Institute of Refractories Engineers

Online Training Event 2020
Low Thermal Mass Linings

Institute of Refractories Engineers

1. What is Thermal Mass
2. Refractory Fibre vs AES Fibre
3. Fibre Production
4. Product types
5. Applications

What is Thermal Mass

- Energy is needed to heat up a material from ambient to service temperatures.
  - Both for product in process and materials in the furnace/kiln etc
  - In addition to energy losses
  - In intermittent (batch) process, this can be a significant cost
- Specific Heat Capacity – Energy needed to heat 1kg of material by 1°C
  - Most refractories have a Spec Heat Capacity of 1000-1300J/kg/°C
  - Light weight linings need less energy to heat them
  - More rapid heating for the same burner – reduced downtime/cycle time

Refractory Fibre

- Produced from alumina and silica, sometimes with zirconia addition for high temperature grades
  - 1250°C grade
    - ~52-58% SiO_2
    - ~42-47% Al_2O_3
  - 1400°C grade
    - ~52-56% SiO_2
    - ~28-32% Al_2O_3
    - ~14-18% ZrO_2
- Form cristobalite in service (depending on temperature)
- Respirable dusts are considered hazardous

AES Fibre

- Alkaline Earth Silicate Fibres
- Body Soluble Fibres, Low biopersistance
- Different compositions from different suppliers
  - Based on silica with lime, magnesia and other oxides
- Forms cristobalite in service

- Classification temp to 1300 ℃

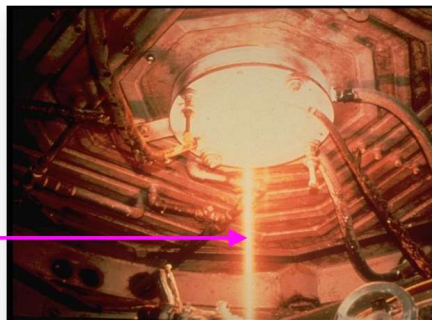
Production Process

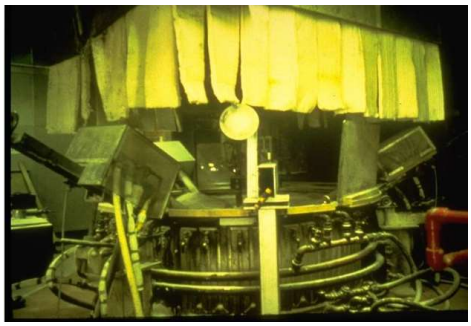
- Raw Materials
- Blending
- Melting
- Melt Stream
- Fiberisation
- Product production

Melting

- Melt at 1700-2000°C
- Submerged Electrode Furnace
- Continuous tapping in a thin stream of molten oxide

Melt Stream



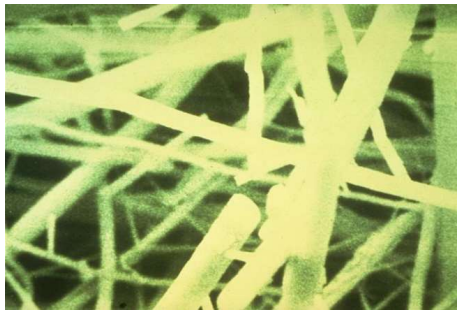


Fiberisation

- Blowing
  - Compressed air blown across melt stream
- Spinning
  - Stream poured onto spinning disc
  - Both method break up stream into droplets which are elongated to fibre shape

Spun vs Blow Fibre

- Spun Fibre
  - Larger Diameter - 3-4μm
  - Longer Length
  - Higher strength and mechanical resilience
- Blown Fibre
  - Finer Diameter - ~2μm
  - Shorter Lengths
  - Better for wet production of product



Blanket Production

- Fibre production and collection
- Needling
- Cutting to width and length
- Roll up
- Package

Blanket Properties

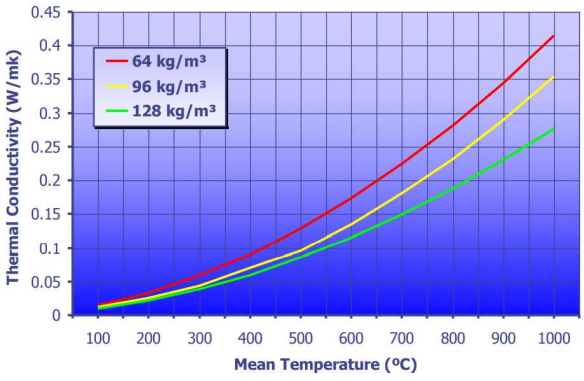
- Grade or Chemistry
- Classification Temperature e.g. 1250 °C, 1400 °C
- Thickness – from 6mm to 50mm
- Can be blown or spun, dependent upon chemistry and grade
- No binder – no organic compoounds

