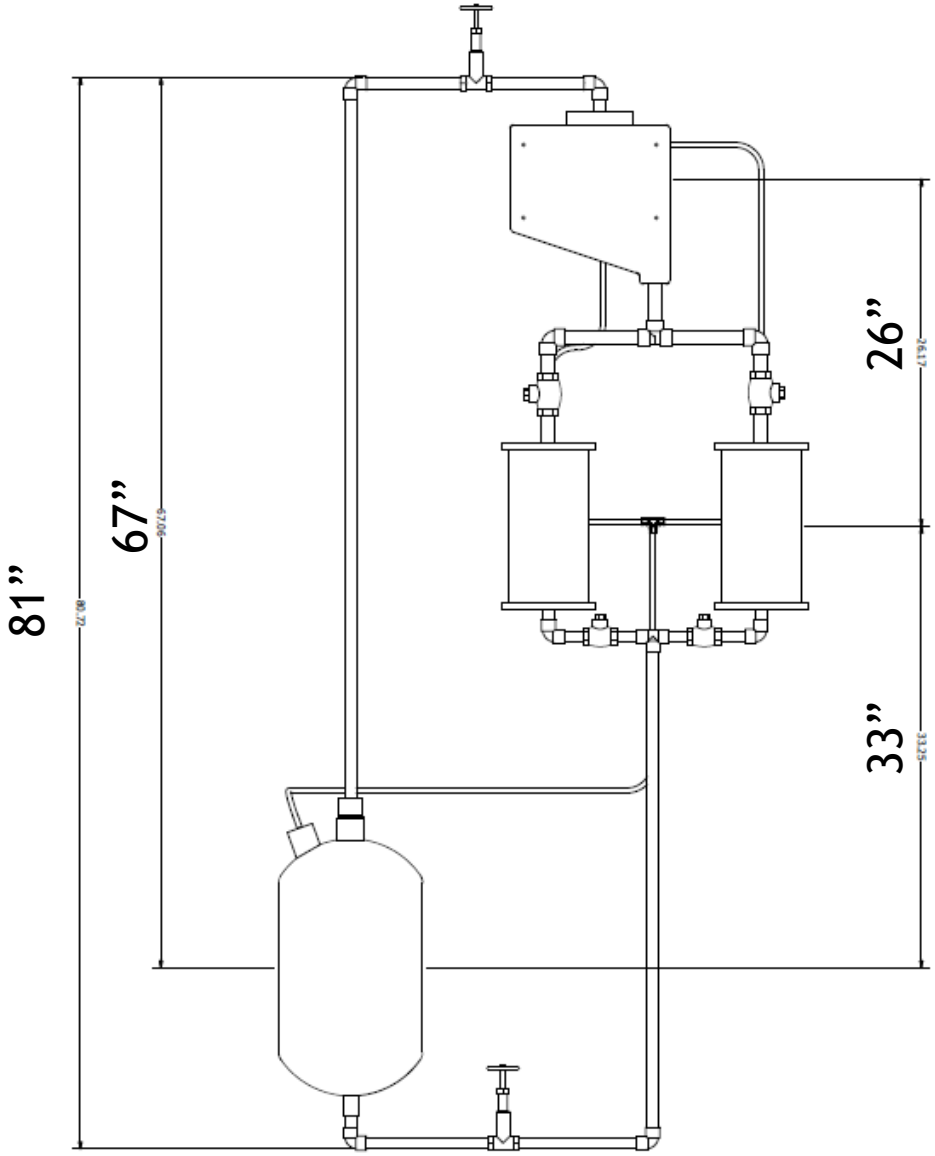
Final Design Concept





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