Moving
Brick Lined Acid Towers

Presented during
Cobras 2013
Recife, Brazil

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Questions Arising Out of a Safe Transportation of Brick-lined Vessels

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These are the main question we will be dealing with in this presentation

- Is there a way to safely ship and lift brick lined vessels ?
- Which are the factors that make Koch Knight LLC lined vessels transportable? Membrane, Brick installation and brick quality, supervision, maintenance, and inspections.
- What are the limitations for shipping and installing on site?
- Will the tower be damaged by bricking on site and then lifting to final location or sliding into final position?
- What are the limitations?

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Lining Considerations

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What role does each component play

- Carbon Steel Shell
  - Process/Pressure retaining vessel. Supporting structure for the brick lining.
- Membrane
  - Is the corrosion barrier for the carbon steel shell. It is the gas/ liquid barrier. The thicker the membrane the more forgiving it is to movements, temperature expansion and chemical swelling of the brick. When we transport vessels we always install our proprietary acid resistant membrane PYROFLEX™
- Brick Lining
  - Is the mechanical and temperature barrier to protect the membrane. If keyed in, by using formed brick, little to no movement will occur during transportation.

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Steel Vessel Design Considerations

- ASME Section VIII Div 1. U-stamped
- Minimum shell thickness 10 mm. To minimize shell deflection
- Watch for pressure cycling. Especially on heads. If vessel is large enough you may need radial stiffeners. FEA is a good way to evaluate.
- Don't skimp on body flange thickness and bolt size.
- Use vacuum rings for extra shell stiffening if required
- Extra re-pads on lifting lugs and trunions to minimize shell deflection. Take a close look at the support system.
- Weld and surface preparation. E.g. NACE #1 or SSPC-SP05, all circumferential and longitudinal welds ground flush, all radius ground to min 3mm. Refer to Koch Knight TL-111
- Check for out of roundness of vessel acc. to ASME or DIN

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Membrane Selection

- Selecting the proper membrane system.
  - Is it compatible with the operating conditions?
  - What is the maximum service temperature at the stated chemistry.
  - Need to determine what temperature to target the membrane for.
  - How much thermal protection do you need to get to the max serviceable temperature. Need temperature profile or FEA analysis
  - Are you moving the tower after brick-lining has been installed

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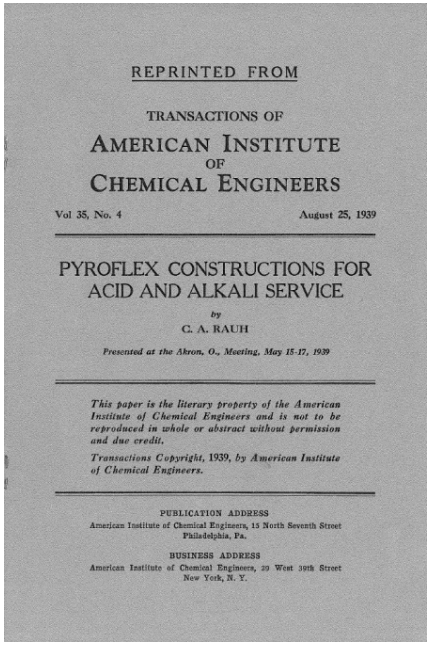
PYROFLEX™ Membrane

- First Introduced in 1935 and continuously improved
- Over 2500 PYROFLEX™ lining application worldwide



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PYROFLEX CONSTRUCTIONS FOR ACID AND ALKALI SERVICE

by

C. A. RAUH

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PYROFLEX™ Membrane

- Fused directly to the steel shell, high bond strength, no adhesives required.
- Acts as an expansion joint between masonry and the steel shell, especially needed in large diameter vessels.
- Much thicker than conventional membranes. Allow for brick and shell expansion/contraction.
- Completely seals carbon steel shell from chemical attack and corrosion.
- Serviceable to 107°C.
- 9 mm thick sheets (700mm x 1075mm sheets)
- Solvent free, no shrinkage during installation. High Flash point.
- Spark testable prior to brick installation.
- Continuous, butt welded uniform lining with no lap joints.
- Remains permanently plastic and resistant to aging and weathering.
- Service life up to 40+ years.

