Design, Manufacturing, Assembling, Installation, Start-up and First Operating Experience of a 56 Foot Long Vertical Molten Sulphur Pump

25th International Pump Users Symposium, Houston, Texas

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Introduction

- New safety concept at a chemical plant in Sweden
- No tapping of tanks on the side wall
- All equipment has to be introduced from the top of the tank
- New sulphur tank at the ship unloading terminal
- Requirement of a 56 foot long vertical molten sulphur pump
Properties of Molten Sulphur

Design

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Properties of Molten Sulphur, H$_2$S Content
Design

- Up to 3 stages: high heads at slow speeds
- Discharge and shaft column compact unit
- Small opening in the tank
- Wet shaft, pressure from impeller back side
- Bearing lubrication from discharge pipe
- Double volute casing, low radial loads
- Materials: Cast Iron, Cast Steel, Stainless Steel
Design

- Pump size: 4” discharge flange
  12” impeller diameter
- Capacity: 308 gpm; Head: 72 foot
- 11 sulphur lubricated intermediate bearings
- 11 shaft pieces
- Setting length: 56 foot
- 3 independent heating sections
- Cast Material: Cast Iron GG 25
- Sleeves: Chrome steel (13%)
- Bushing: Alloyed cast iron (3% Ni)
- Pipes and Shaft: Steel
- Weight: 3.300 lb
Material with similar heat expansion coefficient
Pump will grow 1.1“ (30mm) after heating up
Steam lines and all internal connections flanged
Drain holes in each section to avoid solidification
Shaft piece connections with threats but also sleeves with keys to allow reverse rotation
FEM calculations are mandatory for these pumps
Design

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**Temperature interaction:**

- thermal expansion of the unit
- shaft and pipe expansion
- axial impeller gap

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Site assembly & installation

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**Site assembly & installation**

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### Heating cycles (empty tank)

<table>
<thead>
<tr>
<th>Heating Section</th>
<th>Heating Time</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1. Day (24 hours)</td>
</tr>
<tr>
<td>1 Top</td>
<td>✔️</td>
</tr>
<tr>
<td>2 Center</td>
<td>✔️</td>
</tr>
<tr>
<td>3 Bottom</td>
<td>✔️</td>
</tr>
</tbody>
</table>

- Heating up of entire pump
- Check turning of shaft by hand
- Check direction of rotation
- Start the pump
- Monitor vibrations and current
Start-up and first operating experience

Vibration Measurement

- Start up in May 2006
- Vibration values from 0.07 to 0.1 in/s
- Life time of sleeve bearings?