

Fermentation Vessel Design

by
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March 25, 2004



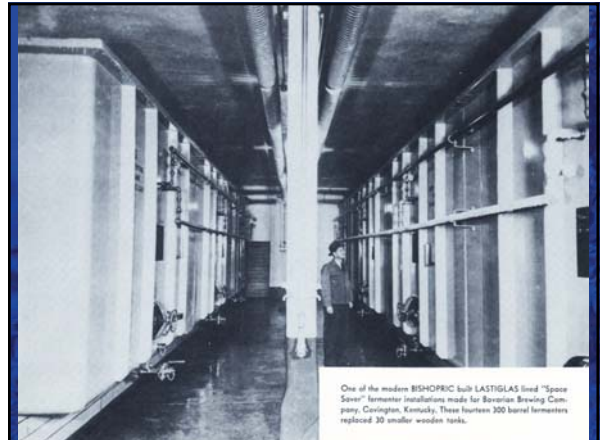
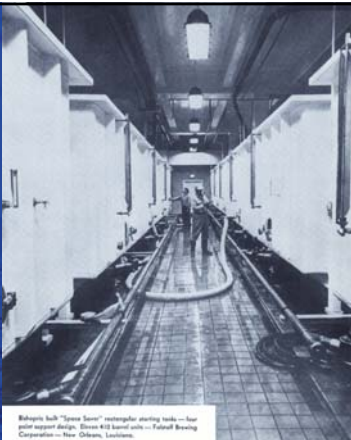
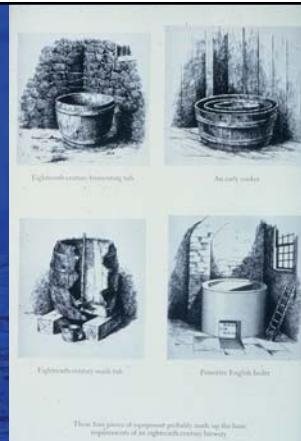
What's new in fermenter design?

- Is it a properly designed cooling jacket system that 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





GUARANTEED
Non-Inflammable . . . Non-Explosive



Outlets
Other
Coatings

No Heating
No Flaming
Easily
Applied
with Brush
or Spray

VAT-VAR BREWERS ENAMEL

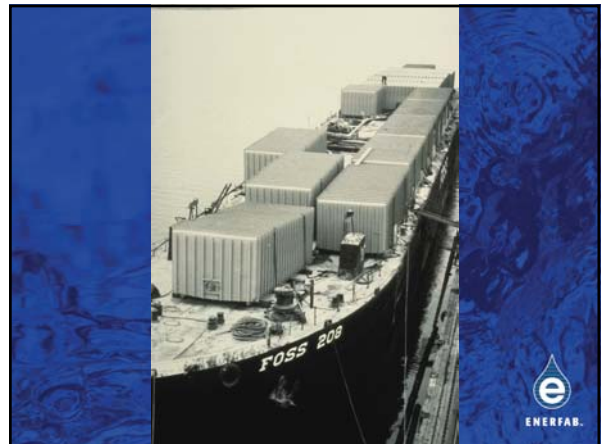
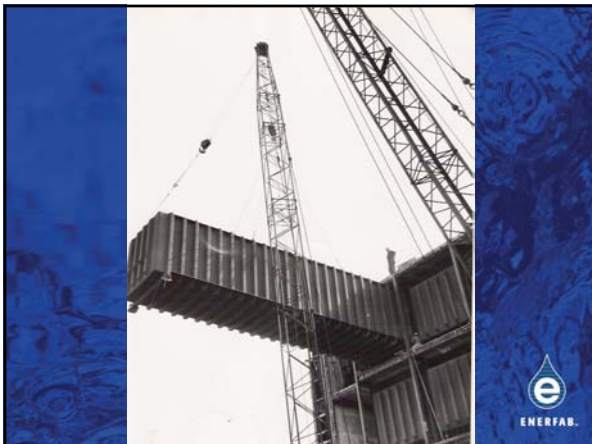
A Flexible Lining for Fermenters,
Storage Tanks and Racker Tanks.
FOR HOT WATER TANKS, WORT TANKS,
MASH TUBS, ETC., SPECIFY
High Melting Point VAT-VAR ENAMEL

