PARTICIPATION SHAPES OUR FUTURE

NIA'S 62ND ANNUAL CONVENTION

NIA's 62nd Annual Convention
Sheraton Grand at Wild Horse Pass
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David Baker

Piping Technology & Products

NIA | National Insulation Association

THE VOICE OF THE INSULATION INDUSTRY™

Piping Technology & Products, Inc.

Piping Technology & Products, Inc. (PT&P)

Established in 1975, is one of the leading manufacturers of pipe supports and other piping products in the world.

- Pipe Supports / Spring Hangers
- Pre-Insulated Pipe Supports
- Mechanical & Hydraulic Snubbers
- Pipe Hanger Hardware

Pipe Shields, Inc.

Established in 1971 and acquired by PT&P in 2004, Pipe Shields and Piping Technology & Products have reached throughout world markets with a unique line of pre-insulated pipe supports, slides, guides and anchors.

Pipe Shields

Designed and developed for industries like:

- Power
- Petrochemical
- Chemical
- Commercial

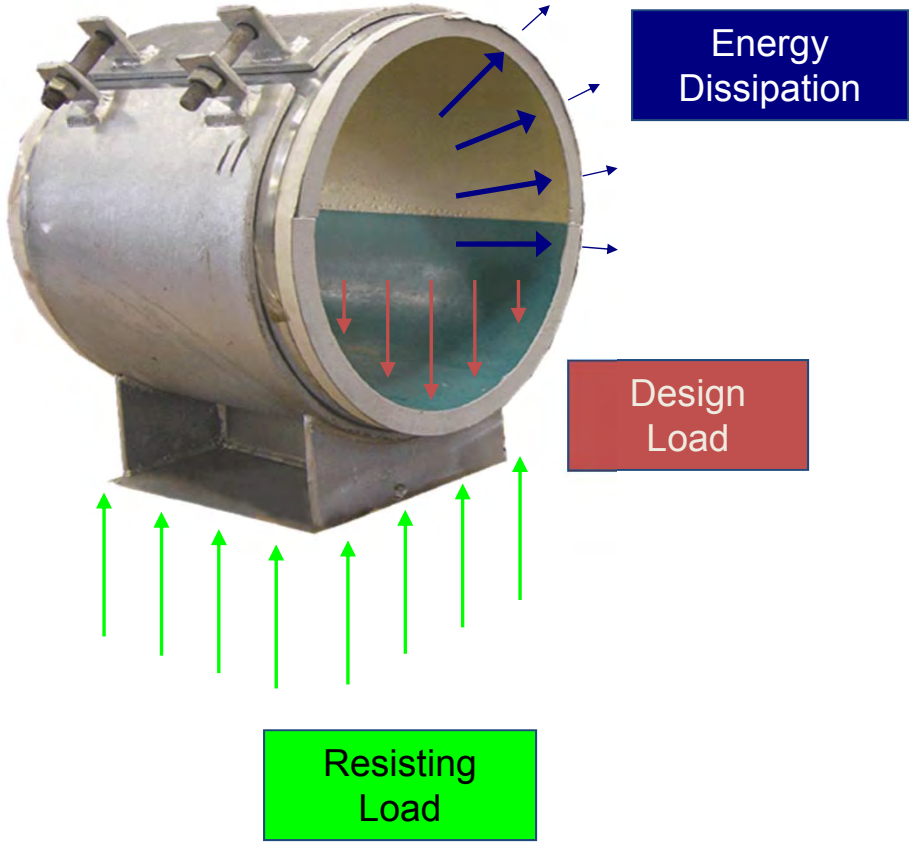
2 Important Questions

- In chemical plants refineries, and power plants, there are high energy systems that have piping that is either very hot (+400-1600F) or very cold (-280F)

Two important questions arise:

- How do we support the pipe?
- How to prevent energy loss?

Complications



There are several complicated issues in this problem.

