LNG Tank Insulation materials

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Thermal insulation must be fitted to refrigerated tanks for the following reasons:

- To minimise heat flow into tanks, thus reducing boil-off.
- To protect around the tanks from the effects of low temperature.

Insulation materials for use on gas carriers should possess the following main characteristics:

- Low thermal conductivity.
- Ability to bear loads.
- Ability to withstand mechanical damage.
- Light weight.
- Unaffected by cargo liquid or vapour.

Materials

- Polyurethane
- Perlite
- Aerogels
- Mineral Wool
- Cellular Glass
- Polystyrene
- Wood

Polyurethane

Low thermal conductivity

- The low thermal conductivity rating of rigid polyurethane foam, one of the lowest values among commonly used insulating materials, allows efficient retention of heat flow.

Strength

- The good balance between the weight, mechanical strength, and insulation properties of polyurethane foam demonstrates its versatility as an insulating material.

Lightness

- Typical 40–45 kg/m3 foam

Low water absorption and low water permeability

Dimensional stability

- Because of their chemical composition, good mechanical properties, reduced moisture pickup, closed cell structure, and chemical resistance, rigid polyurethane foams demonstrate significant size stability.

Chemical resistance

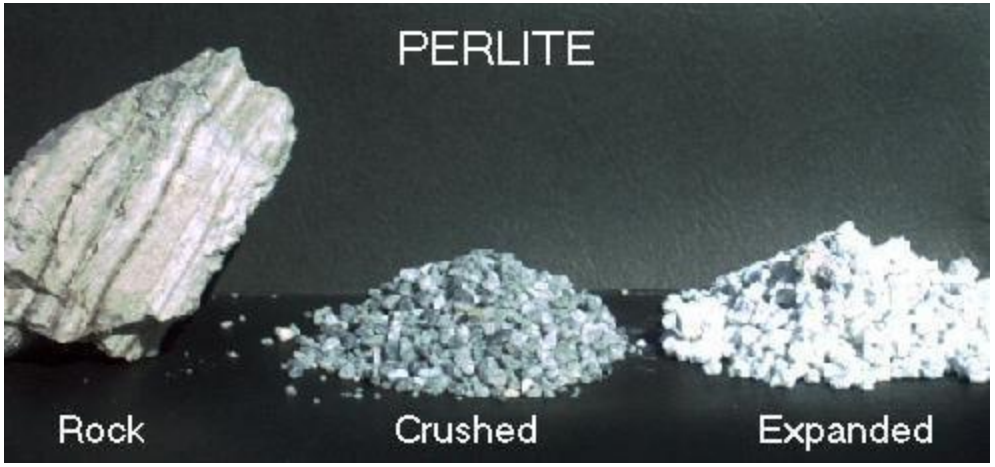
Range of service temperatures (-200 C to +130 C)

Fire properties

- the foams can be formulated to meet the most stringent fire protection standards.

Perlite

- Perlite insulation exhibits low thermal conductivity and has excellent thermal properties.
- Does not shrink, swell, warp or slump.
- Low cost, easy to handle and install.
- Non-combustible, meeting fire regulations and therefore lowers insurance rates.
- Inorganic material that is vermin and rot resistant.
- As a result of its closed cell structure, the material does not retain moisture.



Aerogels

- Environmentally Friendly
- Fire Resistant
- Light Weight
- Durable
- Hydrophobic
- Application
- Thermal Performance
- Structural Integrity
- Dimensional Stability

Mineral Wool

- Constant insulating efficiency
- Noncombustible
- Corrosion resistent
- Long term dimensional stability
- Vermin resistance
- High compressive strength
- Ecologically friendly, sustainable

