Shuttle Valve Design

Team #17

Date
February 13th, 2013

Group Members

Ryan Laney – Team Leader

Billy Ernst – Team Webmaster

Samantha Zeidel – Team Treasurer

Instructor
Dr. Kamal Amin

Sponsor
Verdicorp Inc.
Robert Parsons

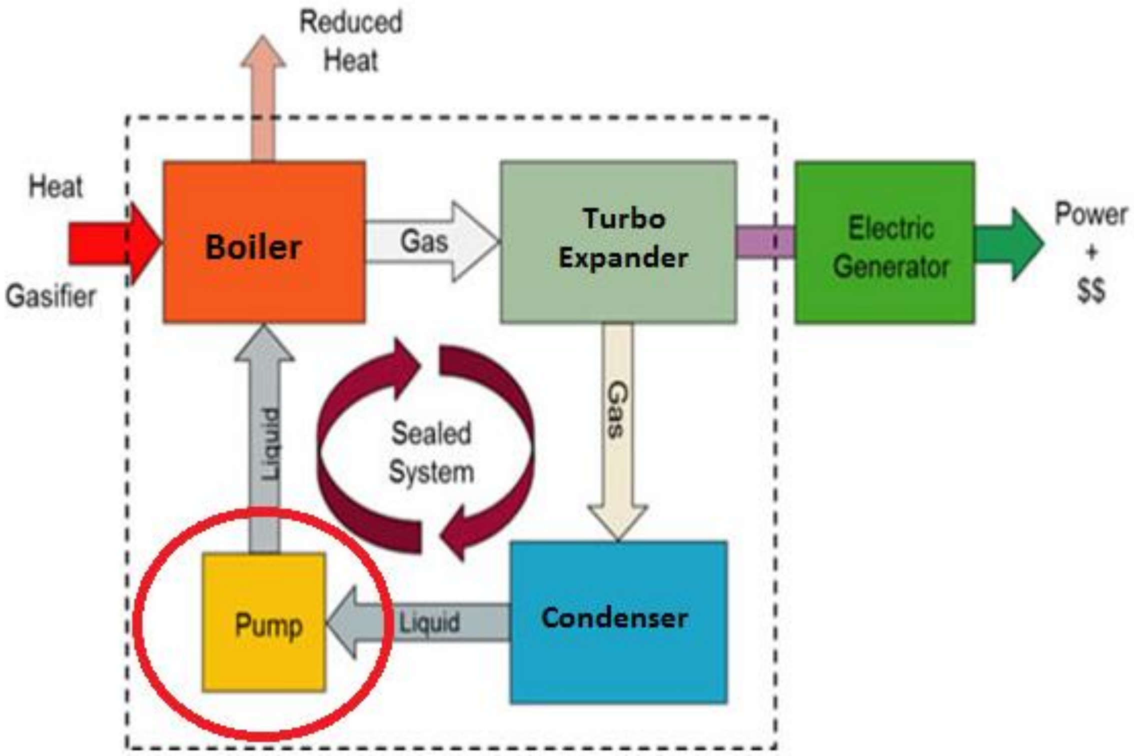
Faculty Advisor
Dr. Steven Van Sciver

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 Semester 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