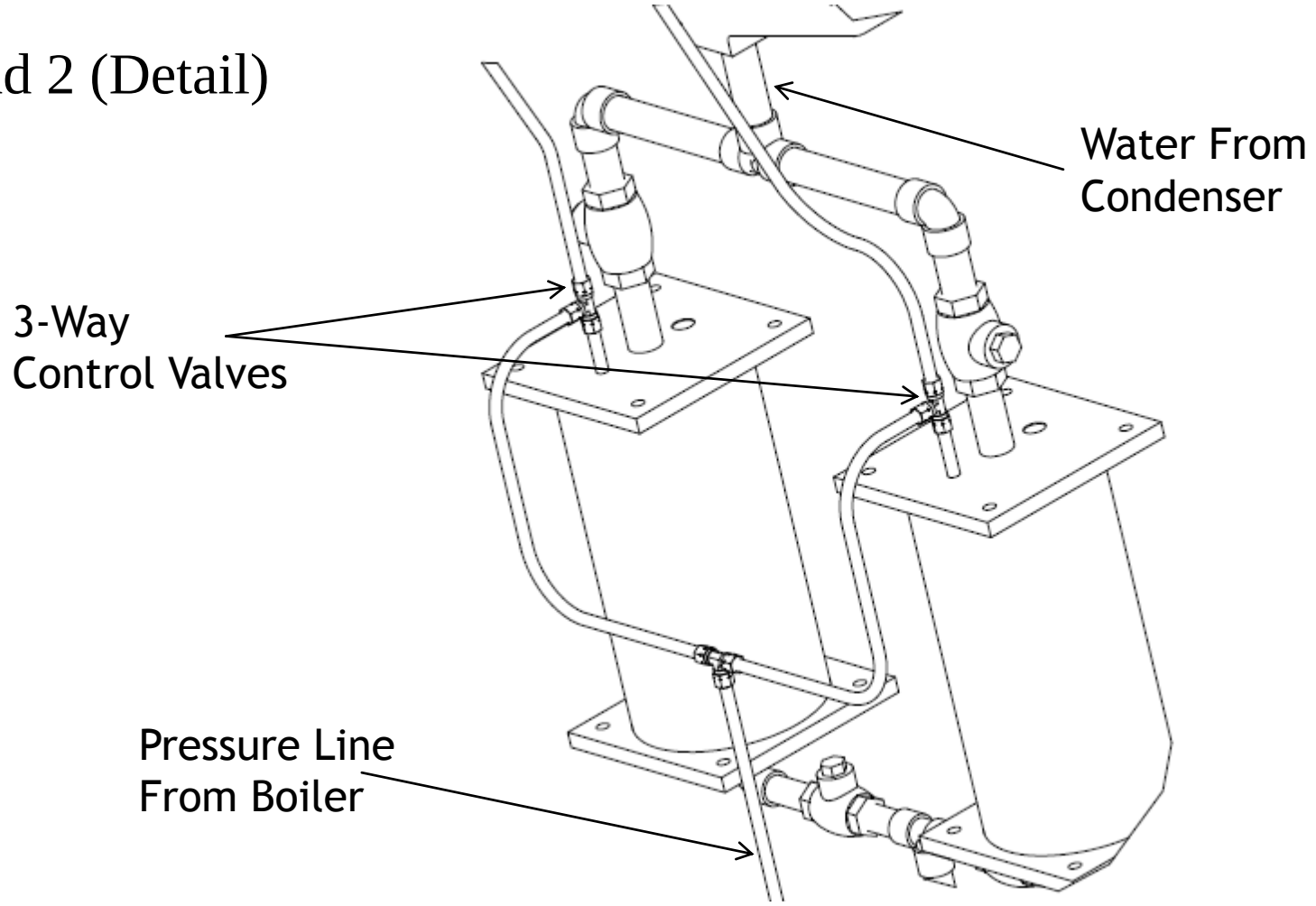
Final Design Concept

- Holding Tanks 1 and 2 (Detail)



