TRADE OF

Industrial Insulation

PHASE 2

Module 4

Insulation – Materials, Science and Application

UNIT: 4

Insulation – Terms, Definitions & Formula

Produced by

SOLAS

An tSeirbhís Oideachais Leanúnaigh agus Scileanna

Further Education and Training Authority

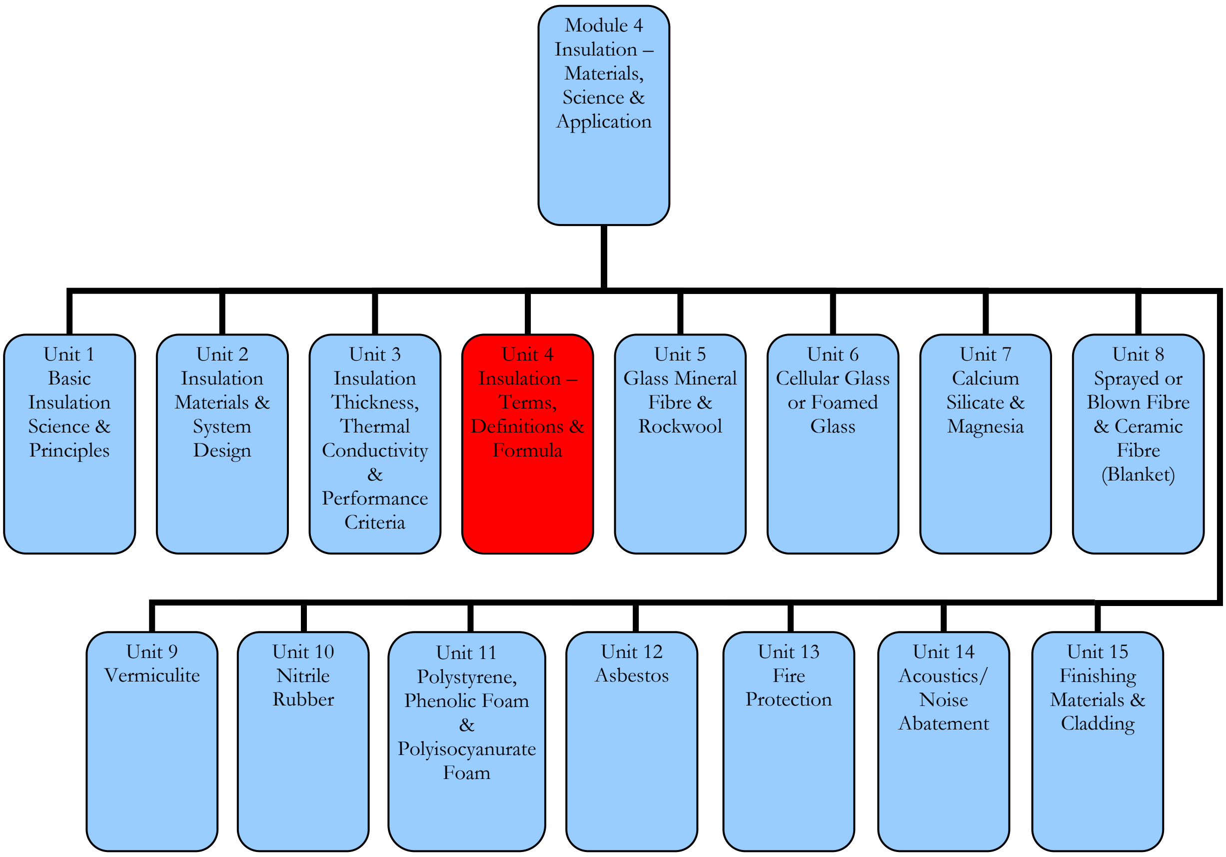
In cooperation with subject matter expert:

Michael Kelly

Table of Contents

Introduction

Thermal resistance, thermal conductivity and thermal transmitting are some of the terms used in the insulation industry. They are a measurement of different factors which make up an insulating product. When choosing and insulation product, we have to take these factors into consideration as part of the overall insulation application. The manufacturers' data and information sheets provide all the information necessary to make an informed choice on which material is best suited for the job.



