TRADE OF

Industrial Insulation

PHASE 2

Module 4

Insulation – Materials, Science and Application

UNIT: 7

Calcium, Silicate & Magnesia

Produced by

SOLAS

An tSeirbhís Oideachais Leanúnaigh agus Scileanna
Further Education and Training Authority

In cooperation with subject matter expert:

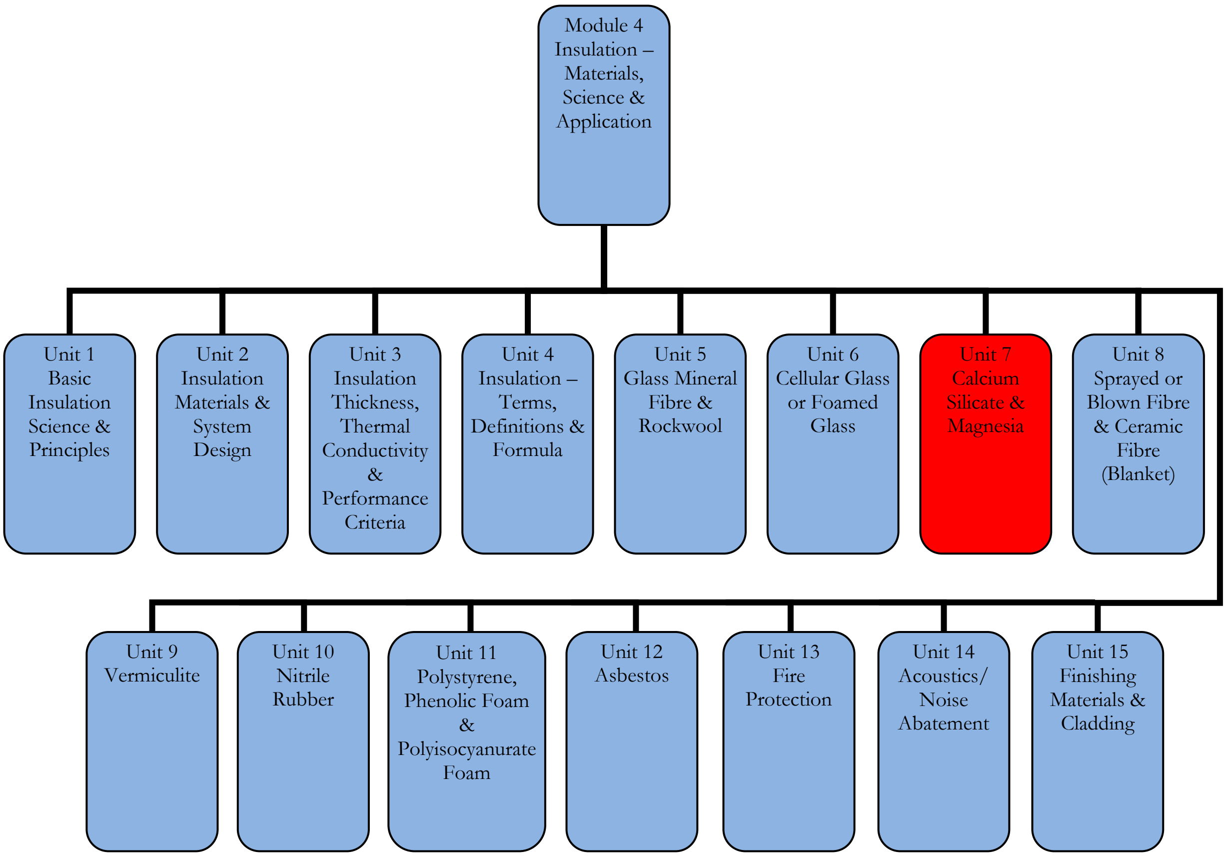
Michael Kelly

Table of Contents

Unit Objective

By the end of this unit ***each apprentice*** will be able to:

- List and describe the properties, uses and applications of calcium silicate and magnesia.
- Identify calcium silicate and magnesia from a selection of samples.
- Demonstrate the safe handling and application of these materials.



Introduction

Calcium silicate is commonly used as a safe alternative to asbestos for high temperature insulation materials. Industrial grade piping and equipment insulation is often fabricated from calcium silicate. Its fabrication is a routine part of the curriculum for insulation apprentices. Calcium silicate competes in these realms against rockwool as well as proprietary insulation solids, such as perlite mixture and vermiculite bonded with sodium silicate. Although it is popularly considered an asbestos substitute, early uses of calcium silicate for insulation still made use of asbestos fibers.

