Sludge Handling Automation

MECH/MECA 440 B– Senior Project
Spring 2010

Final Design Presentation

Tuesday, May 11th, 2010
Design Team Members

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Mechatronic Engineering

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Faculty Advisor: Dr. Ramesh Varahamurti
Industry Sponsor

USS POSCO INDUSTRIES

“…To conduct business in a manner that provides maximum value to our customers, owners, and employees. To be the Safest, Most Competitive Flat Rolled Steel Company”
Project Background

- Water utilized at the facility is treated and returned to San Joaquin river/New York Slough.

- Alum is introduced in the process to meet state clarity requirements, creating sludge.

- Sludge is sent to an Oil Separation Unit (OSU).
Project Background

Current Pumping System
Project Need

Pump the sludge from the clarifiers to the Oil Separation Unit without human assistance
Goal Statement

Automate the existing procedure to pump the correct consistency of sludge from the Clarifiers to the Oil Separation Unit (OSU).
Customer Requirements

• The Design Solution Must:
  • Automate the sludge pumping system
  • Switch between clarifiers
  • Utilize Emergency Switch
  • Back flush

• The Design Solution Should:
  • Human Machine Interface

• Would be Nice:
  • Positive displacement pump analysis
# Engineering Specifications & Targets

<table>
<thead>
<tr>
<th>Requirements</th>
<th>Specification</th>
<th>Metric</th>
<th>Method/Device</th>
<th>Target Range</th>
<th>Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pump Sludge</td>
<td>Flow Rate</td>
<td>GPM</td>
<td>Flow meter</td>
<td>50 ± 10 GPM</td>
<td>Minimum</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>100 ± 10 GPM</td>
<td>Maximum</td>
</tr>
<tr>
<td>Regulate Sludge</td>
<td>% Solids in Water Solution</td>
<td>PPM</td>
<td>Turbidity Meter</td>
<td>20% ± 5% solids</td>
<td>Minimum</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>60% ± 5% solids</td>
<td>Maximum</td>
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<tr>
<td>Pressure in Pipes</td>
<td>Pressure</td>
<td>PSI</td>
<td>Pressure Gauge</td>
<td>&lt; 150 PSI</td>
<td>Maximum</td>
</tr>
</tbody>
</table>
Design Solution
Design Solution

PLC Interface With the System

Nusonics Flow meter

Series 90 G.E Programmable Logic Controller

115 VAC Power Supply

Optical Turbidity Meter

Electro-Mechanical Actuator

Centrifugal Pump

Rugged Pressure Sensor
Design Solution

PLC

PLC Genius Blocks
Design Solution

Automatic / PLC

Select Clarifier

Open South Clarifier Valve

Open North Clarifier Valve

Open Flush Valve (Backflush / Prime)

Wait 5 minutes

Open Pump Out Valve

Start Pump

Close Flush Valve

Wait 1 Hour

Check Flow

> 120 GPM

< 55 GPM

120 > GPM > 55

Check Turbidity

< 20% Solids

> 60% Solids

20% Solids < 60% Solids

Adjust Flush Valve

Adjust Flush Valve

Open Flush Valve Full

Close Clarifier Valve

Wait 5 minutes

Stop Pump, Close all Valves

Hibernate System
Design Solution

Semi Manual

Select Clarifier

Push Start

Open Clarifier Valve

Open Flush Valve (Backflush/Prime)

Open Pump Out Valve

Wait 5 minutes

Start Pump

Wait 1 Hour

Close Flush Valve

Close Clarifier Valve

Wait 5 minutes

Stop Pump, Close all Valves

Hibernate System
Design Solution

1. **Manual**
   - Open Clarifier Valve
   - Wait 5 minutes
   - Close Flush
   - Open Pump Out Valve
   - Start Pump
   - Wait 1 Hour
   - Open Flush Valve Full

2. **Close Clarifier Valve**
   - Wait 5 minutes
   - Stop Pump, Close all Valves
   - Hibernate System
Fabrication Changes

- Design Changes
  - Actuators – Now Pneumatic
  - Valves – Now Butterfly
  - Pump – Only 1 Required

- Simulation of Turbidity Meter
Testing Overview

Tests/Checks

- Assembly/Wiring Check
- Engineering Requirements Test
  - System Isolation Test
  - Emergency Stop Test
  - Automatic Test
  - Semi-Automatic Test
Test Results