Unit Objective

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

- State the units of measurement used in the industrial insulation industry.
- Indentify the symbols used in industry.
- Define the thermal factors used in industry.
- Use manufacturers data sheets to extract the required information.
- Calculate heat losses through insulated and non-insulated pipe work.

1.0 Units of Measurement and Terms Used in the Insulation Industry

Key Learning Points

- Basic SI units: area, heat, length and volume
- Units of measurement for thermal conductivity and thermal resistance.
- The definitions of thermal conductivity. Thermal bridging, condensation

1. Basic S.I. Units

The basic ***International System of Units*** or S.I. units are Length, Area, Volume and Heat.

S.I. basic unit.	Unit.	Symbol.
Length	metre	m

S.I. derived unit.	Unit.	Symbol.
Area	square metre	m^2
Volume	cubic metre	m^3
Heat	joule	J

1.2 Units of Measurement for Thermal Conductivity and Thermal Resistance

Thermal Conductivity (K) = w/mK = Watts per metre Kelvin.

Thermal resistance (R) = d/K = Thickness d divided by the K factor.

1.3 Terms and Definitions Used In the Insulation Industry

Thermal Conductivity

Lambda value = λ.

Thermal conductivity measures the capacity of a material to resist heat transfer. The smaller the lambda λ, the better the thermal insulation.

Thermal Bridging

Comparatively more heat flows through a path of least resistance than through insulated paths. This is known as a thermal bridge, heat leak, or short-circuiting. Insulation around a bridge is of little help in preventing heat loss or gain due to thermal bridging; the bridging has to be rebuilt with smaller or more insulative materials. A common example of this is an insulated wall which has a layer of rigid insulating material between the studs and the finished layer. When a thermal bridge is desired, it can be a conductive material, a heat pipe or a radiative path.

Condensation

Condensation of water vapour occurs on surfaces at temperatures below the atmospheric dew-pint, due to the water vapour being drawn towards the cold surface as a result of difference in partial vapour pressure between the air at ambient temperature and that of the temperature at the cold surface. Unless it is possible for this moisture to be re-evaporated, it can be absorbed into permeable insulating materials that can be applied to the cold surface, thus increasing the thermal conductivity of that material, with impairment of its insulating properties.

Vapour Barrier

The purpose of a vapour barrier is to reduce, and if possible to prevent, the ingress of water vapour into the insulating material. Thus the barrier should always be applied to the warmer surface of the material. It can take the form of a coating or sheet material resistant to the passage of water vapour, and the sealing of joints should be effective.

Dew Point

Dew point temperature is defined as "the temperature at which dew begins to form". Dew is the water you find on the grass or a car early in the morning. If the temperature reaches the dew point temperature then dew will form. The current dew point will never be higher than the current temperature and if the temperature is a dew point and the temperature falls, the dew point must also follow.

Ambient Temperature

Ambient temperature is the average temperature of the medium, usually air, surrounding the object under consideration.

2.0 Standard Insulation Values and Symbols

Key learning Points

- Terminology of the insulation industry
- Typical 'R' values for insulating materials
- Typical 'K' values for insulating materials
- Typical 'U' values for insulating materials
- Typical 'C' values for insulating materials

2.1 Thermal Conductivity or "K" Factor

K factor is a rate at which heat flows through a material or insulation. The lower the K value, the better the insulation value of the material. Some examples are:

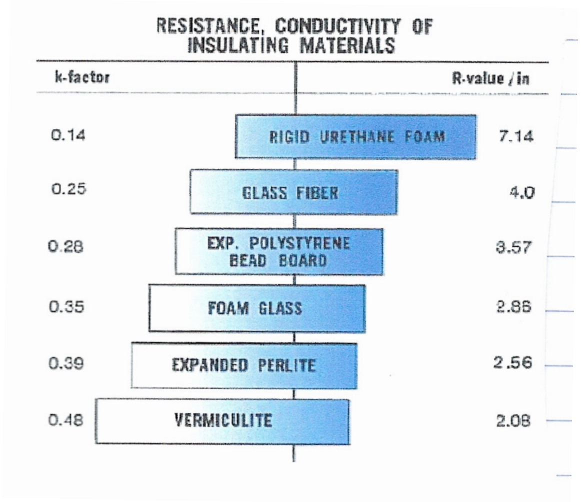
Vermiculite	K=.50-.60
Fiberglass	K=.22=.30
Urethane Rigid Foam	K=.11-.16

A material of low thermal conductivity should be selected to achieve a maximum resistance to heat transfer which is expressed as w/mk (watts per metre Kelvin).