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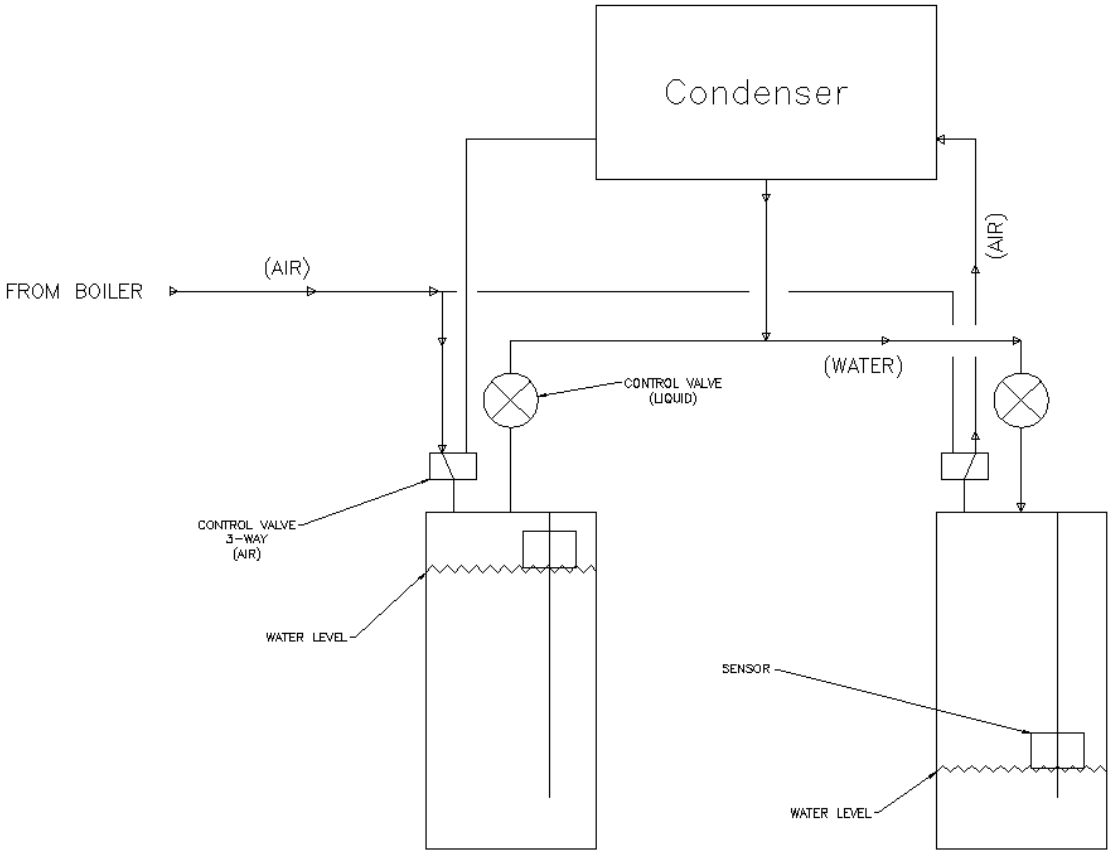
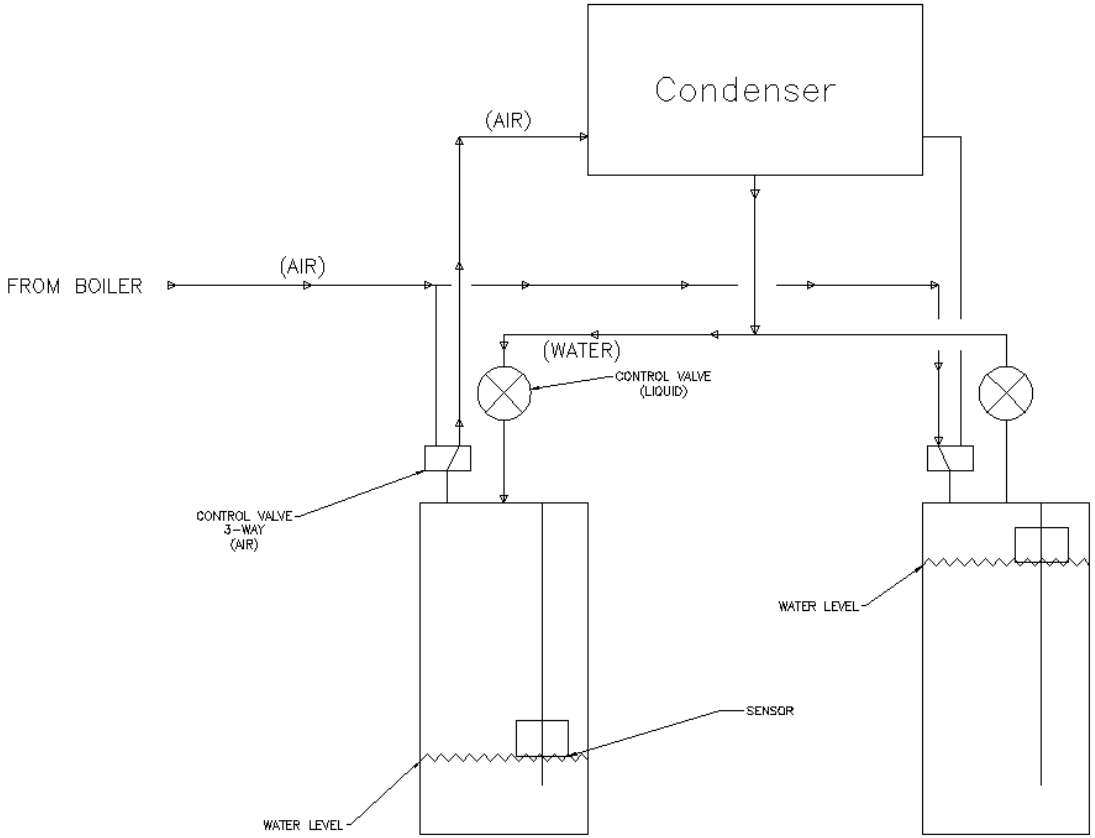
Final Design Concept