(a) Heat transfer from the fluid to the environment at a large temperature differences

(b) Significant elongation and contraction of the pipeline during start-up

(c) Material properties of pipe and support over a wide temperature range

(d) Proper design of pipe support to withstand the load and thermal expansion during start-up

Early Methods

- Cold applications—early methods:
  - Oak is cut to match the curvature of the pipe and be placed beneath the pipe.
  - Steel cradle or other type of support component is placed beneath the insulation wood
  - To prevent the decay of the wood, various coatings were applied.

- **"Impregnation"** of the wood is a method still used.
  - Uses various types of resins or laminated wood plastics.
  - Method yields a wood reinforced with plastic which **provides resistance to moisture** while still maintaining the insulating properties of the wood.
  - These "laminated wood blocks" provide **higher compressive strength** (30,000 PSI) and higher tensile strength (15,000 PSI) than using untreated wood.

Cellular Glass

- Developments made, during the 1950's and 1960's, ushered in the use of chemical compounds to replace previously used natural compounds.

- **Cellular Glass emerged as an inexpensive insulator** for use on cold pipelines.
  - **Lightweight material** having a closed-cell structure and manufactured primarily from recycled glass.

Cellular Glass

High Density Calcium Silicate - Formation

High density calcium silicate provides **greater load carrying capabilities** due to its higher range of densities.

- **High Density Calcium Silicate** is manufactured to be resilient and durable.

High Density Calcium Silicate - Uses

- High density calcium silicate widely used in pipe supports within the power industry.
- By varying the densities, high density calcium silicate can be used at different locations to insulate the piping while acting as a **vertical, lateral or anchor support**.
- When protective coating is applied, the material becomes **highly resistant to moisture**.

High Temperature Insulation

Calcium silicates are used for high temperature applications. They are sold as various names with various densities, such as:

i) High density calcium silicate L

ii) High density calcium silicate M

iii) High density calcium silicate H

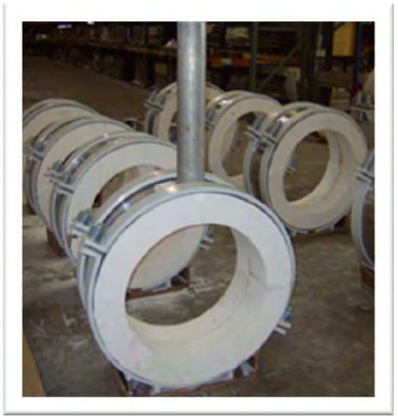
iv) High density calcium silicate I

v) High density calcium silicate M

vi) High density calcium silicate P

vii) High density calcium silicate

Material	Temperature range °F	Thermal conductivity Btu.in/(hr.ft².°F)	Compressive Strength psi	Flexural strength psi	Density pcf
High density calcium silicate L	amb – 1800°F	0.54 - 0.73	450	260	20
High density calcium silicate M	amb – 1800°F	0.61 - 0.8	900	550	28
High density calcium silicate H	amb – 1800°F	0.61 - 0.8	1600	800	35
High density calcium silicate I	amb – 1800°F	0.88 - 0.86	1000	N/A	46
High density calcium silicate P	amb – 1800°F	1.15 - 1.17	3050	N/A	60
High density calcium silicate M	amb – 1800°F	0.88 - 0.86	1000	N/A	46
Calcium silicate .	amb – 1200°F	0.4 – 0.65	100	65 psi	14.5



Various Densities

Thermal conductivities of High Density Polyurethane Foam of various densities are as follows:

Density lb/ft^3	Thermal Conductivity Btu-in/hr-ft^2 ^{o}F	Compressive Strength psi
10	0.114	404
14	0.12	525
20	0.22	750

Various insulation materials have been developed by various companies for both high temperature and low temperature applications, including home insulation.

