Eco Friendly Insulation

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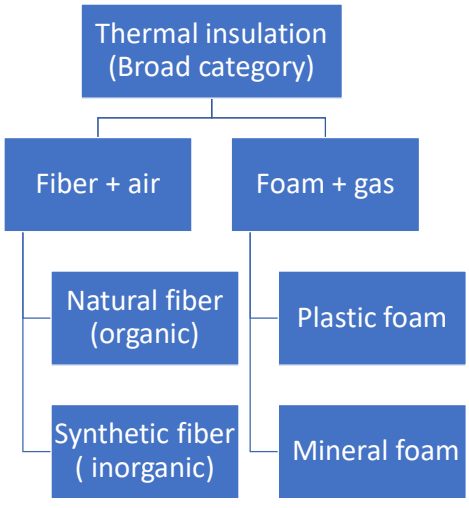
Thermal insulation

- Resist heat transfer, much better than any structural material
- Often consist of micro air-pockets, uniformly distributed and trapped within fiber or foam structure
- Thermal conductivity < 0.05 W/m.K (at 25°C mean)
- Thermal resistance > 0.02 m2.K/W per mm of insulation thickness
- Helps to achieve energy efficiency (of a building or process) by reducing heat load
- Provide thermal comfort and reduce energy demand
- Thermal insulation is indispensable in a green building