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PYROFLEX™ Membrane Installation Movie

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Brick Selection

Selecting the mechanical and thermal barrier

- After selecting the membrane, the brick lining is designed to provide the necessary mechanical and insulating protection to the membrane. The steady state temperature profile should be developed to prove a safe operating temperature.
- Acid resistant brick comes in different ceramic matrixes with different thermal conductivity and thermal expansion coefficients. All of which must be taken into consideration
- Acid brick is also manufactured in different sizes and forms to adapt to the geometry of the vessels and linin requirements.

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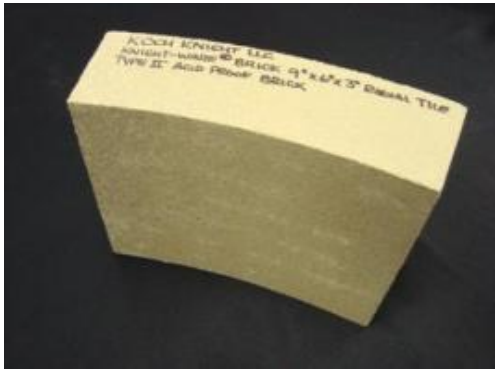
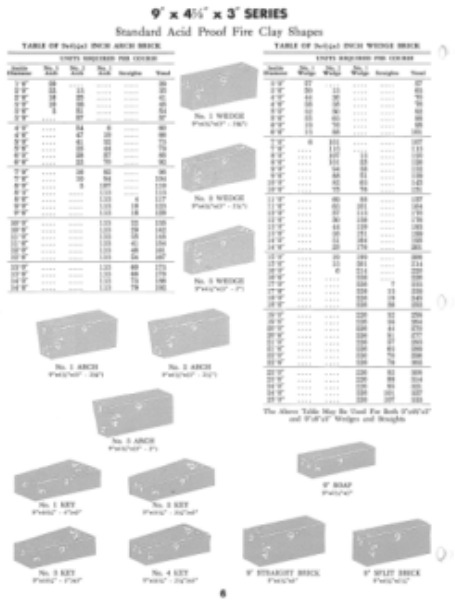
Brick Selection

- **KNIGHT-WARE® ACID PROOF BRICK**
  - Fireclay Acid Bricks. 68%SiO_2/30Al_2O_3
  - ASTM Type II or III
  - Pressed or Extruded shapes
  - Shapes examples:
    - US Standard Shape series
    - Metric Shape series (220 and 240mm)
    - Common Industry shapes
    - Custom shapes for Knuckles, Heads and Compression rings