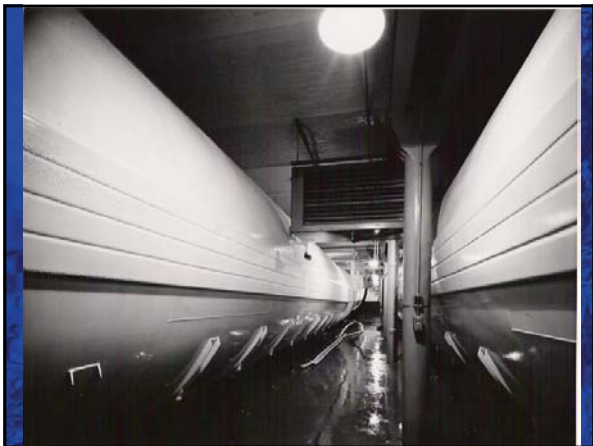
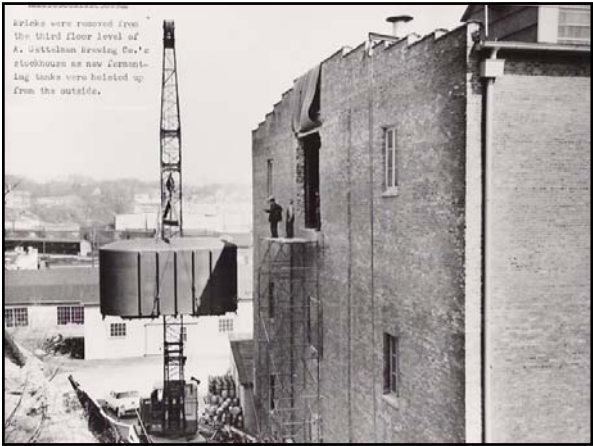
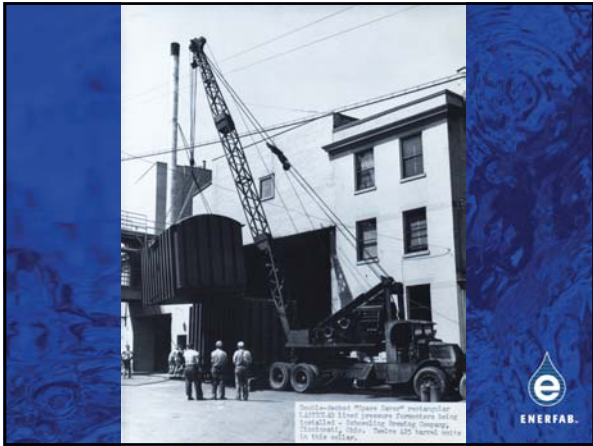
VAT-VAR Thinner

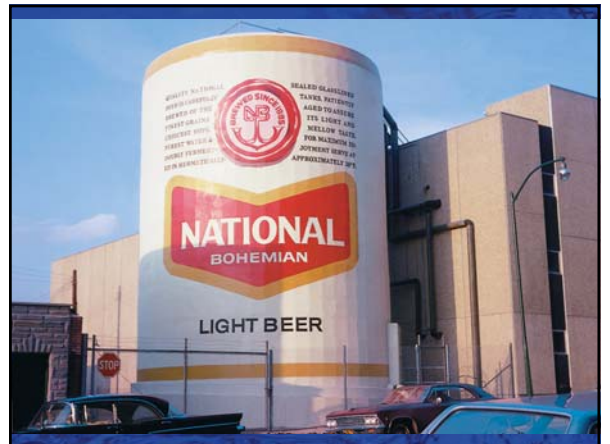
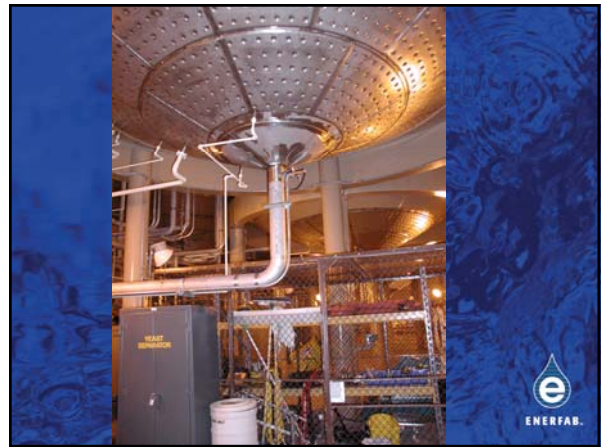
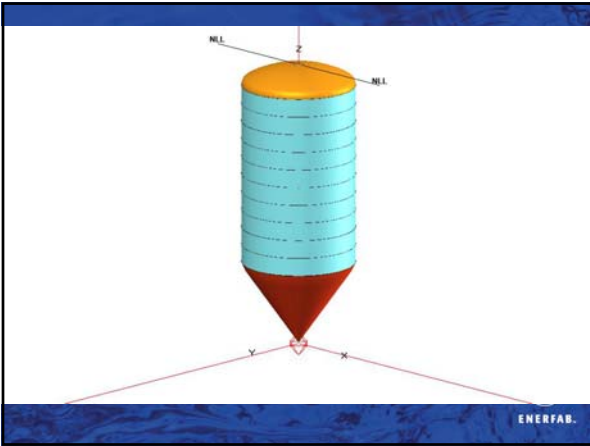
Vat-Var Thinner is added to Vat-Var Enamel in order to reduce evaporation loss. If Vat-Var Enamel has become tacky due to exposure of air, add about one gallon of thinner to every ten gallons of Vat-Var Enamel. This will make the enamel flow smoothly and evenly.