Thermal Insulation Materials

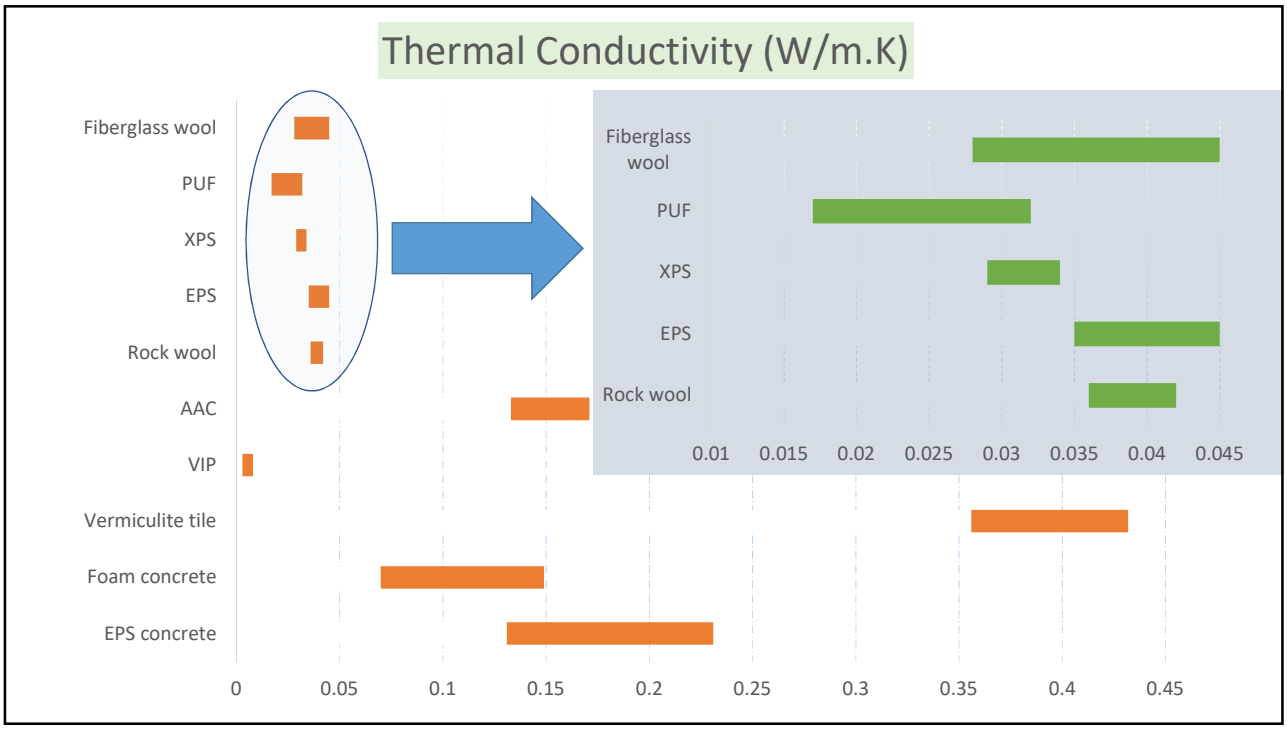
Classifications of thermal insulation

Thermal insulation materials- some examples				
Fiberglass Wool	Rock Wool	PUF	PIR	EPS
Perlite	Celulose	Ceramic Fiber	Calcium silicate	Foam glass
Wood wool	Ship wool	Phenolic foam	Foam concrete	AAC
Extruded Polystyrene	Nitrile Rubber	Cross linked polyethylene	EPS Concrete	Vermaculite
Vaccum Insulated Panel	Recycled textile	Melamine	Hemp	Straw
Aerogel	PE	Slag wool	AES wool	High Al,low silica wool



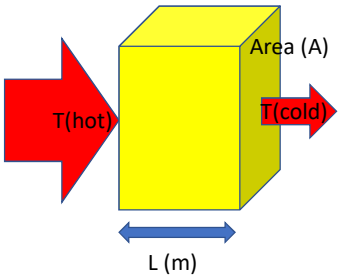
Thermal insulation: Standards

Type	Material	Description	Standard
Inorganic	Fiberglass wool	Man-made inorganic vitreous silicate fibers in bonded form- molten glass is converted into long resilient glass fibers	IS 8183
	Rock wool	Man-made inorganic bonded rock fibers with steel slag- molten rock and slags are fiberized by centrifugal spinning process	IS 8183
Organic	Polystyrene (Expanded)	Rigid, synthetic polystyrene foam- small foam beads contained in a mould and expanded with heat/steam	IS 4671
	Polystyrene (Extruded)	Rigid, synthetic polystyrene foam- melting together the plastic resin and other ingredients. The liquid formed continuously extruded through a die and expands during the cooling process	ISO 4898
	PUF/PIR	Polymeric foam insulation - Polyol reacts with Isocyanate/ Isocyanurate -applying blowing agent to produce PUF/PIR foam	IS 12436
	Phenolic Foam	Plastic foam insulation made out of Phenolic resin at core to form fine closed cells with laminations on the faces.	IS 13204



How building insulation works

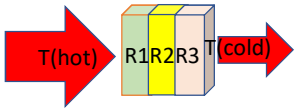
- Heat is the transient form of energy- travels from hot to cold bodies
- Driving force of the heat transfer is temperature difference [dT = T(hot)- T(cold)]
- Heat conduction (Q) is proportional to the temperature difference (dT) between the hot and cold face of the building element (roof, wall) exposed to heat
- Heat conduction is inversely proportional to the thickness of the building element exposed to heat
- The proportionality constant is the thermal conductivity of the roof/wall
- Lower the conductivity (K-value) better is the insulation property
- Thickness/Conductivity determines the thermal resistance (R-value) of the insulation. Higher the R, better is the insulation performance
- 1/total R, determines thermal transmittance (U-value) of the system- lower U-value is desirable for envelope.