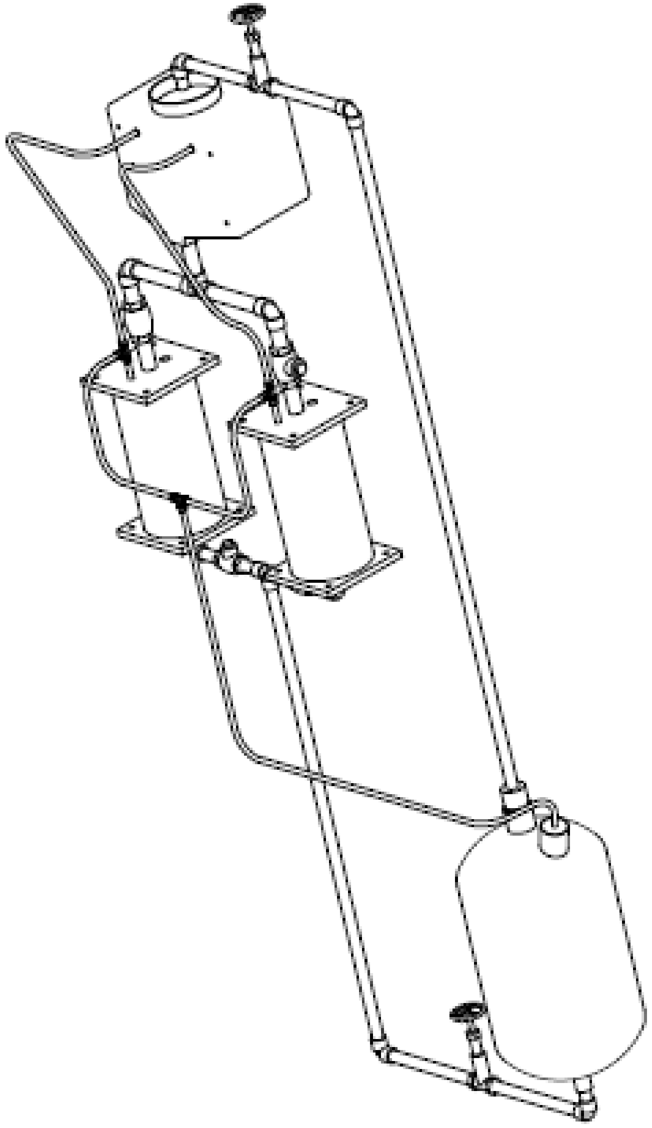
Presented by: Ryan Laney

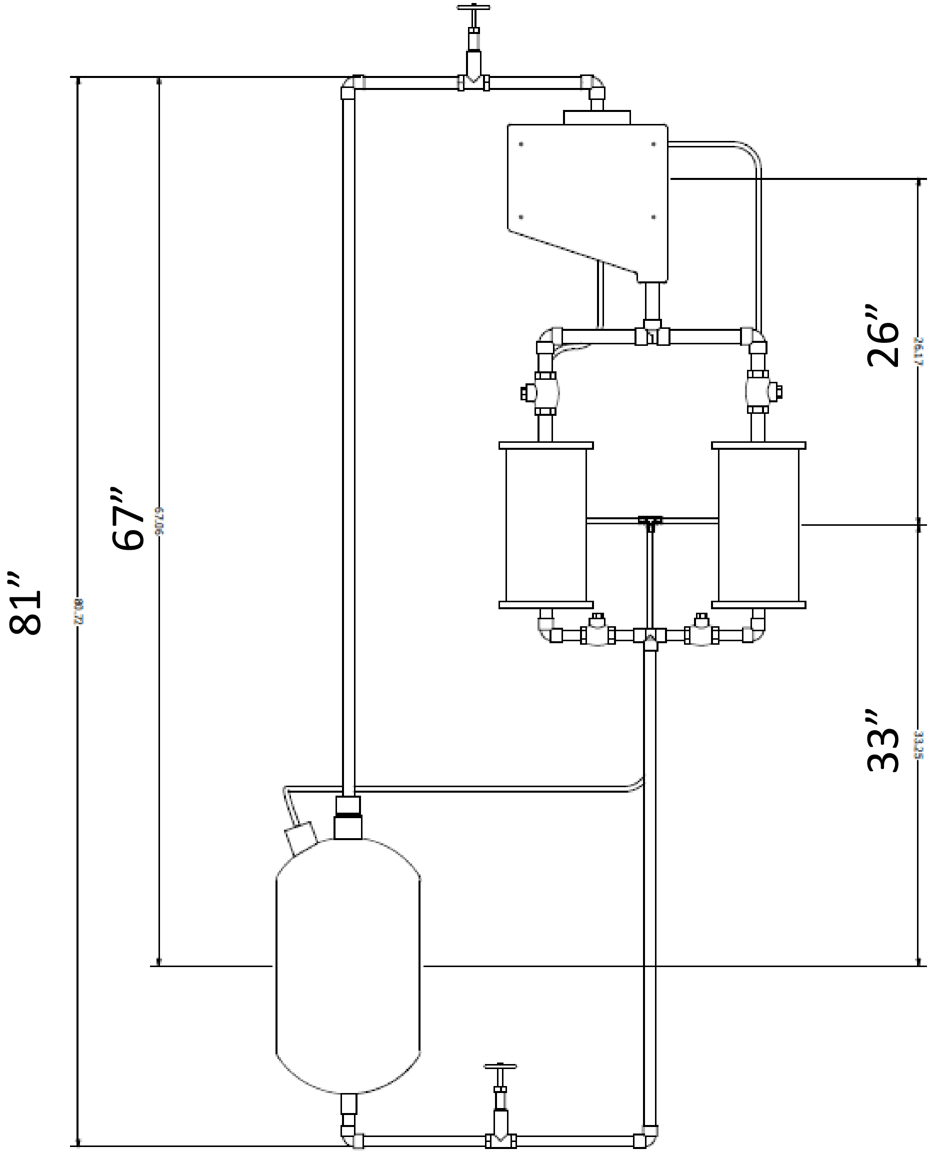
Project Objectives

- Finish any modifications to the final design of the shuttle valve system.
- Maintain the continuous flow of liquid within the prototype (~3 gpm).
- Transfer the liquid from the low pressure side of the system to the high pressure side; Use control valves, the aid of gravity, and balancing the pressure within the system.