- Execution of Holding Tank 1



- Execution of Holding Tank 2



Presented by: Billy Ernst

PIPE-FLO Software Calculations

EngineeredSoftware, Inc.

PIPE FLO®

Boiler to Condenser

- With an internal pressure in the boiler of 50 psi and using ½” PVC, the flow rate will be 39.04 GPM
- A throttling valve will be used to model the turbo expander and provide the pressure drop and decrease the flow rate to the desired 3 GPM

Condenser to Holding Tanks

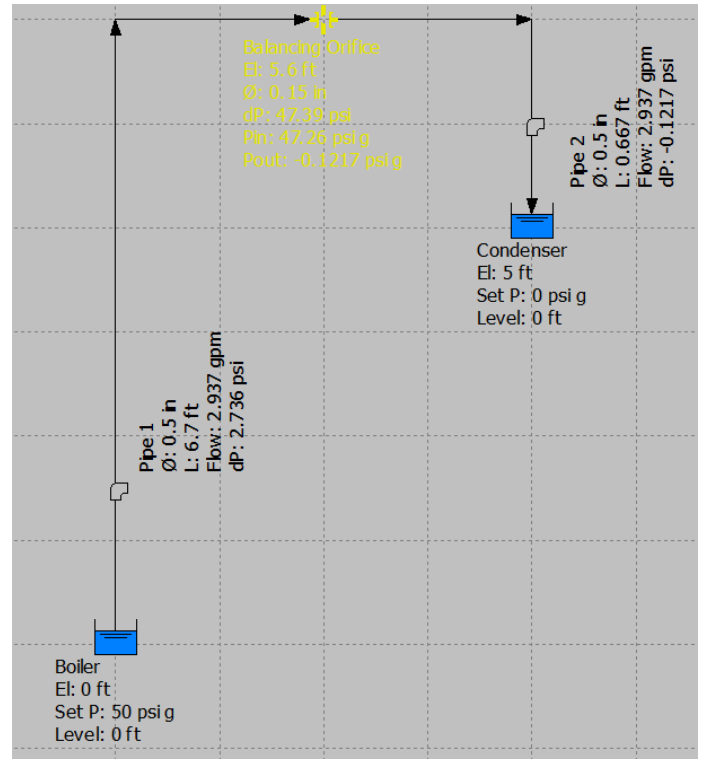
- Using ½” PVC, GPM (max) = 4.6 GPM

Greater than 3 GPM which is acceptable; Tanks will fill faster than they empty

Holding Tanks to Boiler

- Using ½” PVC, GPM (max) = 4.46 GPM

Therefore ½” PVC must be used along with a throttling valve to restrict the flow down to 3 GPM