$Q = K \times A \times [T(hot) - T(cold)] / L$

$Q/A = K \times dT / L$

$Q/A = dT/(L/K) = dT / R$



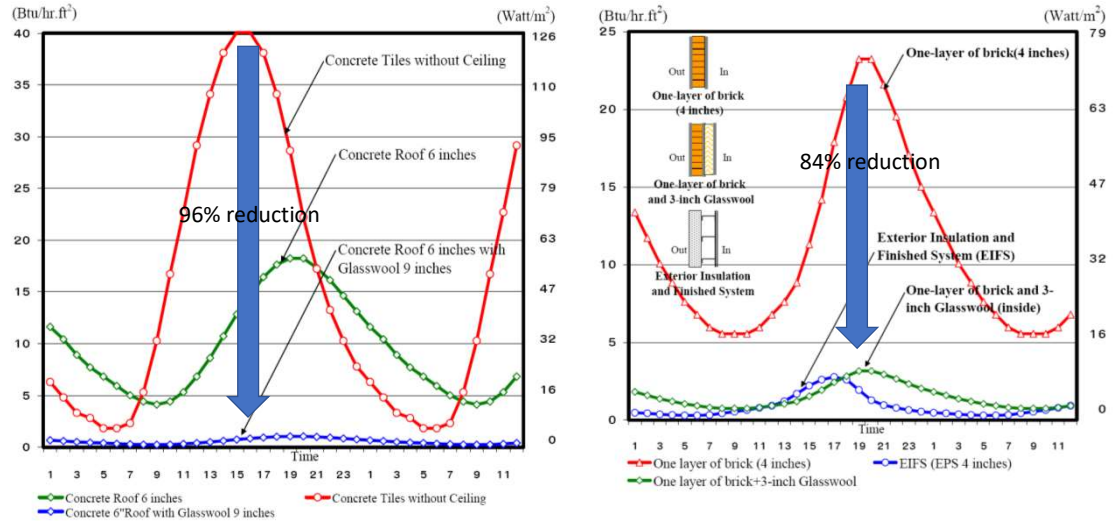
$U = 1/[Ro+(R1+R2+R3)+ Ri]$

U-value calculation : ECBC compliance

U-value Calculation : Wall (<U-SI:0.44 m2.K/W .OR. U-PI: 0.079 Btu/sq.ft.F.hr)				
Mean Temperature of application: 25 degC				
Building Elements	Thermal conductivity (W/m.K)	Thickness (mm)	Thermal Resistance R-value, sq.mK/W	Thermal Resistance R-value, sq.ft.F.hr/Btu
Airfilm resistance(outside)			0.04	0.23
External sand cement plaster[ref- ECBC-page C.9 max k-value for 1860 kg/cu.m density of cement plaster, sand aggregate]	0.72	15	0.02	0.12
AAC blocks	0.162	150	0.93	5.26
Air gap (best value available)			0.15	0.85
Insulation board 32 kg/cu.m and 30 mm thickness	0.032	30	0.94	5.33
Concrete [ref- ECBC-page C.12 max k-value for 2400 kg/cu.m density of Concretes]	2.1	200	0.10	0.54
Internal gypsup plaster[ref- ECBC-page C.9 gypsum plaster for 16 mm thickness]			0.06	0.32
Airfilm resistance(inside)			0.12	0.68
		R(Total)	2.35	13.33
			W/sq.mK	Btu/sq.ftF.hr
		U-value: 1/R(Total)	0.43	0.075

Effect of insulation in building

- Significant reduction in the heat transfer when a conventional wall in insulated conventional insulation materials
- Similar demonstration made for roof with conventional insulation options



Ref: Research paper- Miracle of insulation in hot-humid climate building, S Pongsuwan, IJRE V4,2009

Are all insulation eco friendly ?

yes

- All insulation saves energy
- Reduces CO2 emission
- Provides thermal comfort

no

- Some have high embodied energy
- Some contains hazardous pollutants
- Some are least reusable

Eco label programs play important role to identify true nature of insulation

Eco Labelling- 'how is a product relevant for environment'

What is the design of the product (Eco vision, policy statement, strategies)

How the raw materials are acquired

How much energy and water it consume during manufacturing

How well it performs (thermal conductivity)

Any pollutants or hazardous chemicals

What environmental impact it make in its entire life cycle (LCA)

Any innovation

Eco Friendly insulation – enhancing resource efficiency

Raw material acquisition for insulation manufacturing
Non recyclable/virgin raw material – e.g mineral oxides
Should be abundant in nature and should not impact other natural resources
Should not be in national park or within an endangered community
Recyclable raw material-secondary raw material
Not all secondary raw material is eco friendly i.e it can deplete natural resources (paper/cellulose)
Post industrial – e.g glass cullet
Post consumer – site wastages of insulation (logistic problem- voluminous material)

Eco Friendly insulation – enhancing resource efficiency

- Energy and water consumption
- To declare well defined policy on Energy Efficiency and Water Efficiency
- Renewable energy – as much as possible- Solar, Biomass boilers for steam generation etc.
- To improve the efficiency of equipment (e.g melter) and bring down the temperature (e.g melting temperature- depends on batch mix)
- Closed loop water recycling
- Rain-water harvesting
- Zero discharge ETP

Functional requirement – selection of right product

Light weight material = Low energy consumption in production

– to promote low density/ high volume insulation products

Example : 48 Kg/m3 -50mm = R 9

16 kg/m3-65mm= R 9 ….56% less weight = 56% less energy

Less energy intensity to cover more area with insulation !!!