- Finish purchasing the remaining design components found in the procurement.
- Begin constructing the prototype of the final design by January 28th, 2014.
- Test and troubleshoot the prototype upon completion of its individual segments.
- Final prototype completion and presentation to MEAC Open House on April 17th, 2014.

Presented by: Ryan Laney

Final Design Concept





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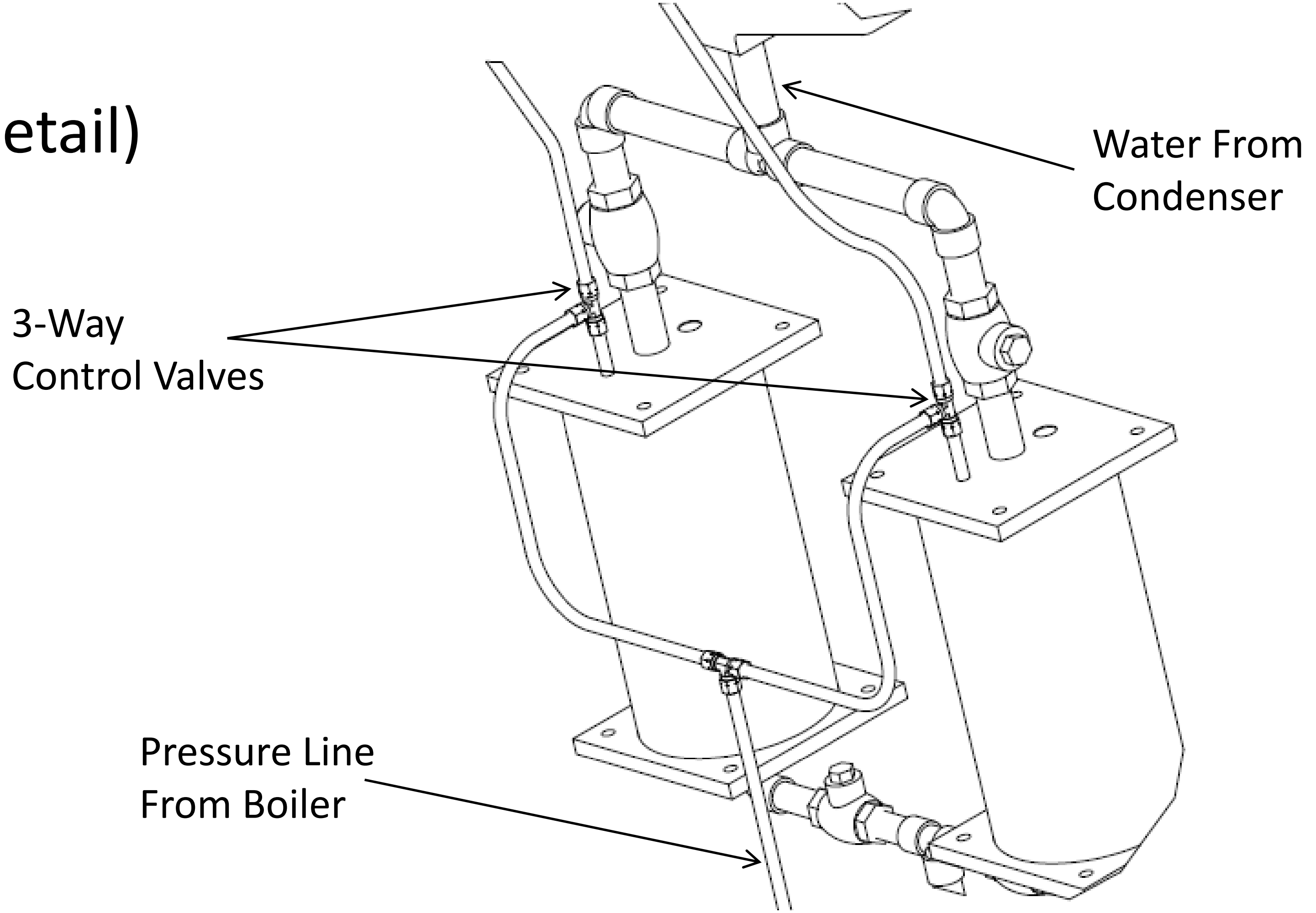
Final Design Concept