1.0 Calcium Silicate and Magnesia

Key Learning Points

- Product composition of calcium silicate and Magnesia
- Compressive strength of calcium silicate and magnesia insulation
- Use of manufacturers' data sheets and instructions
- Advantages and disadvantages of calcium silicate and magnesia insulation
- Service temperature range. Identification of insulation samples
- Fire characteristics

1.1 Product Composition and Characteristics

Calcium Silicate

Calcium silicate is a granular thermal insulation and is made from amorphous silica, lime, reinforcing fibres, and other additives mixed with water in a batch mixing tank to form a slurry. This slurry is further processed through a number of stages until finally dried. After drying, the moulded shapes are trimmed, slit into two or more pieces and then packaged.

The moulded, cured insulation material is essentially a crystalline formation with more air space than solid space (greater than 90 percent air). Millions of tiny air spaces separated by low-thermal-conductivity crystalline walls give calcium silicate its insulating characteristics. Very little infrared radiation is able to pass through it, so it is effective high-temperature insulation material.

Magnesia

Magnesium carbonate is a granular insulation and is produced by extraction from dolomite rock, which is then mixed with fibre reinforcement (generally about 15% fibres) and is cast into appropriate moulds as slurry. After drying, the products are machined to size. Product can also be supplied in plastic form (plasticized by water).

1.2 Properties and Uses of Calcium Silicate Insulation

Properties

- Calcium silicate has high compressive strength – minimum 100 psi.
- It can provide extra support to the metal cladding due to its compressive strength.
- Material is non-combustible.
- Calcium silicate shrinks about 2% after exposure to maximum temperature.

- Some types of calcium silicate contain a chemical inhibitor which helps to prevent corrosion developing under the insulation.

Uses

Calcium silicate is available in pre-formed rigid pipe-sections and in slabs/lags. The insulation is used mainly for higher temperature industrial applications up to 1000ºC, and in some industries requiring a non-fibrous insulation.

1.3 Properties and uses of Magnesia

Properties

- Good refractoriness.
- Good corrosion resistance.
- High thermal conductivity.

Uses

Magnesia is available in both pre-formed slabs and pipe-sections and in a plastic composition. The rigid pre-formed sections are usually applied to straight pipes and the plastic material plasticized by water) is used for insulating valves, irregular shaped pipes and fittings.

1.4 Advantages and Disadvantages of calcium silicate magnesia Insulation

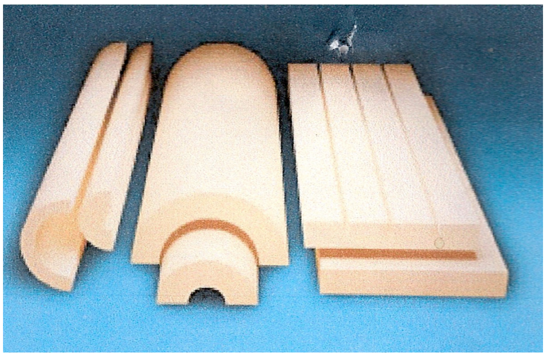
Advantages

- High temperature range – non-combustible.
- Does not contribute to combustion.
- High compressive strength and provides a hard bearing surface.
- High flexural strength.
- It can be formulated and manufactured to inhibit corrosion under insulation.

Disadvantages

- Calcium silicate is fragile and there can be excessive breakage of the material during installation.
- Installation can be labour intensive due to the nature of the insulation.
- Once heated, it tends to fracture and often falls apart when the outer cladding or casing is removed.
- The material will readily absorb moisture that can accelerate corrosion on metal that it is in contact with.

1.5 Forms of Supply and Identification



Calcium silicate is typically applied on high temperature applications on pipe and equipment in industrial facilities, such as chemical plants, refineries, steam electrical power plants, tanks, vessels, steam piping, boilers, vents and exhaust ducts.

Since it is a rigid material with a high compressive strength, high flexural strength, and is non-combustible, it is widely used in high temperature, industrial applications subject to physical abuse and without any loss of its insulating ability. In addition, calcium silicate can withstand vibration induced by high-temperature steam flow around internal pipe obstructions such as valves and measuring devices.

Forms of Supply

Board:	1000mm x 500mm	25-75mm thickness.
Curved sheet	I/D 196 – 3560mm	25-75mm thickness
Pipe Cover	I/D 16 – 171mm	25-75mm thickness

I/D – Inside Diameter

1.6 Manufacturing of Calcium Silicate

Calcium silicate is made from amorphous silica, lime, reinforcing fibres, and other additives mixed with water in a batch-mixing tank to form a slurry. This slurry is pumped to the pre-heater, where it is heated to boiling and quickly poured into moulds. After a few minutes, the material is removed as a wet and fragile solid. These formed pieces are placed into a type of steam pressure cooker for several hours, where the chemical reaction takes place to form calcium silicate. The pieces are then placed into a drying oven. After drying, the pieces are trimmed, slit into two or more pieces, and packaged. The process is relatively low energy, as the highest temperature reached is only about 380°F.