A long-life expectancy- saves money on replacements/ retrofits and ensures that no additional waste generation.

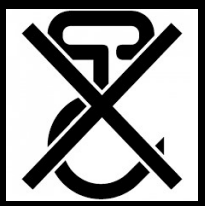
Eco Friendly insulation – enhancing resource efficiency

Environment, Health & Safety: Product testing

Hazardous Chemicals	How to detect
Emission parameter- Total Volatile Content (TVOC)	Small scale environmental chamber determination of organic emission from indoor materials (ASTM D 5116)
Emission parameter- Phthalates	
Emission parameter-Formaldehyde	
Emission parameter- 4-Phynylecyclohexen	
Prohibited flame retardant- Halogenated binding agent and Halogenated flame retardant, Ozone Depleting substances, Polybrominated Biphenyls, Polybrominated Diphenyl Ethers and Short Chain Paraffin	Gas chromatograph with mass selective detector (GC-MSD)
Hazardous substance –Halogenated solvent, Aromatic solvent	Headspace-Gas chromatography (HS-GC-MSD)
Hazardous substance –Mercury, Lead, Cadmium	Inductively coupled plasma atomic emission spectroscopy (ICP-AES)
Hazardous substance – Hexavalent Chromium	UV-Vis spectrometer
Hazardous substance-Tin	Inductively coupled plasma atomic emission spectroscopy (ICP-AES)
Hazardous substance- Asbestos	US NIOSH 9002

Eco friendly insulation – packaging, transportation

- Compressed/ vaccume packaging wherever possible
- Air-tight, water-proof packaging to improve shelf life
- Efficient stuffing and transportation
- Information on packaging– safety, storage and handling



Use and Reuse

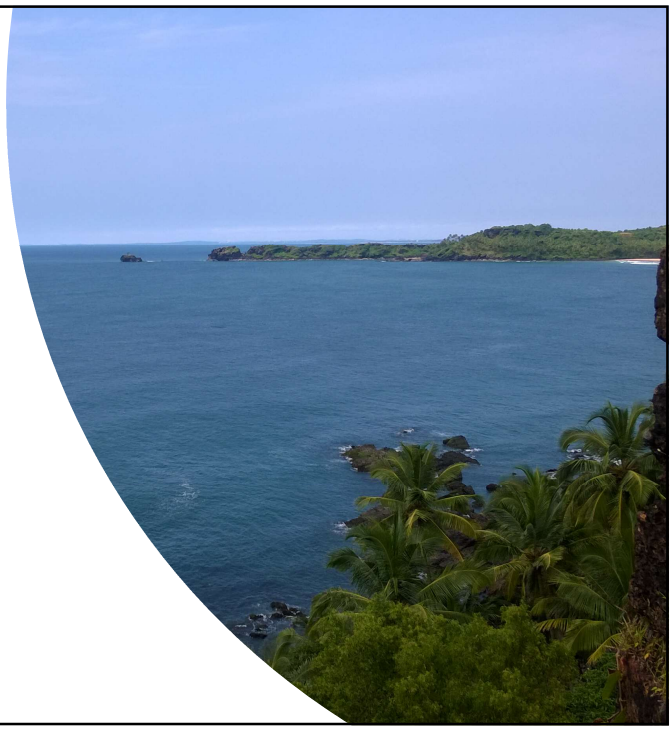
- Right application for efficient use of insulation
- Mechanical fastening – preferred over adhesive (not possible for all cases)
- Reclaiming maximum part of insulation is easy during dismantling the insulated structure (after intended period of use)
- Reusability - in different applications; in different product form

Waste Management

- Right application of material reduces disposal
- Customized product (design) to reduce wastage at site
- Recyclable/reusable material should be preferred
- Used packaging can be recycled

Summary: Eco friendly insulation

- Made from responsible resources
- Generates less waste
- Saves more and use less energy
- Do not have pollutants/hazardous chemicals
- Have long performing life
- Recyclable or reusable
- It goes back to factory only to start afresh



Thank You