Fermentation Vessel Design
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What’s new in fermenter design?
• Is it a properly designed cooling jacket system than can decrease tank time due to faster cooling which also increases fermentation capacity?
• Is it a properly designed refrigeration system that can reduce refrigeration costs significantly?
• Is it because a properly designed insulation system can insure vessel performance?

Topics of Discussion
• History of the fermenter
• Construction styles
• Design criteria
• Materials of construction
• Cost implications
VAT-VAR BREWERS ENAMEL

A flexible lining for fermentation,
Shinee Tubs and Boiler Tubs,
FOR HOT WATER TANKS, WORT TANKS,
MASH TUN, ETC., SPECIFY
High Melting Point VAT-VAR ENAMEL.

VAT-VAR Thinner

Vat-Thinner Thinner is added to Vat-Enamel in order to reduce evaporation loss. If Vat-Thinner has been added, due to exposure of all.

GARANTIES:
Non-Inflammable...Non-Toxic

No Hydrogen
No Fuming
Non-Acidic

No-Bleed
Unaffected with Beer or Heavy Alcohol.

EMERALD.
Fermenter Design Criteria

Operating conditions consider...
• Pressure and temperature
• Structural design
• Vessel support
• Heat Transfer

Design Codes

• ASME Section VIII, Div. 1
• API 620
• API 650

Pressure/Vacuum Safety Devices

• Dead weight
• Spring loaded
• Rupture disc
• Breaker bar
Vertical Fermenter Support Systems

- Solid fill foundation
- Skirt support
- Leg support
- Muscle ring/lug supports
Q = "U" x A x T

Q = Rate of heat transfer
U = Thermal conductivity
A = Jacket area
T – Temperature difference between beer and coolant
28% scale model of the actual production size fermenter
Tank Geometry Cost Analysis

- 2 to 1 H/D vs. a 1 to 1 H/D
- Base price approximately the same
- 2:1 less material waste for the cone, support structure is shorter and smaller compression bars for the top and bottom required
- This more than offsets the 6 – 8% savings in the material, 1:1 requires 10% more jacket for cooling duty

Cooling characteristics of different cone bottom angles

- 45° angle bottom best performance
- 25° angle 2nd best
- 60° angle slightly worse

Cooling Medium Temperature

- 25.5 to 26.6°F produced the best results with no product freezing
- 22.1°F average temperature caused product to freeze at an average product temperature in the fermenter of 37.8°F

Total fermenter project costs

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
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</thead>
<tbody>
<tr>
<td>Building works</td>
<td>19%</td>
</tr>
<tr>
<td>Tanks and insulation</td>
<td>31%</td>
</tr>
<tr>
<td>Cooling system</td>
<td>15%</td>
</tr>
<tr>
<td>Controls</td>
<td>7%</td>
</tr>
<tr>
<td>Piping and valves</td>
<td>13%</td>
</tr>
<tr>
<td>Electrical</td>
<td>5%</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>10%</td>
</tr>
</tbody>
</table>

Insulation Systems

- Panel Systems
- Pour in Place
Refrigeration System Design
Cooling System Capital Costs

Ammonia: $202,500  
Glycol: $235,500

Refrigeration Operating Costs

• 345 tons (75 tons for three crash cooled fermenters + 120 tons for three other tanks in various stages)
  - Ammonia flow rate = 110 GPM = 10 HP pump
  - Glycol flow rate = 1700 GPM = 100 HP pump

Refrigeration Operating Costs

• 26.6° F ammonia w/2 PSIG pressure drop in suction piping = 39 PSIG compressor suction pressure
• Glycol supplied at 21° F & returning at 26° w/2 PSIG pressure drop in suction piping & allowing 5° split in glycol chiller = 16° F ammonia in chiller & 28.4 PSIG compressor suction pressure

Refrigeration Operating Costs

• Compressor operation of 39 PSIG compared to 28.4 PSIG yields 18% compressor power savings
• Compressor + pump HP results in savings of 45,000 KWH per month, based on 20 day cycle for each of the 6 tanks
  - 45,000 KWH x 6 cents per kilowatt hour = $2,700 per month or $32,400 a year in operation savings
• A poorly insulated tank farm can cost you additional dollars

Materials of Construction

• 304 stainless steel in 2B or #4 finish
• Some brewers are mechanically or electro-polishing the bottom cone
• Stainless steel pricing is at a 30-year high due to a variety of factors, China, weak dollar, mine strikes…
• Advice to brewers, to plan project well in advance, have the supplier state surcharge and $/lb in the quotation

Thank you!