- Assembly/Wiring
  - PASS
- System Isolation
  - PASS
- Emergency Stop
  - PASS
## Test Results

<table>
<thead>
<tr>
<th>Requirements</th>
<th>Specification</th>
<th>Metric</th>
<th>Method/Device</th>
<th>Test Results (Automatic)</th>
<th>Test Results (Semi-Automatic)</th>
<th>Conditions</th>
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</thead>
<tbody>
<tr>
<td>Pump Sludge</td>
<td>Flow Rate</td>
<td>GPM</td>
<td>Flow meter</td>
<td>18 GPM</td>
<td>16 GPM</td>
<td>Minimum</td>
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<td>65 GPM</td>
<td>49 GPM</td>
<td>Maximum</td>
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<tr>
<td>Regulate Sludge</td>
<td>% Solids in Water Solution</td>
<td>PPM</td>
<td>Turbidity Meter</td>
<td>N/A</td>
<td>N/A</td>
<td>Minimum</td>
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<tr>
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<td>N/A</td>
<td>N/A</td>
<td>Maximum</td>
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<tr>
<td>Pressure in Pipes</td>
<td>Pressure</td>
<td>PSI</td>
<td>Pressure Gauge</td>
<td>60 PSI</td>
<td>53 PSI</td>
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## Discussion of Results

<table>
<thead>
<tr>
<th>Requirements</th>
<th>Specification</th>
<th>Metric</th>
<th>Method/Device</th>
<th>Target Range</th>
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<th>Test Results (Semi-Automatic)</th>
<th>Conditions</th>
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</thead>
<tbody>
<tr>
<td>Pump Sludge</td>
<td>Flow Rate</td>
<td>GPM</td>
<td>Flow meter</td>
<td>50 ± 10 GPM</td>
<td>18 GPM</td>
<td>16 GPM</td>
<td>Minimum</td>
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<td>100 ± 10 GPM</td>
<td>65 GPM</td>
<td>49 GPM</td>
<td>Maximum</td>
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<tr>
<td>Regulate Sludge</td>
<td>% Solids in Water Solution</td>
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<td>N/A</td>
<td>N/A</td>
<td>Minimum</td>
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<td>60% ± 5% solids</td>
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<td>N/A</td>
<td>Maximum</td>
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<tr>
<td>Pressure in Pipes</td>
<td>Pressure</td>
<td>PSI</td>
<td>Pressure Gauge</td>
<td>&lt; 150 PSI</td>
<td>60 PSI</td>
<td>53 PSI</td>
<td>Maximum</td>
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<tr>
<td>Available to Use, (Already Purchased Parts)</td>
<td>Unit Price</td>
<td>Quantity</td>
<td>Final Price</td>
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<td>-------------------------------------------</td>
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<tr>
<td>Centrifugal Pumps</td>
<td>$1,125</td>
<td>2</td>
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<td>4” - #150 Pipe</td>
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<td>2” Actuated butterfly flow screw</td>
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<td>4” pneumatic Actuated Butterfly valve</td>
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<td>4” Butterfly gate valve</td>
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<table>
<thead>
<tr>
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<th>Unit Price</th>
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<tbody>
<tr>
<td>Viatran 548 Pressure Gauge</td>
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<td>Turbidity Meter and Assembly</td>
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</table>

<table>
<thead>
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<tr>
<td>Design</td>
<td>Mech. Eng.</td>
<td>$34.97/hour</td>
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<td>Meca. Eng.</td>
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<td>Manufacturing</td>
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<td>Overhead @ 40% per labor hour</td>
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<tr>
<td>Benefits @ 37% per labor hour</td>
<td>$8,307</td>
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</tbody>
</table>

Total Cost = $77,208

Parts on Hand = $32,254
Donated Labor + Expenses = $21,200 + 17,287 = $36,754
Final Cost = $77,208 - $69,008 = $ 8,200
Additional Content

- Unique problems encountered
  - Turbidity Meter (Shipping Times)
    - Simulate using current supply
- Suggestions for the future
  - Change injection valve to variable position
- Revise Specifications
  - Refine % Solids once turbidity meter is installed
Conclusion

- All the design specifications are met
Acknowledgements

- USS-Posco
  - Frank Martucci
  - Mike Atwood
  - Natalie Tkachenko
  - Todd McHugh
  - Ron Hatchel