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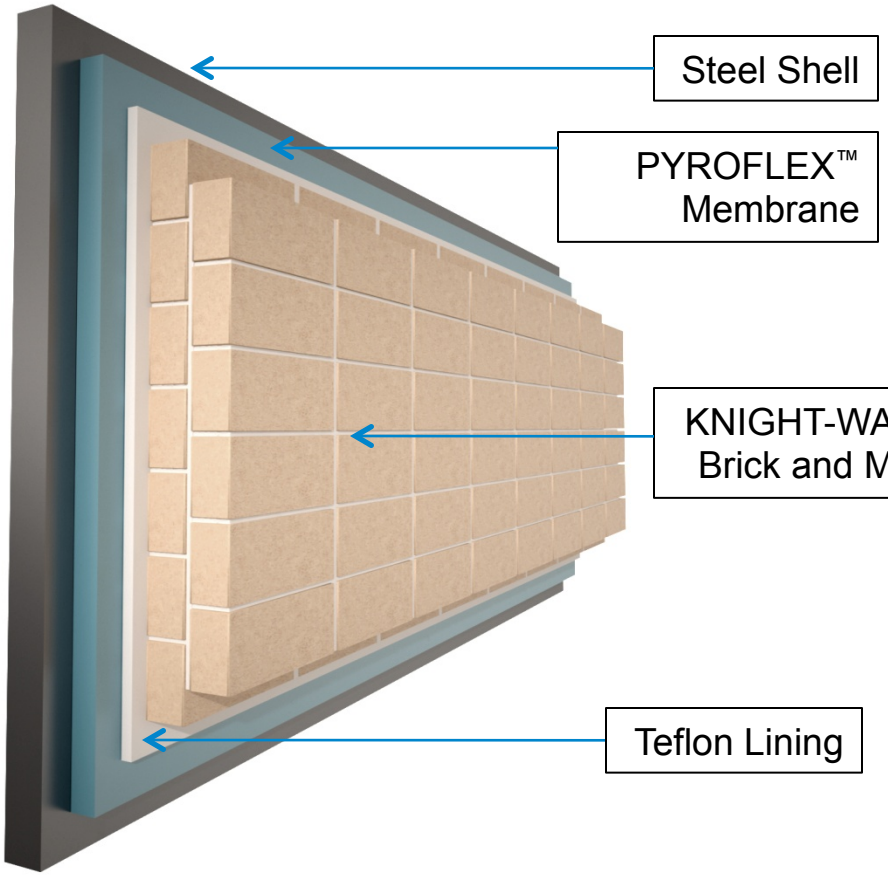
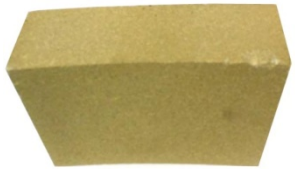
Acid Proof Lining System



Fireclay Type II/ III



KNIGHT-WARE™ Acid Brick
3”[76mm] Radial Tile
138” ID – 144” OD

HD Acid Brick (Type III)

Porcelain

Red Shale Type III

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Limitations on Transportation of Shop- Lined Vessels

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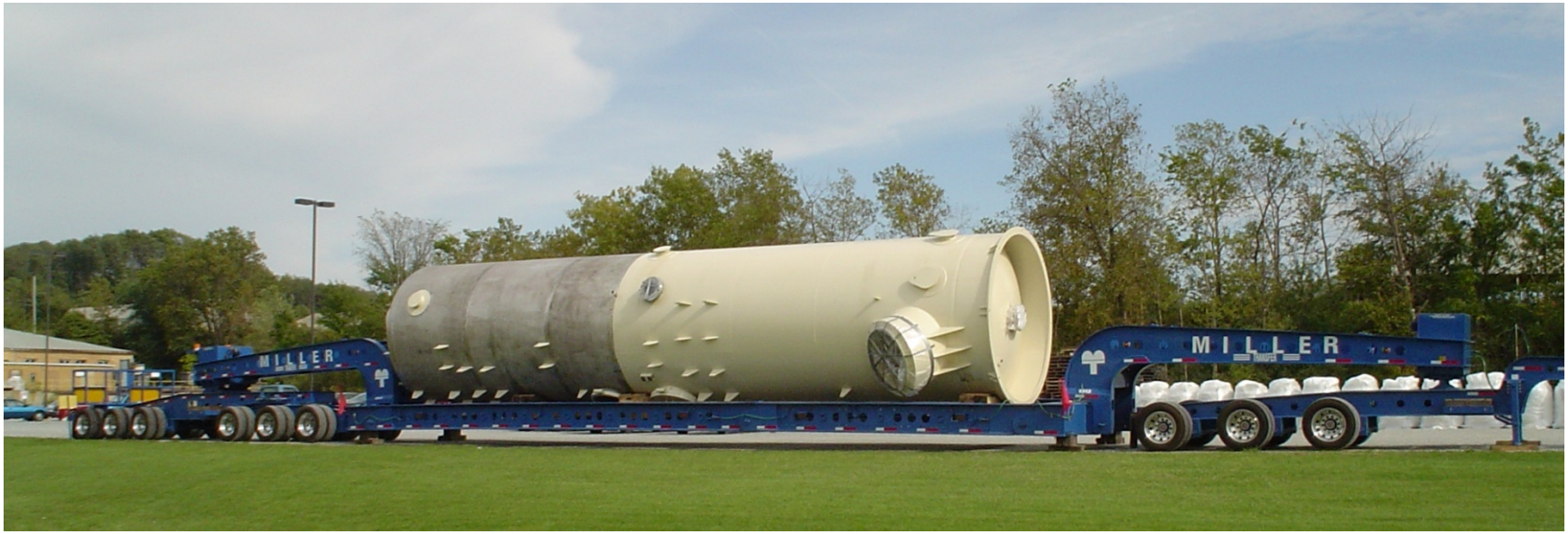
Construction/Installation