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Fermenter Design Criteria

Operating conditions consider...

- Pressure and temperature
- Structural design
- Vessel support
- Heat Transfer



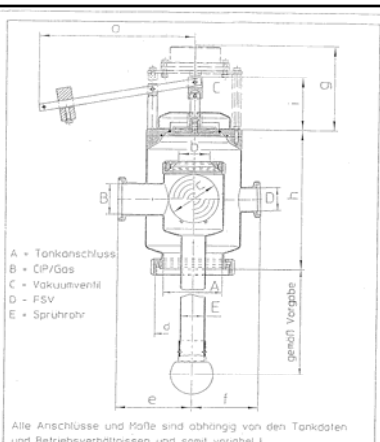
Design Codes

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

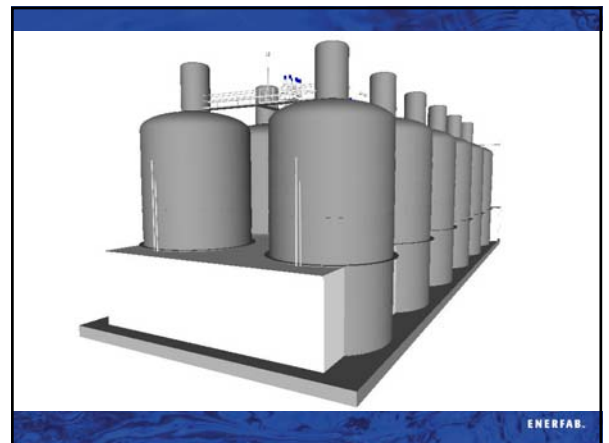
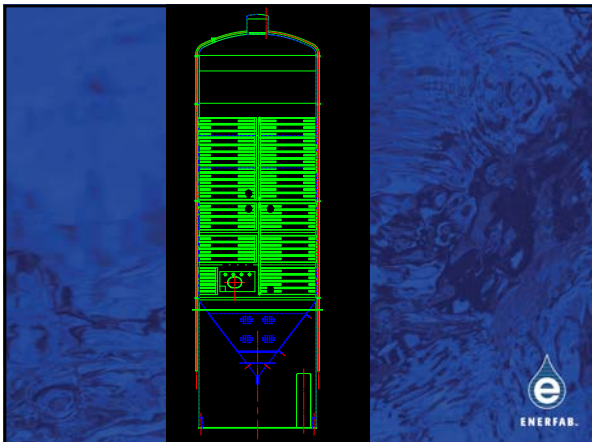
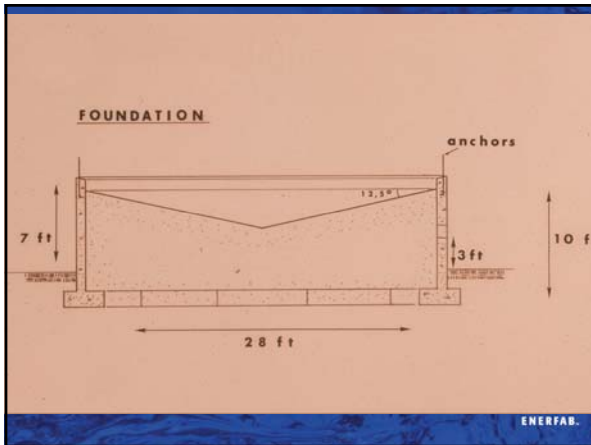
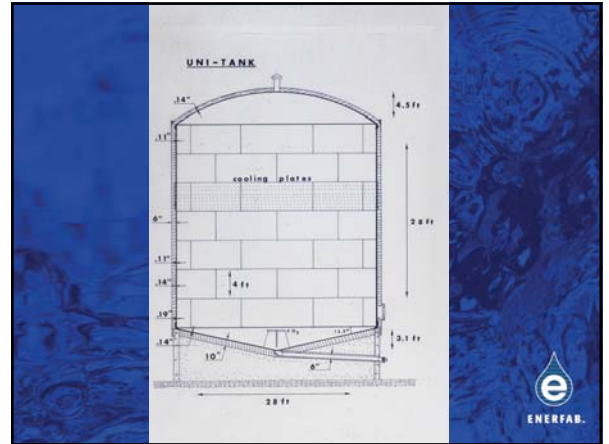