Aerogel Blanket Insulation

High Temperature Blanket - Thickness	0.2 in
Material form	60 in x 260 ft long
Max Temperature	1200 °F
Density	11lb/ft3
Thermal conductivity	0.14 - 0.62 Btu in/hr-ft2 °F for Temperature 32 to 1112 °F
Low Temperature Blanket -Thickness	**0.2 in**
Material form	60 in x 260 ft long
Max Temperature	257 °F
Density	10 lb/ft3
Thermal conductivity	0.096 - 0.13 Btu in/hr-ft2 °F for Temperature -200 to 200 °F

Silica Microporous Blanket Insulation

Silica Microporous Blanket is a high temperature insulation that can be used in low temperature applications.

- Good Insulator
- Thermal conductivity: 0.189 to 0.252 Btu in/hr-ft2 F
- Standard uses 100° to 700°F

Glass-Reinforced Epoxy Laminate

Glass-reinforced epoxy laminate sheets

- Solid and very strong to withstand high load

Some properties are:

Weight density	346lb /ft3
Thermal conductivity	0.81 W/(m·K) =0.467 Btu/hr-ft-^{o}F
Flexural strength	50,000 psi
Tensile	40,000 psi
Compressive strength	60,000 psi

Geometry and Nomenclature

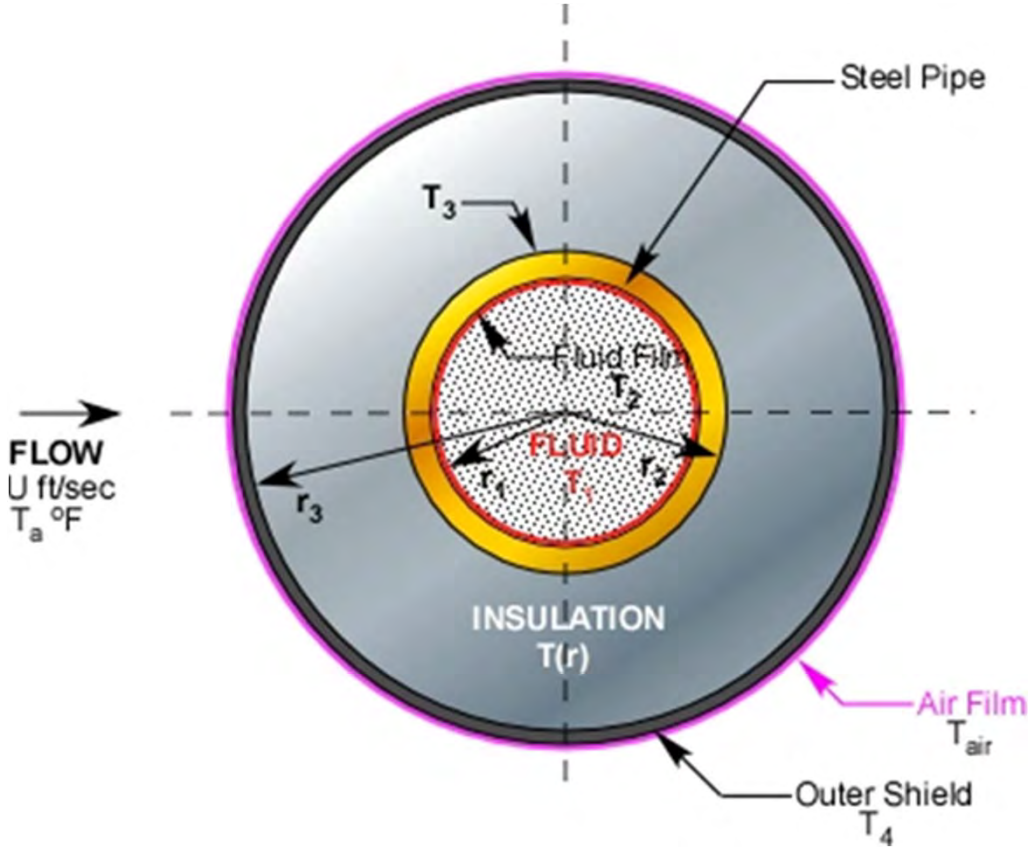


Figure1. Schematic showing the cross sectional view of the pipe with insulations

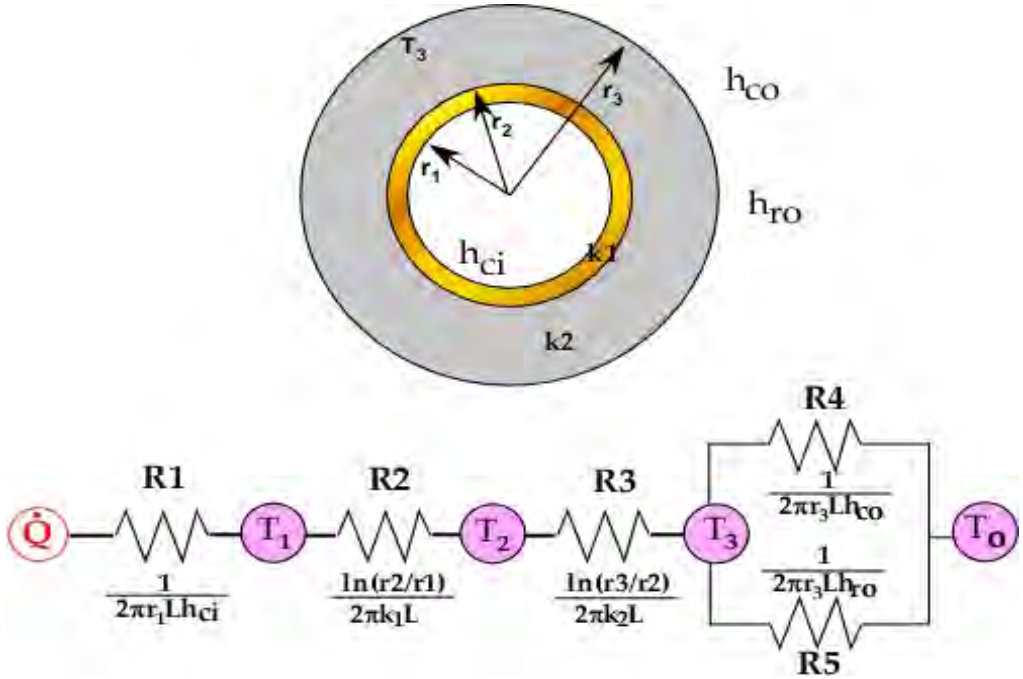