The moulded, cured insulation material is essentially a crystalline formation with more air space than solid space (greater than 90 percent air). Millions of tiny air spaces separated by low-thermal-conductivity crystalline walls give calcium silicate its insulating characteristics. Very little infrared radiation is able to pass through it, so it is an effective high-temperature insulation material.

1.7 Fire Characteristics

Calcium –magnesia-silicate is non-combustible.

1.8 Thermal Conductivity

Non-asbestos Calcium Silicate insulation board and pipe insulation feature with light weight, low thermal conductivity, high temperature and chemical resistance.

Calcium Silicate is rigid, high density material used for high temperature applications ranging ***250°F (121°C) - 1000°F (540°C)***.

2.0 Calcium-Magnesium-Silicate fibre Insulation

Key Learning Points

- Typical uses and applications
- Compatibility of adhesives and sealant
- Use of adhesives and sealants
- Cutting and application methods

2.1 Insulation with Calcium-Magnesium-Silicate Fibre

Insulation materials made of calcium-magnesium-silicate fibre are heat-resistant, inorganic materials which may normally be employed up to temperatures of 850 °C; they consist of silicon dioxide and calcium and magnesium oxides. They are predominantly supplied in the form of boards, mats, felts, loose wool, strings and vacuum form pieces. Dependent upon the form of supply they possess the building material classes A1 or A2 (non-combustible) according to DIN 4102-1.

Modules are normally manufactured on order. Their employment is e. g. required where high temperatures must be lowered down to a value where other insulants, e. g. mineral wool, may be used. In this case, the CMS fibres constitute the hot-side layer of a composite insulation system. Products made of CMS fibres are to be employed in similar fashions as mineral wool products. Webs, felts and boards shall be fastened exclusively with fastening means of heat resisting steel because of their high employment temperatures. The number of pins for the application at plane surfaces must be twice the number given in Table 2 below. The mats shall be applied joint-less. CMS insulation materials shrink at high temperatures both in length and width and also in thickness.

In case CMS insulation materials are employed as first layer of a composite insulation system, a multi-layer application is recommended to preclude the creation of gaps caused by the shrinkage in length and width in connection with the thermal expansion of the object, which would lead to unacceptable temperature exposure of the subsequent insulation layers. The thickness decrease at temperatures up to 800 °C may, dependent upon the pressure, lie between 3% and 15%. In the face of this thickness decrease, the design must ascertain through a respective excess thickness that no cavity develops between the object and the insulation layer. Mats and felts are susceptible to point load. The resilience is notably less than that of mineral wool. The permanent deformation is up to 20% of the original thickness.

Designation	Material/minimum dimension	Employment
Tension band or strap	Galvanised or stainless austenitic steel strap, width ≥ 10 mm	Minimum 4 straps per meter
	Plastic straps, width ≥ 13 mm	
Binding wire	Annealed galvanised wire, diameter ≥ 0,65 mm	Minimum 6 loops per meter. For mats stitched to wire mesh, minimum of 3 meshes on both sides overlapping, maximum distance 150 mm
	Stainless austenitic wire, diameter ≥ 0.5 mm	
Hooks, eyehooks	Galvanised or stainless austenitic wire, diameter ≥ 1,5 mm	
Connecting tongues	-	Minimum 6 connections per meter, maximum distance 150 mm
Pins	Metal pin, diameter ≥ 3 mm[b]	Minimum 6 pins per m^2, at the under side a minimum of 9 pins per m^2
	Metal pins at ventilation pipes, diameter ≥ 2 mm	
	Plastic pin ≥ 5 mm	
a Other fastening means may be compulsory at fire protection insulations, e. g. on ventilation ducts		
b For power plant components, see AGI working document Q 101		

Standard fastenings.

2.2 Insulation with Calcium Silicate

Calcium silicates can be produced through a synthesis of the raw materials lime and sand in an autoclave. Then they are not susceptible to moisture. CS products not produced in an autoclave on the other hand are destroyed by water.

Calcium silicate insulants possess the building material class A1 (non-combustible) according to DIN 4102-1. The material has an alkaline character and is therefore not resistant against acid condensates. Calcium silicate insulation materials possess high compression strength; they can therefore be used in constructions under compressive loads even in the areas of high temperatures.

Calcium silicates do not have any shrinkage up to 250 °C; up to 500 °C, a shrinkage rate of < 1% occurs. Above 250 °C, the insulation shall be multi – layered with staggered joints. Calcium silicate boards can be cut, milled and drilled with simple wood-treatment tools. Calcium silicate must not be used as an insulation material for objects made of aluminium or stainless austenitic steel because of its alkaline character.

Form pieces of calcium silicate shall be fastened according to Table 2 above.