- Holding Tanks (Detail)



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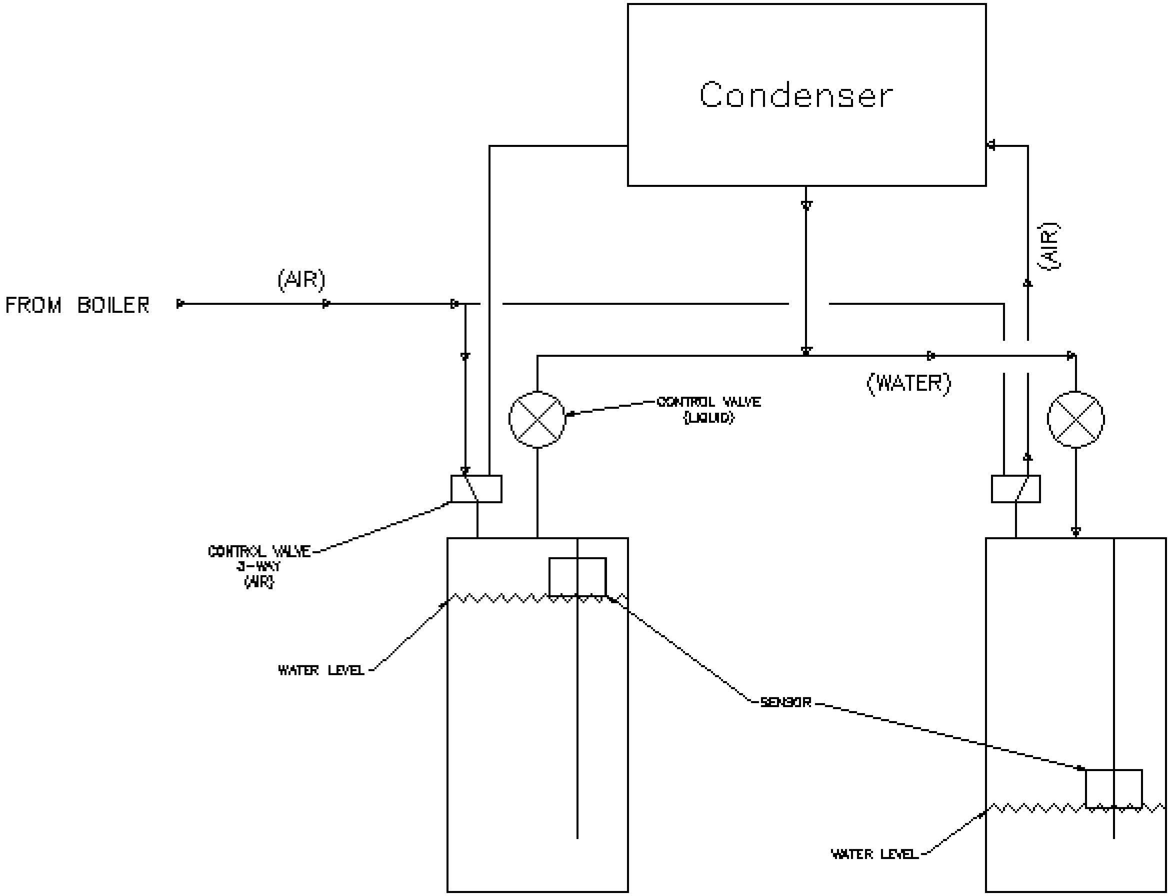
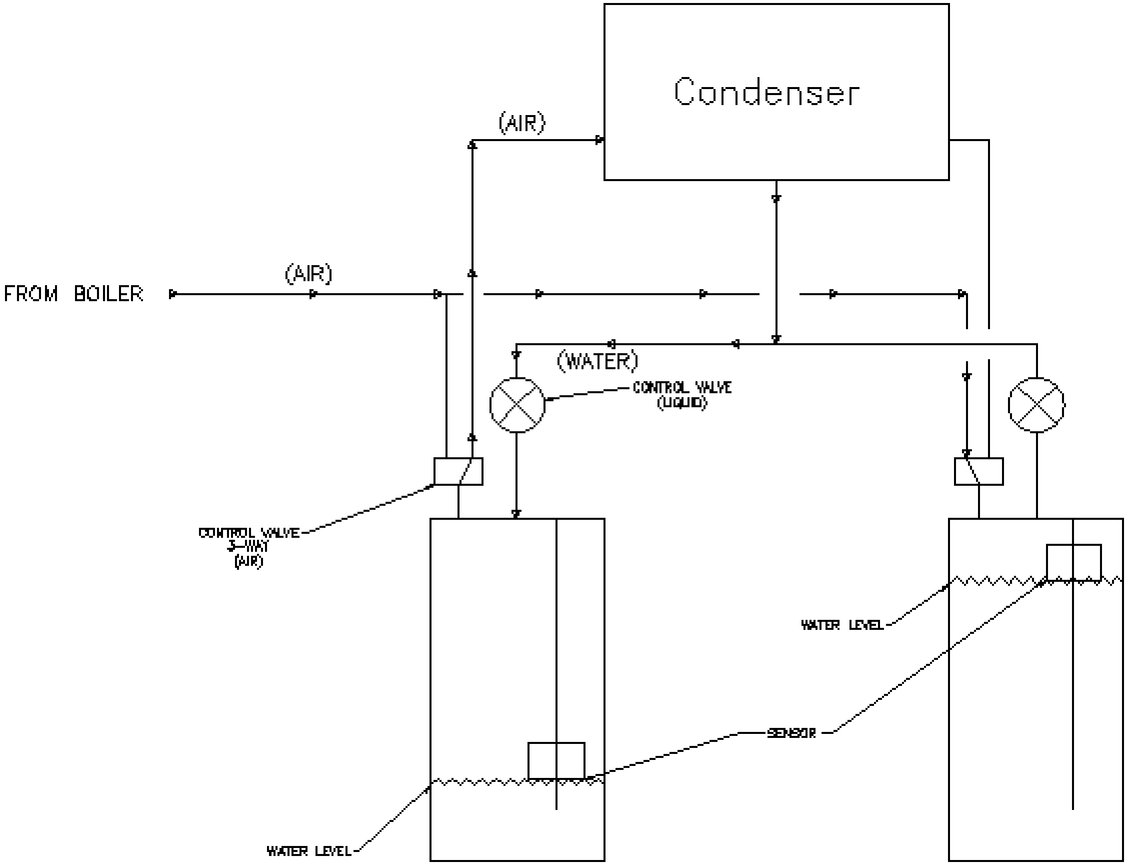
Final Design Concept