Cellular Glass

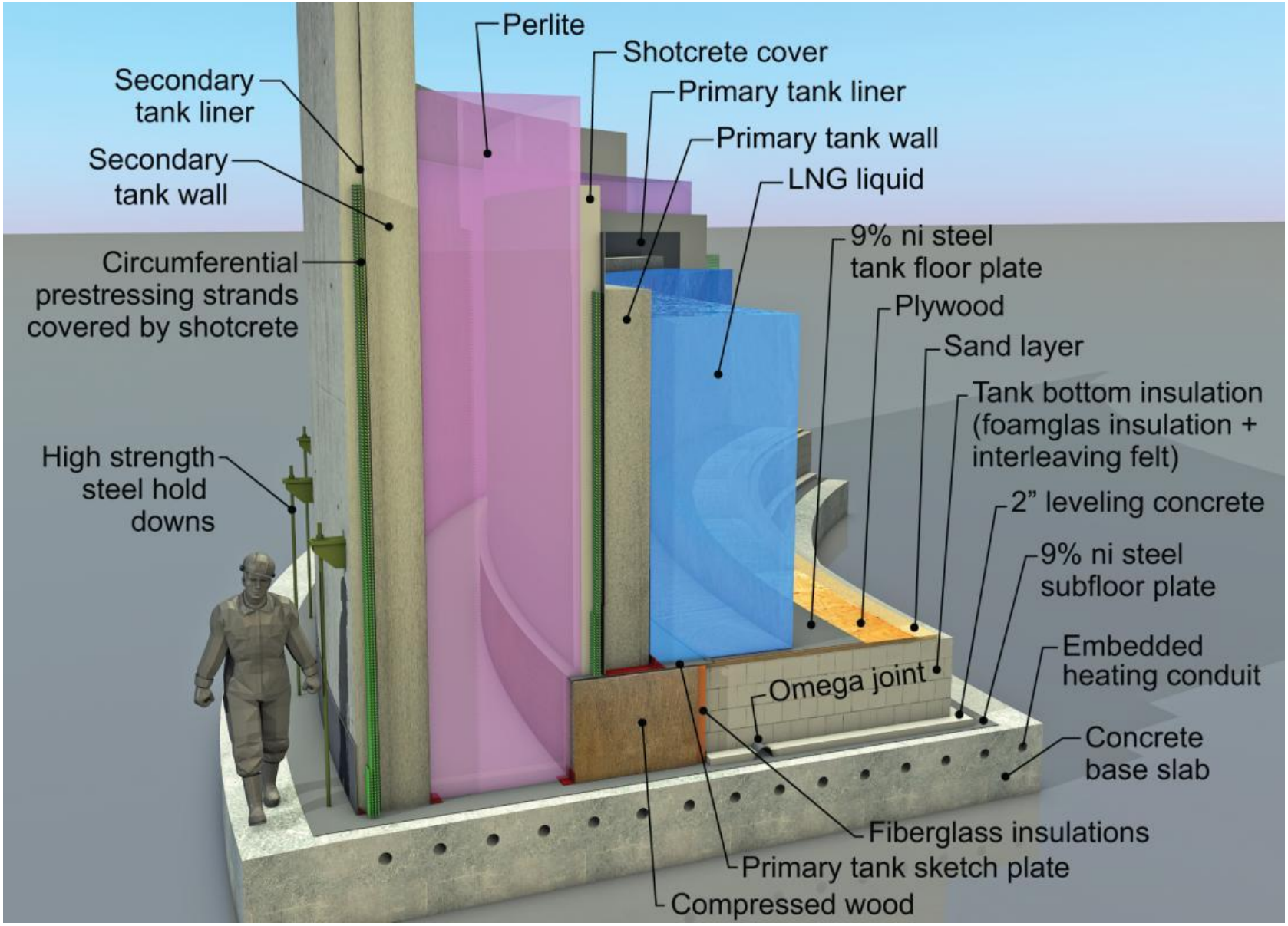
- The matrix of the foam glass is glass, so it does not absorb water.
- The mechanical strength is high, and the intensity change is proportional to the apparent density. It has excellent pressure resistance and can withstand the erosion and load of the external environment more than other materials.
- Foam glass has good thermal and moisture permeability, so the thermal conductivity is stable for a long time, and it does not change due to environmental influences, and the thermal insulation performance is good.
- Foam glass is a matrix wet glass, so it will not burn spontaneously and will not be burned. It is an excellent fireproof material. Foam glass has an operating temperature range of -200 to 430 ° C, a small expansion coefficient (8 × 10 ° C) and is reversible, so the material properties are unchanged for a long time, are not easy to embitter, and have good stability.
- Dyeing property of foam glass is good, can be used as insulation decoration materials.