- Flexible
- Lightweight
- Easy to cut
- Standard sized rolls

Blanket - Density

- Standard densities are 64, 96 and 128 kg/m³
- Strength increases with density
- Thermal conductivity decreased with density
  - Denser fibre is MORE thermally efficient

- Example of effect of density
  - 1000 ℃ Hot Face
  - 150mm fibre
  - 25 ℃ Ambient

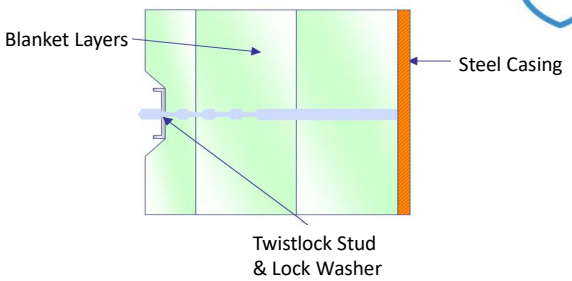


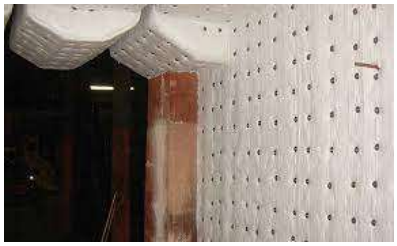
Blanket Density	64	96	128
Cold Face Temp ℃	102	94	81

Blanket – Layered Linings

- Boilers, Ducts
- Kilns and furnaces

- Low gas velocity
- No abrasive dusts
- Backup insulation



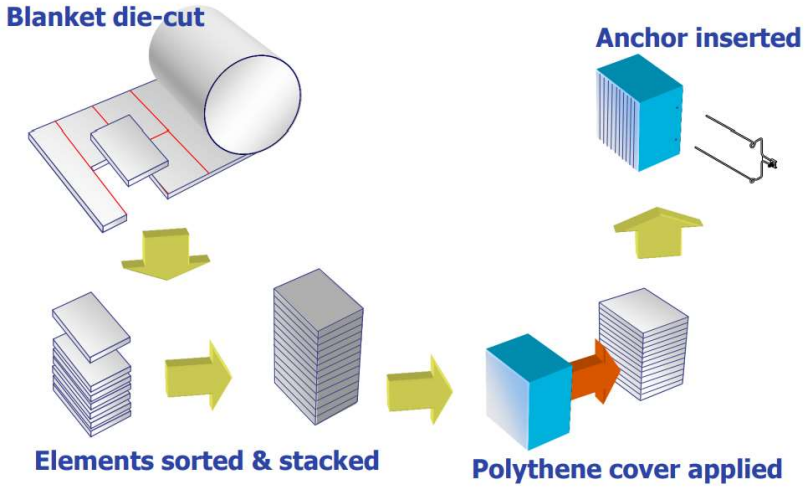


Modules

- Dense blocks of high temperature fibre insulation
- Manufactured using die-cut pieces or folds of blanket
- Supplied with or without internal metallic hardware (anchor)
- Developed for industrial furnace linings

- Anchorage located at cold face
- Higher gas velocity resistance

Module Production



Module Applications

- Petrochemical
  - Steam crackers and heaters
  - Boiler
  - Furnaces
- Metallurgy
  - Reheat Furnaces
  - Heat Treatment
  - Ladle Lids
- Ceramic Kilns
- Power Generation