- Execution of Holding Tank 1



- Execution of Holding Tank 2



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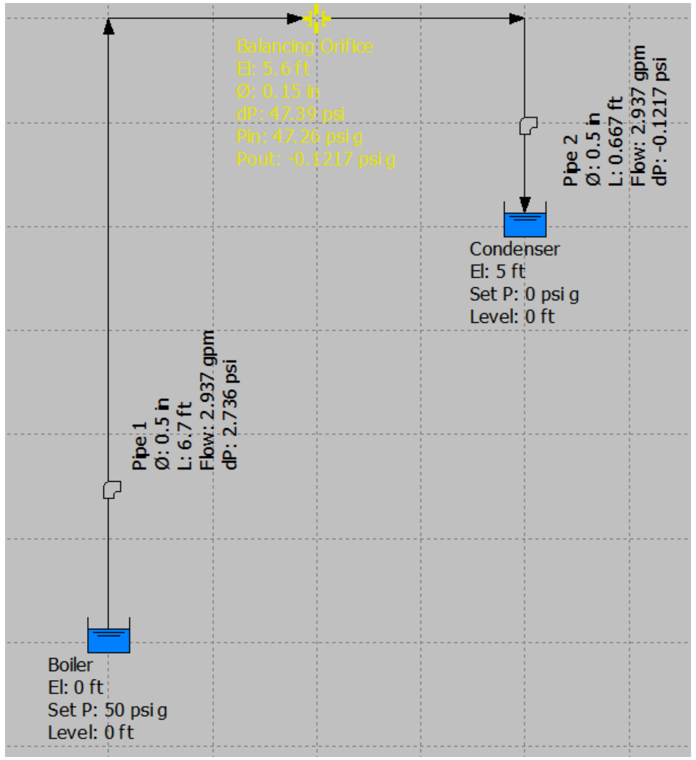
PIPE-FLO Software Calculations