Geometry and Nomenclature cont.

The various symbolic nomenclature used in the analysis are as follows:

- Ta: ambient temperature
- T air: Air film temperature
- T1: Pipe fluid temperature
- T2: Pipe fluid film temperature
- T3: Outer Temperature of pipe
- r1: Inner pipe radius
- r2: Outer pipe radius
- r3: Inner pipe radius
- r4: Outer shield radius
- K1: Thermal conductivity of steel and outer shield pipe
- r4: Outer shield radius
- K1: Thermal conductivity of steel and outer shield pipe
- K2: Thermal conductivity of foam
- Ka: Thermal conductivity of air
- □: Fluid Kinematic viscosity
- hci =inner fluid thermal coefficient
- hco = outer fluid thermal coefficient
- hro = outer fluid radiation coefficient
- Pr air =Prandtl Number: □□□□ Kinematic viscosity/thermal diffusivity; □□K/Cp
- ReD=UD/□□ Reynolds Number; U=fluid velocity; D= pipe diameter; □: Kinematic viscosity
- NuD = hcD/K □ Nusselt Number; hc = film coefficient; D=pipe diameter

Insulated Pipe Schematic

Figure 2. Schematic of an insulated pipe showing temperature distribution and thermal circuit resistances.



All resistance to heat flow must be accounted for in calculating the overall insulation thickness.