Shop Lining up to 3500mm DIA and up to 35 000 mm

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On Site Construction: Steel Work

Field Lining over 3500 mm

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"Myths" regarding brick lined vessels

- Brick lined vessels are quite sturdy and can be "pushed and lifted" around.
- Lifting and pushing means that some more in depth structural analysis has to be done insuring stresses and strains in the shell and bricklining are taken care of
- Towers can even fall from a truck and not need any repair afterwards. We check in any case that the lining is intact in perfect working conditions.
- Limitation to lift normally are given by the weight the available crane can handle. In developing countries this might be a limitation, but not in industrialized ones.

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"Myths" regarding brick lined vessels

- An alternative to lifting is pushing the vessel into place. This alternative works as long as there is a free path to the final position .
  Here are some examples of "bigger boys" having been pushed into another position to be able to save them. Both are constructions made out of concrete or brick, which are quite sensitive to being moved in an abrupt manner.
  - Cudecom Building in Bogota Colombia with a weight of 7,000 Tons pushed into new position 1974.
  - Cape Hatteras Light Station in North Carolina with a weight of 4,400 tons pushed into new position 1999.

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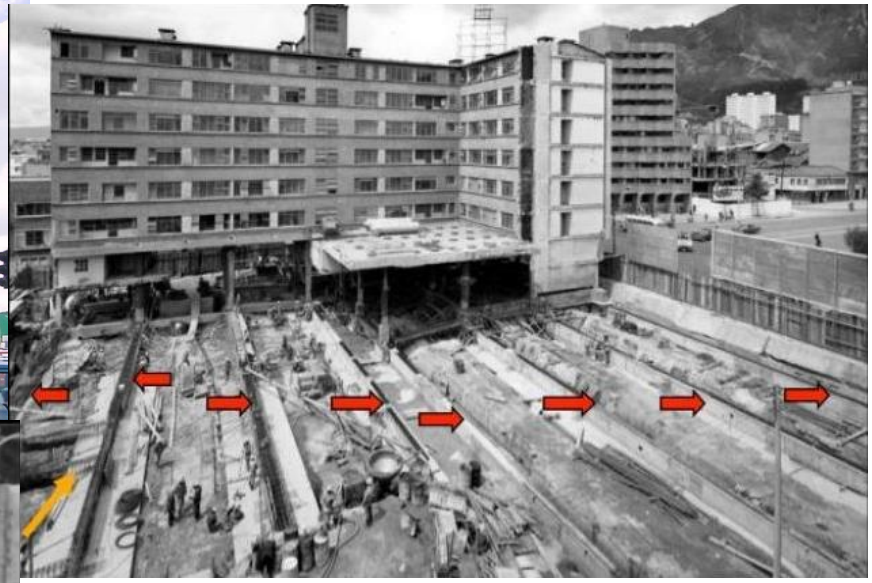
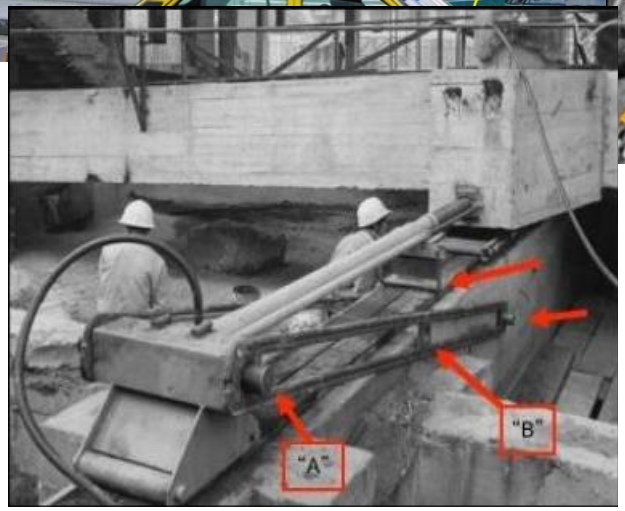
Examples of Buildings moved around