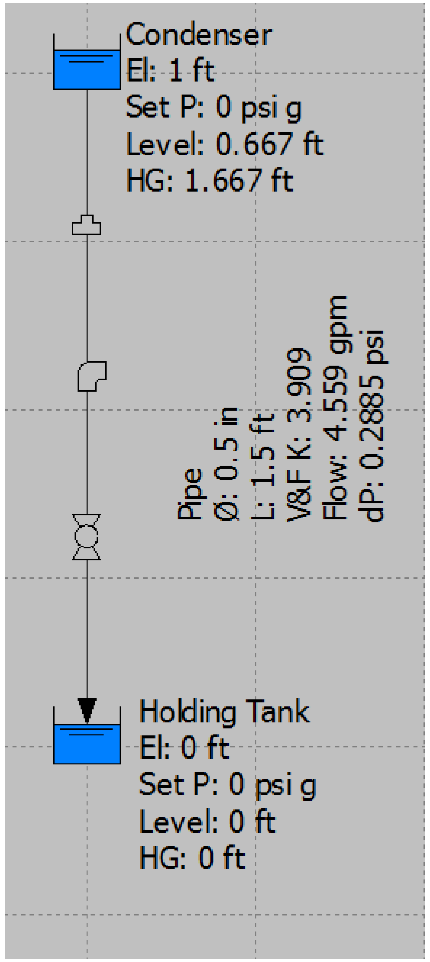
- **Boiler to Condenser**
  - dZ = 60 in. (Hydrostatic Head)
  - Minor Losses (2 90° Elbows, 1 Globe Valve) – Major losses (L = 88 in.)
  - With an internal pressure in the boiler of 50 psi and using ½” PVC, the flow rate will be 39.04 GPM
  - A throttling valve will be used to model the turbo expander and provide the pressure drop and decrease the flow rate to the desired 3 GPM



Presented by: Billy Ernst

PIPE-FLO Software Calculations

- **Condenser to Holding Tanks**
  - Flow rate will be gravity driven
  - dZ = 20 in. (Hydrostatic Head)
  - Minor Losses (1 90° Elbow, 1 Tee, 1 Control Valve) (To each tank)
  - Using ½" PVC, GPM (max) = 4.6 GPM
    - Greater than 3 GPM which is acceptable. Tanks will fill faster than they empty. (different from last semester)