Thermal Analysis

The heat transfer problem we are interested in is heat transfer through a insulated pipe.

Equation (1) is in the form of Ohm's Law, and the thermal resistance of a cylindrical shell can be expressed as:

$$\dot{Q} = \frac{2\pi kL(T1 - T2)}{\ln(\frac{r2}{r1})} \qquad \text{------(1)}$$

$$R = \frac{\ln(\frac{r2}{r1})}{2\pi kL} \qquad \text{------(2)}$$

1 Cradle Support with isolation pad.

- Attaches to pipe directly either weld or bolt
- Isolation pad has high compressive strength, with good insulation properties
- For pipe sizes 12” NPS or greater can fit into smaller spaces

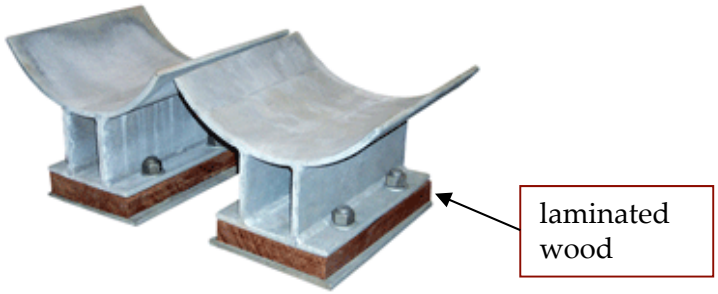


Figure 5a. Picture of Insulated Pipe Supports with laminated wood

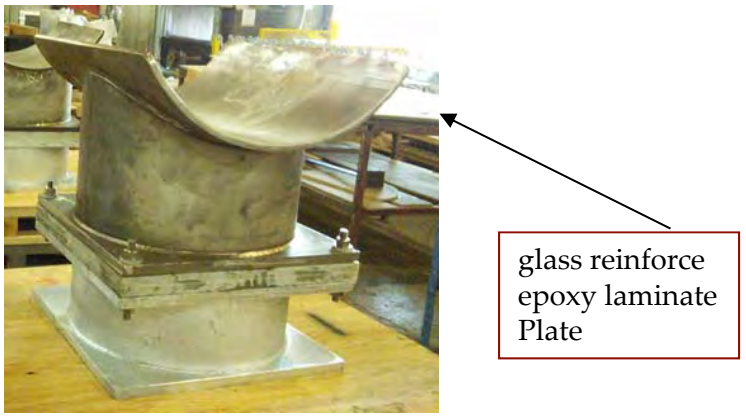


Figure 5b. Picture of Insulated Pipe Supports with glass reinforce epoxy laminate

2 Clamp-On Saddle Support

- For Larger loads can withstand vertical or lateral loads
- Can be guided
- Multiple types of insulation based on application

Figure 5. The support is a c-clamp welded to a rectangular hollow frame

3 Clevis Support

- For smaller loads and movements.
- Commonly used on chilled and heated water systems.
- Most popular with mechanical contractors.

Figure 6. Clevis support from above

4 Base Mounted Pre-Insulated Support

- For larger loads (vertical and lateral) and movements.
- Supports the pipe from below.
- Slide plates and guides are optional.

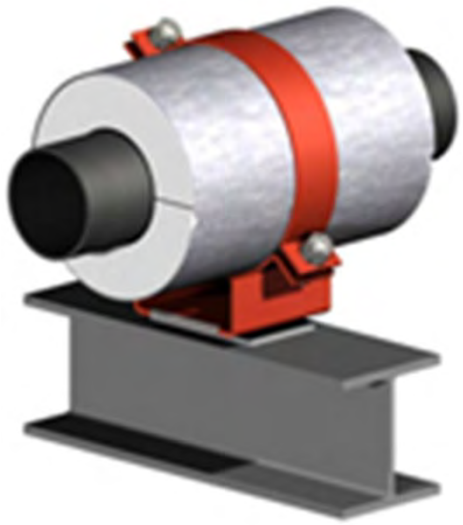


Figure 7. Base mounted pre-insulated pipe support

5 Pipe Resting Support

- Used for larger multi-directional loads and movements.
- Supports the pipe from below.
- Restrains movement of the piping system.