Presented by: Billy Ernst

Major Design Components

- **Condenser**
  - Non-pressurized vessel in our system
  - Two holes must be drilled into the top of the tank to allow for insertion of 3/16 in. copper tubing
- **Holding Tanks**
  - Pressurized vessel in our system (50 psi)
  - 1 ft. segments of 6 in. acrylic tubing were cut (CHANGING)
  - 3/4 in. aluminum stock end caps were machined and press fitted to the tubing by 3/8 in. tie rods
- **Boiler**
  - Pressurized vessel in our system (50 psi)
  - Water level tube attached on outside of tank
  - Two caps were machined for the two holes on top of the boiler
  - Bottom of tank was modified to insert ½ in. PVC from holding tanks

Presented by: Samantha Zeidel

Electrical Components

Air and Liquid Control Valves

- Air: 24VDC Pneumatic Single Solenoid, 3-way, 1/8 in. NPT
- Liquid: 24VDC Pilot Operated Solenoid Valves, 2-way, ¾ in. NPT

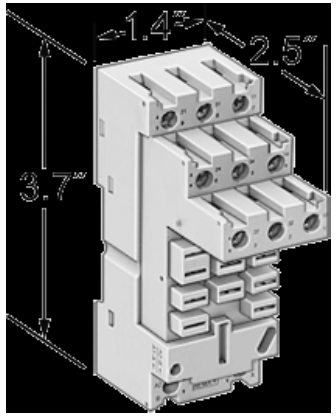
3/4" NPT - 24V DC

Power Supply

- Siemens 6EP1332-1SH31
- AC 230/120V to DC 24V converter

Sensor

- Will be entirely constructed by the design team; ½ in. PVC pipe
- Outside: Magnet with Styrofoam attached to it (floats with water level)
- Inside: Salvaged magnet sensors (24VDC) adjusted until at proper heights



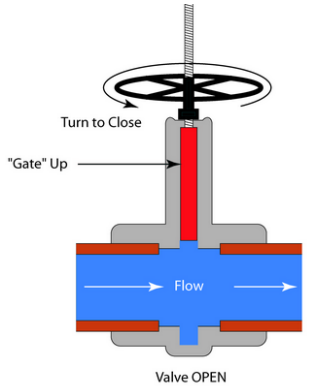
Relay

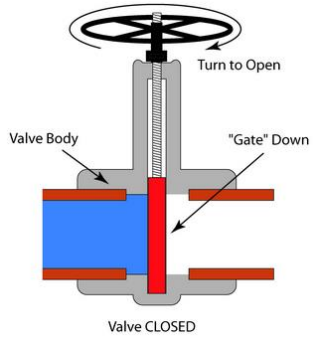
- Purchased from McMaster-Carr
- Voltage: 24 VDC (Voltage for all electrical components)
- No coding required for electrical components

Presented by: Samantha Zeidel

Remaining Components

- **Piping**
  - **Water Pipes:** ½ in. PVC Schedule 40
  - **Pressure Pipes:** 3/16 in. Copper Tubing
  - **All piping components will be threaded to allow for easy modification**





- **Valves**
  - ½ in. PVC SCH 40 In-Line Check Valves
  - ½ in. Plastic Globe Valves (Throttling)
  - ½ in. Brass Gate Valve
  - Require testing to decide which is optimal for design
  - Pressure Relief Valve

- **Pipe Fittings**
  - ½ in. PVC SCH 40 90° Elbow
  - ½ in. PVC SCH 40 Tee
  - ½ in. and ¾ in. Male Fittings

Presented by: Samantha Zeidel

Design Changes

- **Holding Tanks (Walls)**
  - 6 in. acrylic tubing used for the walls of the holding tanks cracked
  - Replaced by 6 in. polycarbonate tubing

- **Holding Tanks (Execution)**
  - Sponsor requested that the holding tanks should fill completely before draining
  - Simplifies the logic behind the electrical components in the system

Presented by: Samantha Zeidel

Potential Challenges and Risks

- **Challenges**
  - Time constraints
  - Budget constraints
  - Getting electrical components to work properly
  - Filling up the prototype

- **Safety Risks**
  - Machine shop safety
  - Refrigerant 245fa replaced with water and compressed air
  - Pressure relief valves to prevent over pressuring system