2.3 Adhesives

A variety of adhesives types are available for many different applications including insulation attachment, insulation fitting fabrication and facing. Adhesives are available in water based, solvent based, hot melts, reactive cure, pressure sensitive adhesives and aerosol formulations for application by numerous methods including brush, spray, trowel and roller. When selecting an adhesive the insulation type, service temperature limits, application method and required adhesive strength should all be considered. Refer to the adhesive manufacturers' product selection guides for assistance in choosing adhesives for specific uses. In all cases, regardless of the type of adhesive used to secure the insulation, it is important to prepare the surface being adhered to. It must be free of dirt, rust, loose particles, and oil. Wiping the surface with denatured alcohol is often recommended. Ambient and surface temperatures are also important factors when selecting an adhesive. When considering ambient temperatures, it is important to factor in the temperature over the entire curing time.

Cements are available which are a proprietary blend of hydraulic cement, calcium silicate and inorganic mineral fibres, with corrosion inhibitors, that provide a smooth finish over high temperature insulation. No wire mesh is required. They can also be used as a general-purpose insulating cement, as they are easy to trowel on and resist water after initial application.

Silicate-based glues are also available for thermal insulations. They set quickly to provide a high temperature bond for porous insulating materials.

2.4 Installation of Calcium Silicate Insulation

Apply Insulation to Straight Pipes and Tubes as Follows

- Secure each layer of insulation to pipe with stainless-steel bands at 250mm intervals and tighten without deforming insulation materials.
- Apply two-layer insulation with joints tightly butted and staggered at least 75mm. Secure inner layer with soft-annealed, stainless-steel wire spaced at 250mm intervals.
- Secure outer layer with stainless-steel bands at 250mm intervals.
- Apply skim coat of mineral-fibre, hydraulic-setting cement to surface of installed insulation.
- When dry, apply flood coat of lagging adhesive and press on one layer of glass cloth or tape.
- Overlap edges at least 25mm. Apply finish coat of lagging adhesive over glass cloth or tape.
- Thin finish coat to achieve smooth finish.

Apply Insulation to Flanges as Follows

- Apply preformed pipe insulation to outer diameter of pipe flange.
- Make width of insulation segment same as overall width of flange and bolts, plus twice thickness of pipe insulation.
- Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of block insulation of same material and thickness as pipe insulation.
- Finish flange insulation same as pipe insulation.

Apply Insulation to Fittings and Elbows as Follows

- Apply pre-moulded insulation sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
- When pre-moulded sections of insulation are not available, apply mitred sections of calcium silicate insulation. Secure insulation materials with stainless-steel wire.
- Finish insulation of fittings same as pipe insulation.

Apply Insulation to Valves and Specialties as Follows

- Apply mitred segments of calcium silicate insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
- Apply insulation to flanges as specified for flange insulation application.
- Finish valve and specialty insulation same as pipe insulation.

3.0 Health and Safety

Key Learning Points

- Health risks and safe handling techniques
- Safe disposal of waste.

3.1 Safe Handling of Materials

Gloves should be worn when handling insulation products. The calcium silicate insulation is easily cut using a trimming knife or hand saw. When working in elevated positions or in strong winds care should be taken that the insulation panels are not blown away. When cutting, avoid dust generation, wear a dust mask to eliminate inhaling the dust particles. Eye protection should be worn if cutting the insulation with a mechanical saw.

3.2 Disposal of Materials

Waste material should be disposed of correctly and in accordance with local authority regulations. Dispose of waste materials regularly to avoid possible ignition or wind dispersal. Ensure polythene packaging is kept away from children.

Summary

Calcium silicate is a granular thermal insulation and is made from amorphous silica, lime, reinforcing fibres, and other additives mixed with water in a batch mixing tank to form a slurry. This slurry is further processed through a number of stages until finally dried. After drying, the moulded shapes are trimmed, slit into two or more pieces and then packaged.

Magnesium carbonate is a granular insulation and is produced by extraction from dolomite rock, which is then mixed with fibre reinforcement (generally about 15% fibres) and is cast into appropriate moulds as slurry. After drying, the products are machined to size.

Insulation materials made of calcium-magnesium-silicate fibre are heat-resistant, inorganic materials which may normally be employed up to temperatures of 850 °C; they consist of silicon dioxide and calcium and magnesium oxides. They are predominantly supplied in the form of boards, mats, felts, loose wool, strings and vacuum form pieces.

Since it is a rigid material with a high compressive strength, high flexural strength, and is non-combustible, it is widely used in high temperature, industrial applications subject to physical abuse and without any loss of its insulating ability. In addition, calcium silicate can withstand vibration induced by high-temperature steam flow around internal pipe obstructions such as valves and measuring devices.

SOLAS

An tSeirbhís Oideachais Leanúnaigh agus Scileanna
Further Education and Training Authority

Castleforbes House
Castleforbes Road
Dublin 1