Figure 9. Anchor type Pipe support

6 Pipe Anchor

- These are convenient for larger multi-directional loads and movements.
- The fixed ends, welded to the clamp, take the axial load through the insulation (shown white color)
- Supports the pipe from below. Restrains movement of the piping system.

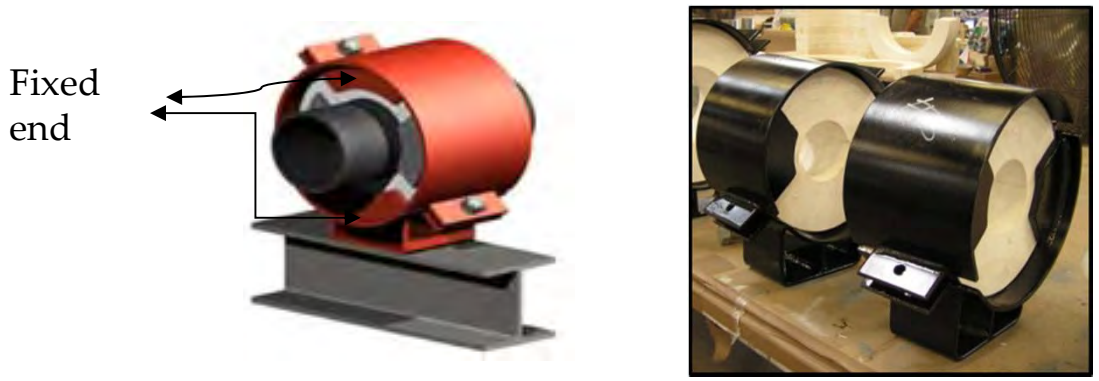


Figure 10. Type 2 Anchor type Pipe support

7 Clamp on Hanging Support

- Used in HVAC and large bore piping systems
- Supports pipe from above
- Takes advantage of larger spacing due to load capacity

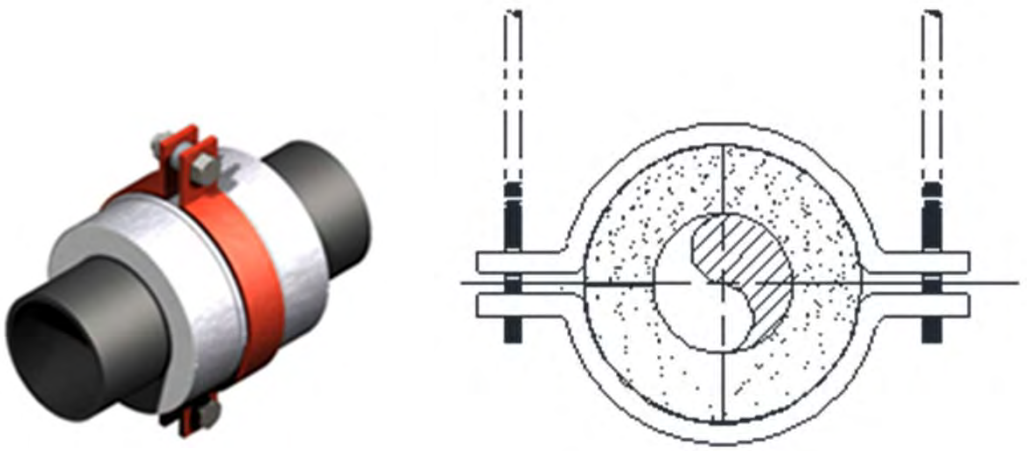


Figure 11. Support from using rods

8 Pipe Riser Clamps

- For both smaller and larger loads and movements, the pipe can be supported in the vertical direction.
- This is known as vertical "riser" configuration.