2.2 Thermal Resistance or "R" Factor

The R factor is a measure of the resistance to heat flow. R factor can be determined for a single insulation material at a specific thickness. The R factor can be determined by dividing the thickness of the insulation by the K factor. The R factor = the thickness divided by the K factor or R=t/K.

Example: With rigid urethane foam thickness at 3 inches the "R" factor = 3/.15 = 20 or could be stated to have a "R" value of 20 or R20 value.



From the table above3, it can be seen that rigid urethane foam is 60% better than fibreglass and 350% better tan vermiculite when all are the same thickness.

2.3 Thermal Transmitting or "U" Value

The U factor is the overall coefficient of heat transfer (conductivity) for all the elements of construction, as well as the environmental factors. The U factor is the transmission of heat through a material. An example would be the U factor of a composite structure as gypsum wallboard, fibreglass core and exterior wood sheathing. The U factor should not b used with a single material, only with a combination of materials.

A U factor can also be determined by adding the C factors of the various individual materials making up a composite structure. U= C1+C2+C3, etc. If the materials are not in close contact, the C factor of the air space must be taken into consideration and included in the calculation. The smaller the "U" factor, the better the insulation value of the composite structure.

The "U" factor has an inverse relationship to the R factor. For example, a building with material with an R factor of R-11 converts to a U factor of 0.09 (1 divided by 11).

Lets' use a window as an example in our U factor discussion:

The U factor measures how well a product prevents heat from escaping. The rate of heat loss is indicated in terms of the U-factor of a window assembly. U-factor ratings of windows generally fall between 0.20 and 1.20.

The insulting value (factor) is indicated by the R-factor, which is the inverse of the U-factor. The lower the U-factor, the greater a window's resistance to heat flow and the better its insulating value (R value or R factor).

2.4 Thermal Conductance or "C" Factor

The C factor is also a rate of heat loss through a material, but could be for any given thickness, not just at 1 inch. C factor at 1 inch would be equal to the K factor. C factor of the same material at 3 inches is one third of the K factor and the same material at 2 inches is half the K factor. The lower the C value the higher the insulating value.

3.0 Information Gathering

Key Learning Points

- Types of vapour barriers
- Calculations of heat loss for insulated and non-insulated pipe work
- Use of manufacturers' data sheets to extract relevant information, problem solving and information gathering.

3.1 Insulation and "K" Factor

Insulation is typically the largest resistance component in a heat loss system. The better the insulation resistance, the longer it takes to reach thermal equilibrium. Factors such as insulation type, thickness and operating temperature conditions affect overall insulation resistance. The K factor determines the efficiency of insulation. The lower the K factor, the better it acts as an insulator. Conversely, insulation with a higher K factor results in less efficiency. Although the K factor is regarded as a constant value, K factors are affected by temperature. This is due to the fact that many insulations become less efficient as the temperature increases.

3.2 Vapour Barriers

Refer to Module 4 – Unit 11 – Section 4 – Vapour Barriers.

3.3 Heat Loss Calculations

Refer to Module 4 – Unit 3 – Section 3.1.

3.4 Use of the Manufacturer's Data Sheets

The use of the manufacturer's data sheet is vitally important in gathering information on different insulation products. Each data sheet will contain all the information required regarding 'R', 'U', 'C' and 'K' values, as well as health and safety information, storage and handling information when using these products. These data sheets take the guess work out of choosing the correct material for the application.

Summary

Architects and contractors use various "factors" to express the insulation value of a material or a composite structure: 'K', 'R', 'U', 'C'. Material suppliers often speak of products having a particular K factor which is the rate at which heat flows through a material or insulation. The lower the 'K' value the better the material acts as an insulator.

All of these factors provide us with the information we need when choosing the correct material for the job. The manufacturers of insulation products provide material data sheets which provide us with the necessary information when using their products, such as health and safety, thermal values and correct installation procedures.

An tSeirbhís Oideachais Leanúnaigh agus Scileanna
Further Education and Training Authority

Castleforbes House
Castleforbes Road
Dublin 1