Presented by: Billy Ernst

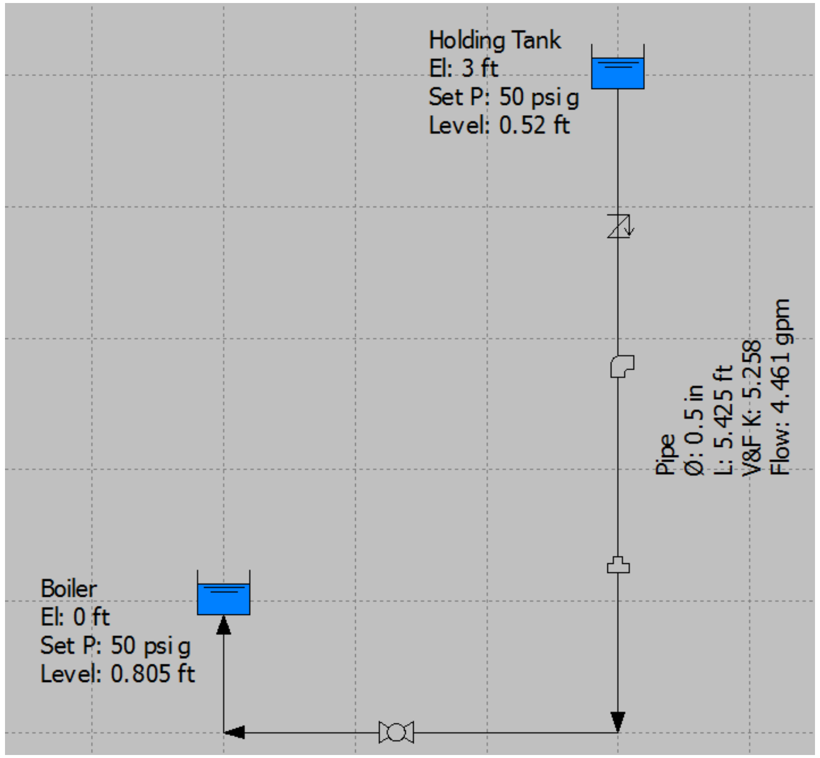
PIPE-FLO Software Calculations

- **Holding Tanks to Boiler**
  - Flow rate will be gravity driven
  - dZ = 36 in. (Hydrostatic Head)

  - Minor Losses (3 90° Elbows, 1 Tee, 1 Check Valve, 1 Globe Valve)(From each tank)

  - 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

Components of Design

- **Boiler**
  - Pittsburgh Automotive 6.25 Gallon Oil Extractor
  - Water level tube attached on outside of tank
  - Pressurized vessel in our system (50 psi)

- **Condenser**
  - Ace / DenHartog 3 Gallon Rectangular Specialty Rinse Tank
  - Non-pressurized vessel in our system

- **Holding Tanks**
  - 6 in. Acrylic Tubes (Walls)
  - 2 – 3 in. Aluminum Stock (End Caps)
  - Needs to be constructed by the team
  - Pressurized vessel in our system (50 psi)

Presented by: Samantha Zeidel

Manufacturing/Machining

- **All modifications will be done at the Verdicorp machine shop**

- **Boiler**
  - Two caps must be designed/machined for the two holes on top of the oil extractor tank
  - First cap must allow the insertion of ½ in. PVC leading to condenser
  - Second cap must allow the insertion of two 1/8 in. stainless steel tubing
  - Bottom of tank must be modified to insert ½ in. PVC from holding tanks

- **Condenser**
  - Two holes must be cut into the top of the tank to allow for insertion of 1/8 in. Stainless Steel tubing

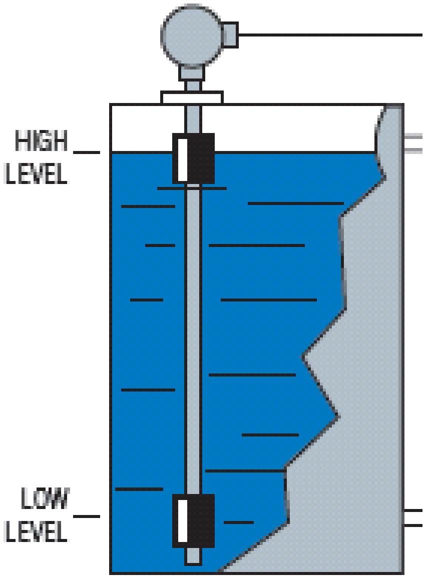
- **Holding tanks**
  - Will be made from 6 in. acrylic tubes (Walls) and aluminum stock (End Caps)
  - Cut acrylic tubing into roughly 1 ft. segments; Machine aluminum stock
  - End caps will be attached to the tube from being press fitted
  - Holes for valves and switches must be made on the end caps

Presented by: Samantha Zeidel

Components of Design

- **Air and Liquid Control Valves**
  - Air: Pneumatic Single Solenoid, 3-way, 1/8 in. NPT
  - Liquid: Pilot Operated Solenoid Valves, 2-way, ¾ in. FPT

- **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 adjusted until at proper heights
  - Sensors will be attached to Relay