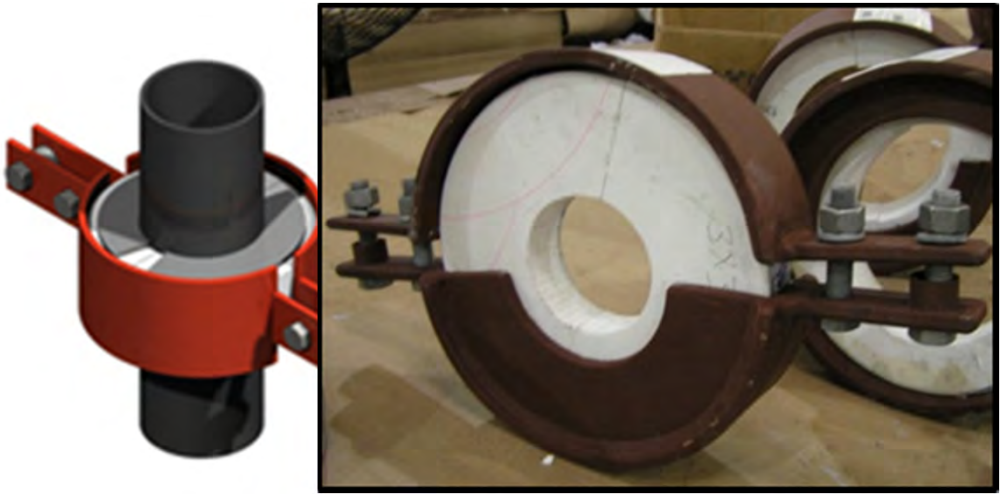


Figure 12. Insulated Pipe Riser Clamps

9.0 Insulated Pipe on Roller

- The pipe sits on a cradle and cradle is supported by a roller.
- This allows a large axial movement

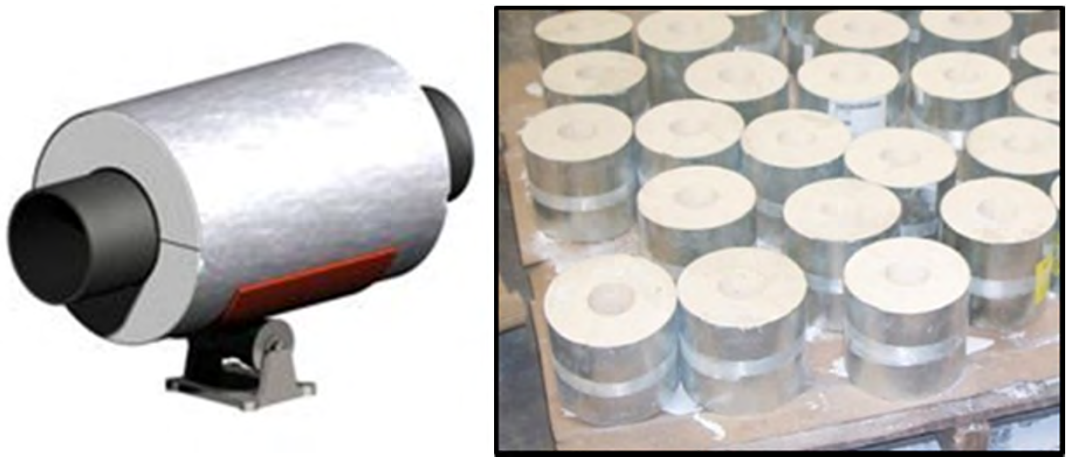


Figure 13. Insulated Pipe on a Roller

Concluding Remarks

- Pre-insulated supports play an important role in not only many modern industrial complexes, refineries, chemical plants, power plants and commercial facilities.
- This involves various branches of science and engineering.
- There are many types of supports and the application is important when choosing the insulation type and configuration of the support.

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