Post-Pump Measurement and Composition Specifications. These specifications are from ASME B73 Pump Standards (Burkhardt & Wood, n.d.).

According to OSHA 29 CFR-1910, several safety precautions must be kept in mind when purchasing counter-heating pumps in the system. The solution will prevent the corrosion in the pipe infrastructure.

### Oil Analysis

#### Reasons for an Oil Analysis

A large factor in the deterioration of the bearings within Weyerhaeuser's thermal oil systems was determined to be the low quality of oil being pushed through the thermal oil pumps.

#### Oil Quality

Oil can decline when various particulates end up in an oil reservoir. These particulates can range from sodium to potassium to various metals. The quality of the oil is measured through ISO codes.

ISO Codes

As presented in Table 1, ISO codes are a numeric representation of the number of particulate present in a fluid (note that the values are not limited to those shown in the table, ISO code values below and above 24 exist). The higher the ISO code number, the lower the particulate present, and the lower the oil quality. ISO codes are presented in groups of three representing >4 µm, >6 µm, and >14 µm respectively. An ideal ISO code value would be 10/10/10.

Weyerhaeuser's ISO codes far exceeded this, which is why filtration is being recommended.

<table>
<thead>
<tr>
<th>ISO Code</th>
<th>Description</th>
<th>ISO Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>000</td>
<td>Below 1 µm</td>
<td>005</td>
<td>1-6 µm</td>
</tr>
<tr>
<td>010</td>
<td>6-14 µm</td>
<td>020</td>
<td>14-32 µm</td>
</tr>
<tr>
<td>025</td>
<td>32-64 µm</td>
<td>040</td>
<td>64-128 µm</td>
</tr>
<tr>
<td>050</td>
<td>128-256 µm</td>
<td>075</td>
<td>256-512 µm</td>
</tr>
<tr>
<td>100</td>
<td>512-1024 µm</td>
<td>150</td>
<td>1024-2048 µm</td>
</tr>
<tr>
<td>200</td>
<td>2048-4096 µm</td>
<td>300</td>
<td>4096-8192 µm</td>
</tr>
</tbody>
</table>

### Summary

The pre-mature bearing wear in Weyerhaeuser’s pumps was determined to be caused by the high particulate count in the oil flowing through the system. The pre-mature bearing wear of the oil analysis showed that the oil is not cost effective.

#### Design Alternatives

**Kidney-Loop Filtration System**

- Often used to circulate fluids of systems in the reservoir to filter contaminants out of the fluid
- Consists of a pump, motor, and filter, which act independently from system
- Fluids pump through a short filtration circuit, then returns clean fluid to the reservoir
- This type of filtration system is secondary filtration

**Side-Stream Filtration System**

- An industry-standard for piping systems with centrifugal pumps
- The flow is running antiparallel to the flow through a pump
- The initial junction of the filter is on the system supply side of a pump
- The final junction of the filter system is at the return side of the pump

### Total Flush of the System

The high contamination of the thermal oil could indicate sludge in Weyerhaeuser’s thermal oil pump system. Identification by large amounts of buildup at the bottom of storage tanks and corrosion in the pipe infrastructure.

Common management of excessive particulate in a system is a total flush. Flushing is a procedure that drains and cleans a pump system by a three-phase process: draining, flushing, and purging.

### Kidney Loop Filtration Unit

#### Reasons for Decision

- Minimal pressure loss in system
- Low initial cost compared to other the alternatives
- Minimal to no plant downtime
- Low filter exchange over entire period of usage
- Low safety risk

#### Requirements

- Must be able to operate with thermal oil temperatures above 500 degrees Fahrenheit
- Filtration pump must provide enough outlet pressure to pump the oil through the filtration system and back into the reservoir
- Approximately 30 gallon per minute pump and 80 psi max pressure

### Implementation

- Attached to existing reservoir
- Powered by Motor Control Center unit
- Installed by provider or Weyerhaeuser technician

### Maintenance

- Rental option
- Requires about 8 filter exchanges the first month of the first year
- Requires about 1 filter exchange during the month in years 2-5
- Purchase Option
- Requires about 19 filter exchanges during the first year
- Requires about 6 filter exchanges in years 2-5
- Miscellaneous monthly checkups to maintain structure integrity
- Service offered by provider, but may be handled by Weyerhaeuser

### Economic Analysis

Two quotes were obtained for high particulate removal kidney loop systems from Reliable Industry Group (RIG) and SC Industrial. These economic criteria were used to determine whether the rental or purchase option would be more cost effective.

#### Cost Ratio

<table>
<thead>
<tr>
<th>Economic Criteria</th>
<th>RIG Rental Option</th>
<th>SC Industrial Rental Option</th>
</tr>
</thead>
<tbody>
<tr>
<td>Net Present Value</td>
<td>-$39,792</td>
<td>-$84,407</td>
</tr>
<tr>
<td>Benefit to Cost Ratio</td>
<td>0.77</td>
<td>0.79</td>
</tr>
<tr>
<td>Payback Period</td>
<td>3.33 years</td>
<td>3.50 years</td>
</tr>
</tbody>
</table>

#### Economic Criteria RIG Purchase Option Comparison

<table>
<thead>
<tr>
<th>Economic Criteria</th>
<th>RIG Purchase Option</th>
<th>SC Industrial Purchase Option</th>
</tr>
</thead>
<tbody>
<tr>
<td>Net Present Value</td>
<td>-$4,150</td>
<td>-$84,407</td>
</tr>
<tr>
<td>Benefit to Cost Ratio</td>
<td>0.49</td>
<td>0.79</td>
</tr>
<tr>
<td>Payback Period</td>
<td>3.76 years</td>
<td>3.71 years</td>
</tr>
</tbody>
</table>

### Summary and Recommendation

The pre-mature bearing wear in Weyerhaeuser’s pumps was determined to be caused by the high particulate count in the oil flowing through the system. The pre-mature bearing wear of the oil analysis showed that the oil is not cost effective.

**Economic Analysis**

- Analysis between the purchase and rental options showed that the rental option is more cost effective.
- The high particulate removal kidney loop system from RIG was chosen for the final design solution based on the higher net present value, benefit to cost ratio, and nearly the same payback period.
- Compliance with timely communications and helpful information given by RIG was a factor that helped decide to choose their filtration system, as they were very invested in responding with any requested information.

### References


### Acknowledgements

Our team would like to thank Weyerhaeuser for the opportunity to work on this project. Special thanks is to be given to Matt Barnhart, the maintenance manager for Weyerhaeuser, who acted as our contact, and aided us throughout the duration of the project. We would also like to thank our instructors, especially Dr. Srivastava, for their guidance.