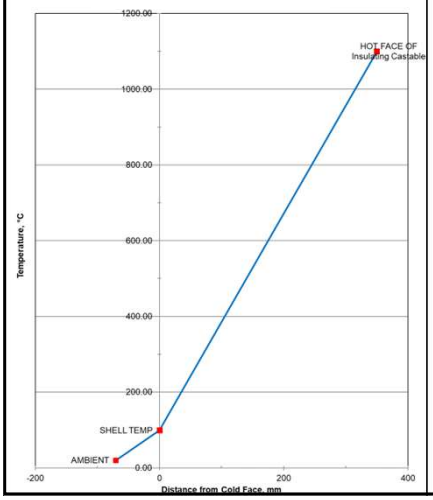
Energy Saving and Energy Storage

Example – Insulating Castable vs ins Firebrick vs Fibre Blanket

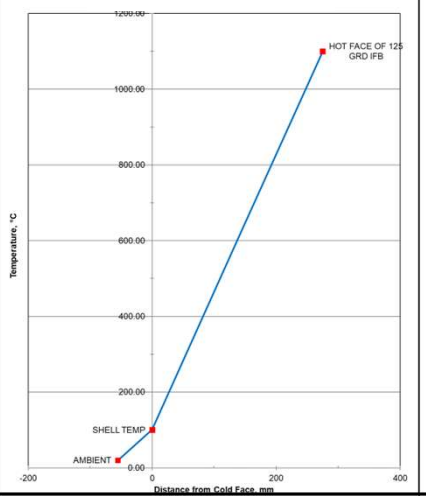
- 1100°C Hot Face
- 20°C Ambient, Still air, emissivity 0.8
- Shell Temp to be <100°C

Example – Thermal Gradient

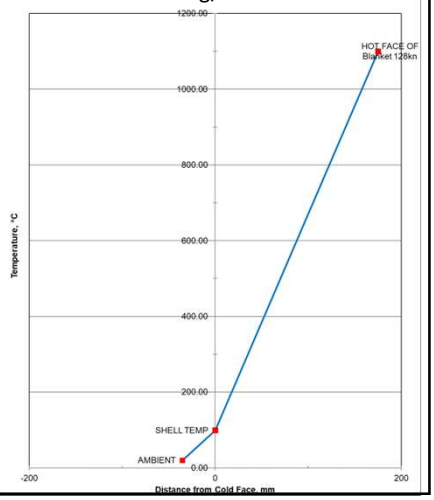
Ins Castable – 350mm



IFB – 300mm



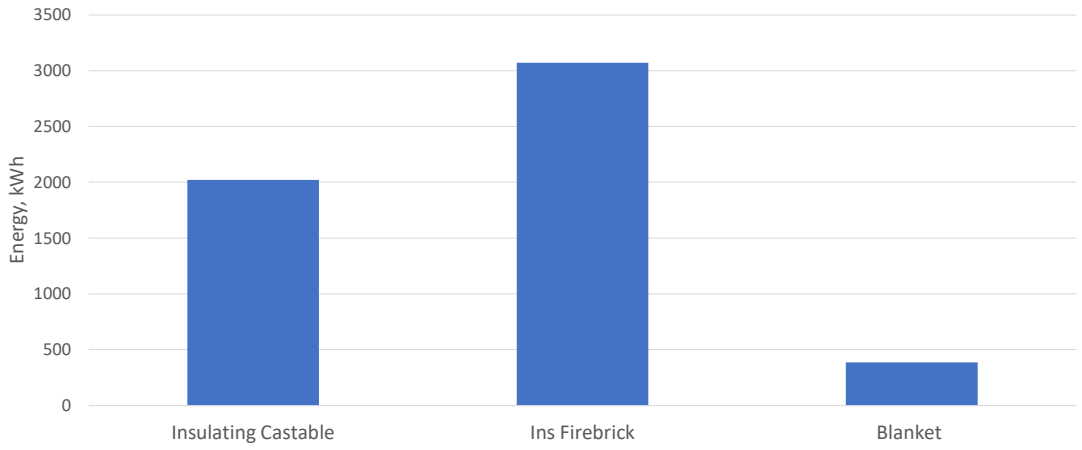
Blanket 128kg/m3 – 175mm

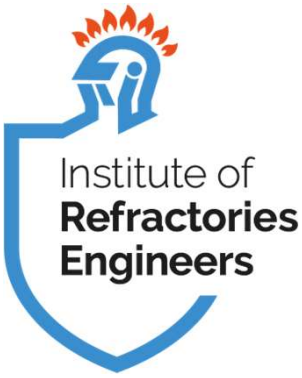


Example

	Insulating Castable	Ins Firebrick	Blanket
Density, kg/m3	350	650	128
Thermal Cond At 200°C At 1000°C	 0.29 0.33	 0.18 0.30	 0.03 0.27
Spec Heat Cap J/kg/°C	1100	1050	1150
Thickness mm	350	300	175
Hot Face Temp°C	99	100	99
Heat loss at steady state W/m2	852	873	857
Lining Weight/m2	122	195	22.5
Energy to heat up 50m2 area MJ kWh	 7277 2021	 11057 3071	 1391 386

Energy to heat up lining





Thank you

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