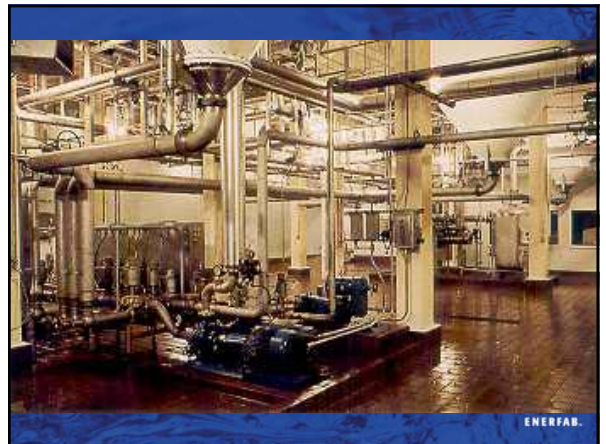
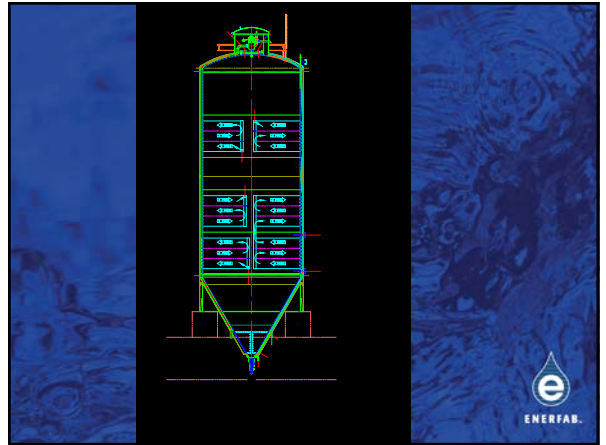
Pressure/Vacuum Safety Devices

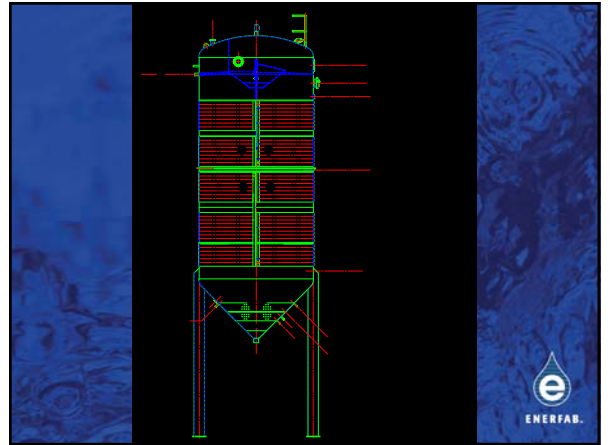
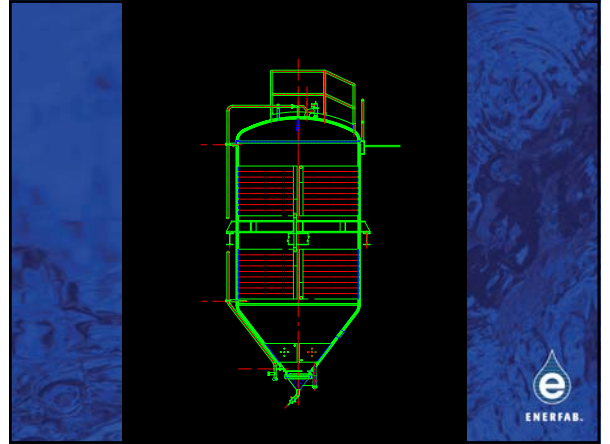
- Dead weight
- Spring loaded
- Rupture disc
- Breaker bar