Thermal properties of materials at -160 C

	Thermal conductivity (W/mK)	Density (kg/m3)	Heat capacity (J/kgK)
Polyurethane	0.02	45	400
Perlite	0.025	80	380
Aerogels	0.012	81	100
Mineral Wool	0.033	24	680
Cellular Glass	0.018	128	
Polystyrene	0.015	100	347
Fiberglass	0.3	2.5	316
Wood	0.02	680	50

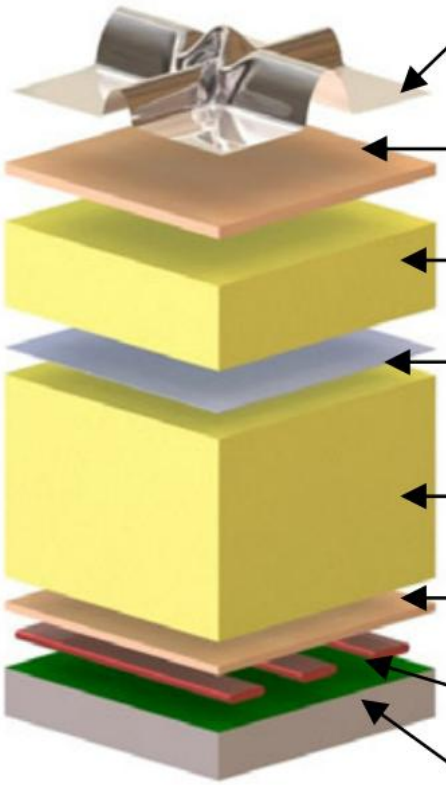
New Systems

- Cabot, aerogel beads (Nanogel®)
- Aspen Aerogels, aerogel blankets (Pyrogel® and Spaceloft®)
- Sordal, polyimide foams (SOLREX®)
- Inspec Foams, polyimide foams (SOLIMIDE®)
- TAI, pipe insulation panels
- NASA, Layered Composite Insulation (LCI)
- NO
- MARK III


Perlite
Shotcrete cover
Secondary tank liner
Primary tank liner
Primary tank wall
Secondary tank wall
LNG liquid
9% ni steel tank floor plate
Circumferential prestressing strands covered by shotcrete
Plywood
Sand layer
Tank bottom insulation (foamglas insulation + interleaving felt)
High strength steel hold downs
2” leveling concrete
9% ni steel subfloor plate
Embedded heating conduit
Omega joint
Concrete base slab
Fiberglass insulations
Primary tank sketch plate
Compressed wood

On the left, the five 200,000 m^3 LNG storage tanks under construction at the South Hook LNG Receiving Terminal in South Wales, UK await the arrival of large ships from the Qatar plants. The photo on the right shows one of many QatarGas LNG storage tanks in Ras Laffan used to hold LNG prior to loading onto LNG ships.