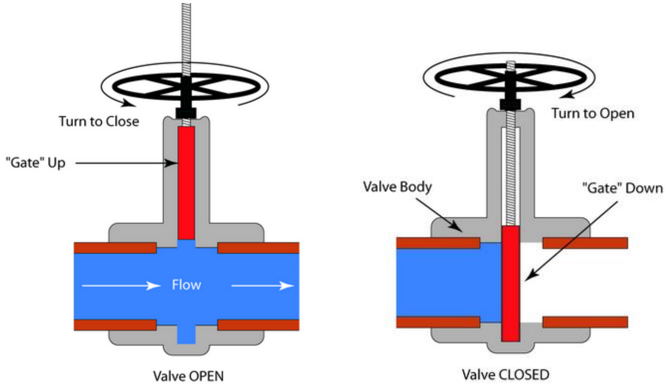


- **Relay**
  - Salvaged from old machines in Verdicorp machine shop
  - Voltage: 24 VDC (Voltage for all electrical components)
  - Control valve position changes will be made from sensor detection
  - No coding required for electrical components

Presented by: Samantha Zeidel

Components of Design

- **Piping**
  - **Water Pipes:** ½ in. PVC Schedule 40
  - **Pressure Pipes:** 1/8 in. Stainless Steel Tubing
  - **All piping components will be threaded to allow for easy modification**

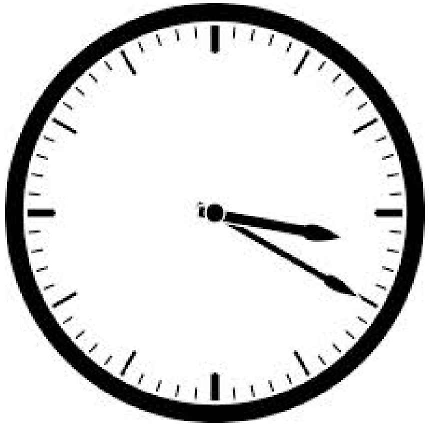


- **Check, Plug, and Throttle Valves**
  - ½ in. PVC SCH 40 In-Line Check Valves
  - ½ in. Plastic Globe Valves
  - ½ in. Brass Gate Valve
  - Require testing to decide which is optimal for design

- **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

Potential Challenges and Risks



- **Challenges**
  - Time constraints
  - Budget constraints

- **Safety Risks**
  - Machine shop safety
  - Refrigerant 245fa
    - Irritation with eye contact
    - Dizziness and increased heart rate if inhaled
    - Testing and calculations will be done with water and compressed air

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	Received
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)	$61.48	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	Pipe Components: Plug Valves, PVC Fittings: Male Fittings for PVC	ACE Hardware	$15.00	Received
Air Compressor, Sensor, Relay, Outer Frame	3.5 Gallon Pancake Air Compressor Sensors, Relays, and Outer Frame from old machines in Verdicorp machine shop	Verdicorp	$0	Received

Presented by: Ryan Laney

Project Procurement

Component	Product Description	Vendor	Estimated Cost	Status
Pressure Line Piping	Stainless Steel Tubing, 1/8” NPT Two 6 ft. segments	Grainger	$25.52	Not Received
PVC and SS Components	Additional PVC and Stainless Steel components, fittings, and piping.	Home Depot and Grainger	$25	Pending
Holding Tanks (End Caps)	End caps will be constructed out of Aluminum stock with 3/8” threaded rod and nuts	Purchased through Verdicorp	$100	Not Received
Pressure Gauges and Flow Meters	Measurement devices to show the proper operation of the prototype	Valves and Instruments (Online)	$200	Pending

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Financial Analysis

- **Overall Budget: $2000**

- Expenditure (Purchased Components): $513.03
  - Air and Liquid Control Valves: $178.34
  - Heat Exchanger: $145.11
  - Condenser: $54.15
  - Holding Tanks (Walls): $88.20
  - PVC Piping, PVC Fittings, Standard Valves: $47.23
  - Air Compressor, Sensors, Relays, Outer Frame: $0

- Estimated Expenditure (Remaining Components): $350.52
  - Pressure Line Piping: $25.52
  - Additional PVC and SS components: $25
  - Holding Tanks (End Caps): $100
  - Pressure Gages and Flow Meters: $200

- **Total Expenses: $863.55**
- **Remaining Budget: $1136.45**

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 for the prototype.
  - The majority of the components have been purchased and are in the possession of the design team.
  - The remaining components are in the process of being purchased.
  - Machining of the components requiring modification has already begun.

Presented by: Ryan Laney

Future Plans

- Finish constructing and machining components that require modification
- Construct the sensors and get all electrical components working
- Finish purchasing the remaining components
- Continue building and testing individual portions of the system
- Analyze the operation of the prototype and make necessary improvements

Any Questions, Comments, or Advice?

Presented by: Ryan Laney