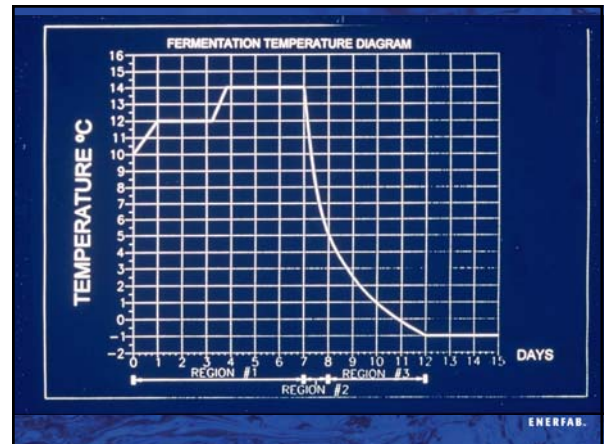
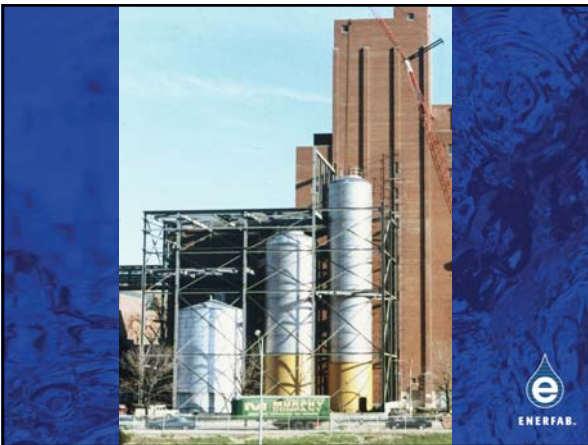
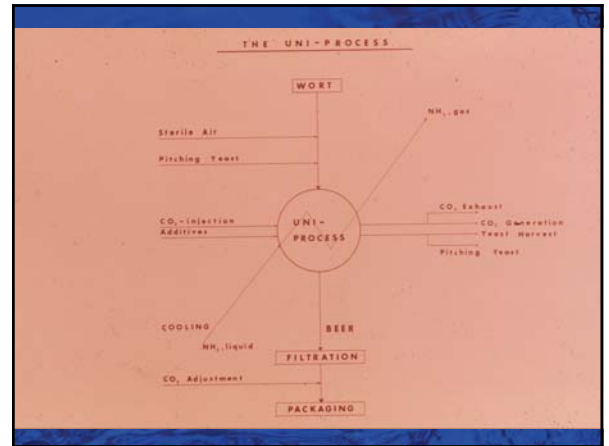