Insulating panel



Corrugated Stainless Steel Membrane **Primary Barrier**

Plywood

Polyurethane foam

Triplex **Secondary Barrier (TPS)**

Polyurethane foam

Plywood

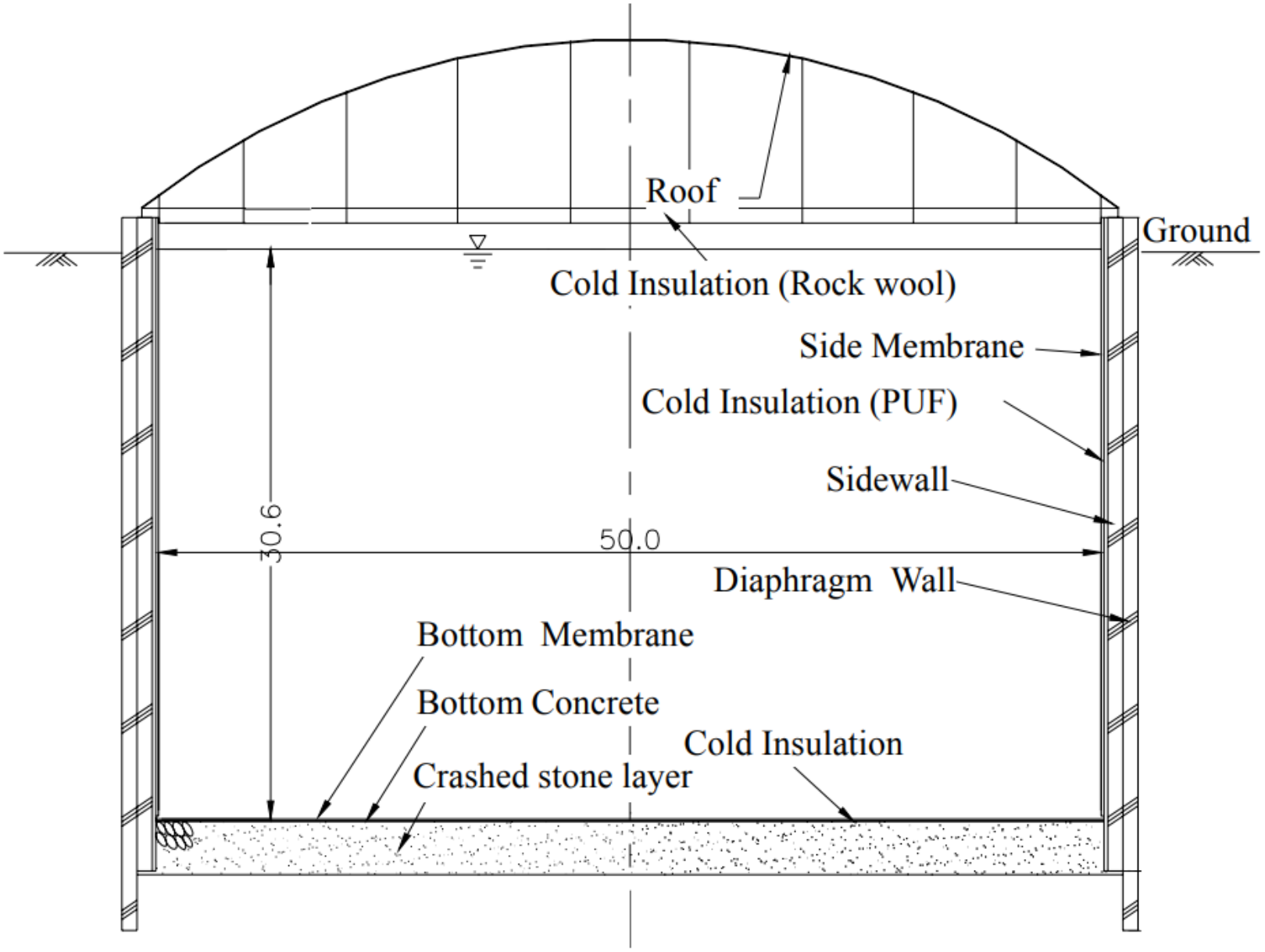
Anchoring elements: Mastic & Studs

Concrete wall covered with moisture barrier

LNG TANK

Perlite concrete being poured into molds

Perlite Concrete Blocks Curing



Structure of the TL-6 tank

Structure of the TL-6 tank

Parts		Materials
Membrane	Side	18Cr-8Ni stainless steel (SUS304)
	Corner	18Cr-8Ni stainless steel (SUS304)
	Bottom	18Cr-8Ni stainless steel (SUS304)
Cold insulation	Side, bottom	Hard polyurethane foam (PUF)
	Suspension deck	Rock wool
Roof	Plate, beam	Carbon steel
	Compression ring	Carbon steel
	Shell plate	3.5Ni steel
Suspension deck	Deck	Aluminum alloy
	Rod	18Cr-8Ni stainless steel (SUS304)
Concrete body	Sidewall	Reinforced concrete
	Diaphragm wall	Reinforced concrete
Bottom structure	Bottom concrete	Concrete
	Crushed stone layer	Crushed stone