Presented by: Samantha Zeidel

Project Procurement

Component	Product Description	Vendor	Total Cost	Status
Boiler	6.25 Gallon Oil Extractor	Harbor Freight Tools	$145.11	Received
Condenser	Ace / DenHartog 3 Gallon Rectangular Specialty Rinse Tank	The Tank Depot (Online)	$54.15	Received
Holding Tanks (Walls)	6” Acrylic Tubing (Walls) Purchased a 6 ft. segment of tube	U.S. Plastics (Online)	$88.20	CHANGED
Control Valve (Air)	Parker Air Control Valve Single Solenoid, 3-way, 2-pos, 1/8” NPT	Global Industrial (Online)	$116.86	Received
Control Valve (Liquid)	Pilot Operated Solenoid Valves 2-way, 2-pos, 3/4” FPT	Zoro Tools (Online)	$99	Received
PVC Piping, Components, and Fittings	PVC Piping: 1/2” and 3/4” Piping Pipe Components: 1/2” Throttle Valves PVC Fittings: Tees, 90° Elbows	The Home Depot	$32.23	Received
PVC Fittings, Pressure Relief	Pipe Components: Plug Valves, PVC Fittings: Male Fittings for PVC	ACE Hardware	$15.00	Received
Air Compressor, Sensors, Outer Frame, Pressure Piping	3.5 Gallon Pancake Air Compressor Sensors, and Outer Frame from old machines in Verdicorp machine shop	Verdicorp	$0	Received

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Project Procurement

Component	Product Description	Vendor	Total Cost	Status
Flow Meter	Orange Research In-Line 2320 Series Flow Meter, 0-5 GPM	Harbor Freight Tools	$106.00	Received
Holding Tanks (End Caps)	3/4” aluminum stock, O-ring, and threaded rods	Purchased through Verdicorp	$114.52	Received
Holding Tanks (Walls)	Reordered 6” polycarbonate tubing for end caps	Purchased through Verdicorp	$61.52	Received
PVC and Copper Components, Pressure Gauges	Additional PVC and Copper components and fittings. 0-100 PSI Pressure Gauges	ACE Hardware, Lowes	$130.56	Received
Relays	24 VDC Relay That’s Stays Switched, Sockets	Purchased through Verdicorp	$43.17	Received

Component	Product Description	Vendor	Estimated Cost	Status
PVC and Copper Components	Additional PVC and Copper components, fittings, and piping.	Home Depot and Grainger	$50	Pending

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Financial Analysis

- **Overall Budget: $2000**

- Expenditure (Purchased Components): $1006.32
  - Air and Liquid Control Valves: $215.86
  - Heat Exchanger: $145.11
  - Condenser: $54.15
  - Holding Tanks (Walls): $61.52 ($88.20)
  - Holding Tanks (End Caps): $114.52
  - Relays: $43.17
  - PVC Piping, PVC Fittings, Standard Valves: $47.23
  - Air Compressor, Sensors, Outer Frame, Pressure Line Piping: $0
  - Flow Meter: $106.00
  - Pressure Gauges, PVC and Copper Components: $130.56
- Estimated Expenditure (Remaining Components): $50
  - Additional PVC and Copper components: $50

- **Total Expenses: $1006.32**
- **Remaining Budget: $993.68**

Presented by: Ryan Laney

Project Summary

- **Final Design**
  - Modifications have been made to the final design selected in the Fall semester, but conceptually still the same design.
  - Pending the testing of individual segments of the prototype, modifications will be made based on team and sponsor input.
- **Project Components**
  - All of the components have been selected and purchased for the prototype.
  - Machining of the components requiring modification has already begun.

Presented by: Ryan Laney

Future Plans

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ENVIRONMENTAL TECHNOLOGIES

- Finish constructing and machining components that require modification
- Construct the sensors and get all electrical components working
- Continue building and testing individual portions of the system
- Analyze the operation of the prototype and make necessary improvements
- Have the entire prototype ready for full-scale testing by the end of March 2014.

Any Questions, Comments, or Advice?

Presented by: Ryan Laney