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Examples of Buildings moved around

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"Myths" regarding brick lined vessels

- In the end moving and lifting is a matter of
  - Good planning
  - Having done your structural homework regarding shell thickness. Lifting lugs, supporting structure, dome support ring, differential temperatures on shell, seismic and wind loads, etc.
  - Implementing the correct transportation and lifting/ pushing techniques to achieve the goal of setting the vessel in its final position
  - Getting the right people and companies on-board to do the job. The local "old guy" with a truck and a crane won't do.

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Some examples of Shop-lined Vessels sent to site

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Shop Lined Vessels

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Shipping and Installing Brick Lined Vessels

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Shipping Vessels

Brick Lined Vessels

Safely transport from shop lined facility to site.

Must adhere to state and federal transportation laws and load barring routes.

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Shipping Vessels

Oversized Vessels

Require specialized tractor-trailer and certified drivers to transport.

Must adhere to state and federal transportation laws and load barring routes.

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Shipping Vessels

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Shipping Vessels

Even with an unforeseen incident, during transportation, the brick lining system was undamaged and repair work to the outer shell was minimal.

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Installing Vessels

Brick Lined Vessels

Once transported to site, easily can be craned or railed into position without damage to the brick lining system.
Internals are installed on site.
In some cases, some bricks may come loose and spot fix will be necessary.

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Installing Vessels

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Inspections and Supervision

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Installation and Supervision

- Need Competent/Good medium-skilled labor installation
  - Worker who can follow industry installation standards
- Need Good Supervision of lining installation
  - Experience is everything here!

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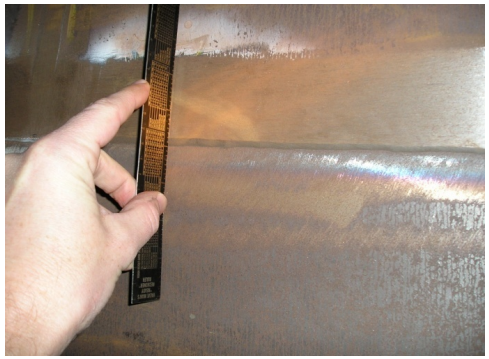
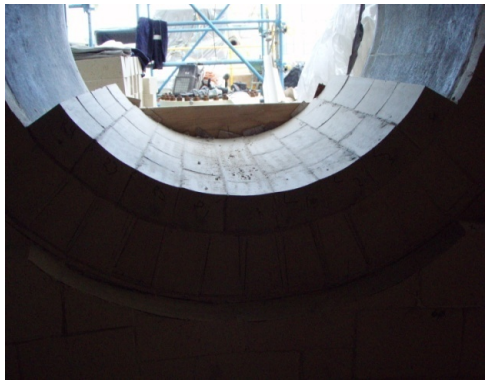
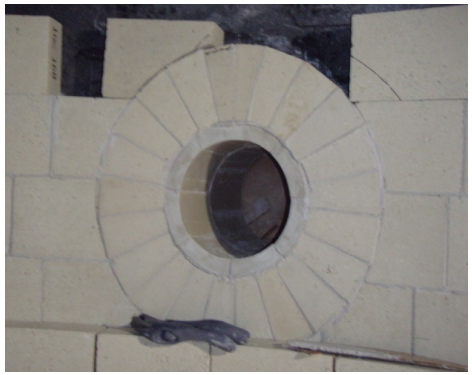
Inspections of Installation

Koch Knight takes great care inspecting and installing our manufactured parts and materials to ensure our customers' receive process equipment within specifications.

- Inspection and installation shown from our Australian project







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QUESTIONS ?

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