- Solid fill foundation
- Skirt support
- Leg support
- Muscle ring/lug supports









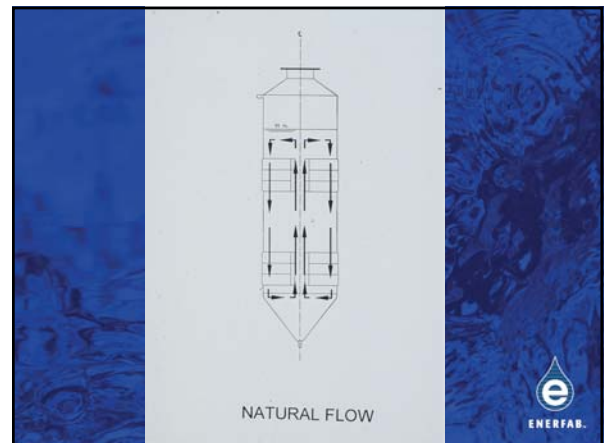
$$Q = "U" \times A \times T$$

Q = Rate of heat transfer

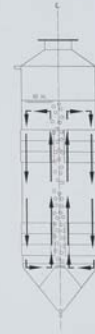
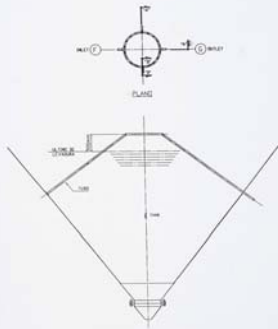
U = Thermal conductivity

A = Jacket area

T – Temperature difference between beer and coolant



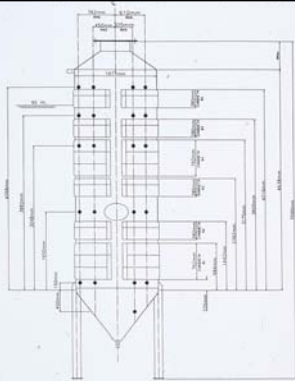
CO₂ INJECTION RING



FLOW WITH INJECTION OF CO₂



28% scale model of the actual
production size fermenter



• TEMPERATURE SENSOR



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

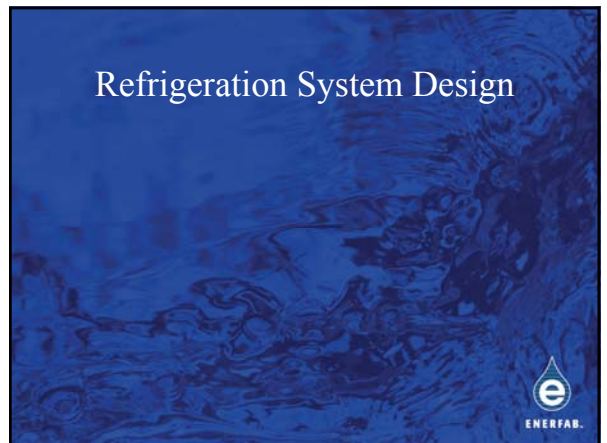
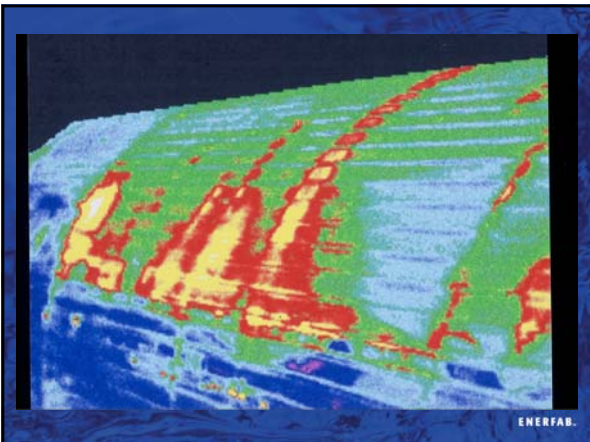
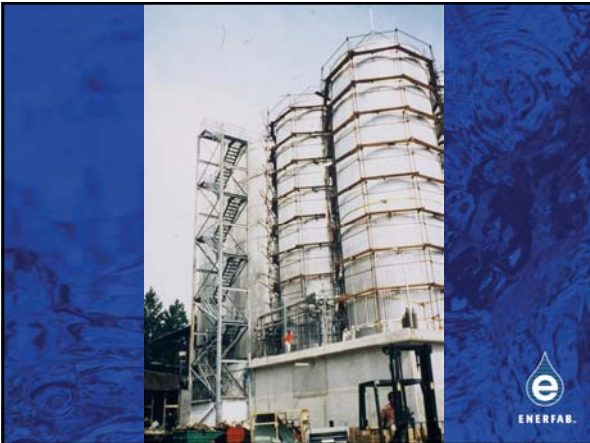
Building works	19%
Tanks and insulation	31%
Cooling system	15%
Controls	7%
Piping and valves	13%
Electrical	5%
Miscellaneous	10%



Insulation Systems

- Panel Systems
- Pour in Place





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!

