



# International Journal of Engineering Research and Science & Technology

ISSN : 2319-5991  
Vol. 5, No. 3  
August 2016



[www.ijerst.com](http://www.ijerst.com)

Email: [editorijerst@gmail.com](mailto:editorijerst@gmail.com) or [editor@ijerst.com](mailto:editor@ijerst.com)

Research Paper

# HEAT TRANSFER PROCESS AND THE MECHANICAL ROLE FOR THE INSULATION MATERIALS

Fuad Abdulrahman AlKandari<sup>1\*</sup>

\*Corresponding Author: **Fuad Abdulrahman AlKandari** ✉ [fuad71@yahoo.com](mailto:fuad71@yahoo.com)

About half the energy consumed by humans is inside buildings and this illustrates the immense amount of energy that can be saved when adopting the designs that contribute to reducing the costs of cooling and heating and air conditioning and lighting in buildings in the GCC Countries in general and in Kuwait in particular. This paper focuses on studying thermal insulation materials in building the desert and its role in reducing electric energy consumption needed to provide the right comfort level for buildings' users. Thus, this research study has addressed the following: "Definition of Thermal Insulation" Benefits of Thermal Insulation" Thermal Insulation Materials" Thermal Insulation Materials' properties" Thermal Insulation Materials' Selection Determinants "The use of Thermal Insulation Materials in Buildings" Rationalization of energy by using Thermal Insulation" Conclusions and Recommendations.

**Keywords:** Thermal insulation, Heat leaking energy consumption

## INTRODUCTION

The desert areas climate is characterized by drought and soaring temperatures of up to 50 Celsius sometimes and as a result, large amounts of heat seep into the building which requires a large amount of electrical energy consumption for cooling the building. And to reduce energy consumption, it is necessary to use thermal insulation in the ceilings and walls to reduce heat transfer and leakage into the building.

## Thermal Insulation and Energy Conservation in Buildings

Studies indicate that the margin of heat leaking out of the walls and ceilings in desert areas architecture is about 60-70%, while the rest come through the windows and door openings, and that means that the heat leaking from the walls and ceilings represent the bulk to be disposed through air conditions, therefore, the thermal insulation is of great importance as it leads to reduce heat leaking into the building, and thus reduce the consumption of electrical energy used in cooling it.

<sup>1</sup> The Public Authority for Applied Education and Training, 3, Kuwait.

### Definition of Thermal Insulation

Thermal insulation can be defined as the use of material with heat insulating properties (low heat conduction), in which it helps to reduce heat leakage and transition from outside to inside the building in summer and vice versa in the winter. The heat is transferred into the building through ceilings, walls and windows.

### Benefits of Thermal Insulation

The main benefits of thermal insulation are as follows:

- Reducing the electrical energy consumption which is one of thermal insulation's most important advantages.
- Thermal insulation leads to make the air inside the building without air conditioning relatively acceptable in hot summer days, where temperatures without air conditioning inside the building reach 35 m Celsius noting the huge difference between the inside temperature and the outside temperature, and the building retains the right temperature for a long time without having to run the air longer.
- Reducing the use of air conditioning and thus reducing the health and psychological impact on humans due to the noise generated from the operation of devices.
- Reducing the thickness walls and ceilings needed to reduce the heat transfer into the building.

### Thermal Insulation Materials

Are materials which, if used in an appropriate manner can reduce or prevent heat transition by the various means of heat transfer (conduction, load and radiation). Insulation materials, forms and its most common types can be identified as follows:

### Classification of Insulation Materials

Insulation materials are classified into three groups as follows:

- Inorganic insulating materials composed of fibers or cells such as glass, asbestos, rock wool, calcium silicate, perlite and vermiculite.
- Metal insulation materials such as aluminum and reflective tin.

## THERMAL INSULATION MATERIALS' PROPERTIES

The selection of any insulation material depends on identifying its different properties represented in the thermal and mechanical properties, and the property of absorption, property of safety, health and acoustic properties. These properties can be clarified as follows:

### Thermal Properties

It means the material's capacity to thermal insulation and its measured by thermal conductivity coefficient, and the less the conductivity coefficient gets, the resistance to heat transition increases.

### Mechanical Properties

Some insulation materials have capacity to load, thus, it can be used to contribute to support and load the building in addition to its primary objective which is thermal insulation, therefore, the withstand pressure, tensile and shear power is taken into account.

### Absorption

The presence of water in the insulation material reduces the thermal insulation value and its thermal resistance value (water's thermal conductivity).

### Safety and Health

Some insulation materials have properties that

can expose humans to danger, whether during storage or transport or installation or even during the period of use, where it can cause permanent or temporary deformities in the human body.

### **Acoustic Properties**

Some insulation materials are used to meet some acoustic needs, such as sound absorption or dispersion and absorption of vibrations.

## **THERMAL INSULATION MATERIALS' SELECTION DETERMINANTS**

There are several determinants to select thermal insulation materials, namely:

### **Coefficient of Thermal Conduction**

The less is thermal conductivity coefficient; the better is the material's capacity of insulation.

### **Effective Chronological Age**

The insulation material must retain its capacity for insulation for a period compatible with the building's life span.

### **Physical Properties**

It's the resistance of pressure that must be proportional to the applied loads, dimensions stability, temperature limits, biological and chemical resistance.

### **Water Vapor Absorption and Permeability**

Water permeability into the thermal insulation leads to increase the thermal conductivity coefficient and thus weaken its thermal resistance.

### **Water Resistant**

Insulation materials must have the capacity to resist fire, or to have self-extinguishing property. It is noted that the mineral wool materials such

as fiberglass, rock wool and Perlite resist fire well, and most of the plastic insulation materials (polystyrene, polyurethane) boast of self-extinguishing property, which is sufficient in most cases of use.

## **The Use of Thermal Insulation Materials in Buildings**

### **Thermal Insulation Location in Buildings**

When using thermal insulation in buildings, both in walls or roofs, that shall reduce the heat transfer from outside to inside the building, and the insulation material's impact and effectiveness on its location in the building.

### **Roofs Insulation**

There are two types of systems used in roofing insulation, namely the traditional insulation and inverted insulation.

#### ***Traditional Insulation***

In this system, the water insulation layer shall be over the heat insulation layer.

#### ***Inverted Insulation***

In this system the heat insulation layer shall be over the water insulation layer which leads to the water insulation prevention from the heat exhaustion as it must be of high resistance to moisture absorption, high resistance to thermal change and resistance to decomposition and decay over time.

### **Insulation of Walls**

Exterior walls either insulated from the inside or from the outside or in the middle, as follows:

- Walls internal insulation: Executed by using panels composed of polyurethane or polystyrene.
- External insulation: It consists of a thermal insulator from the outside added to a light



plastering layer with a reinforced Viper gridiron, this type of insulation is characterized by achieving a complete insulation of external walls, including pillars and roof tiles.

- Isolation amid walls: insulation panels are placed between two walls with a thickness of 5 cm.

## **RATIONALIZATION OF ENERGY**

Studies have shown that the use of electric power for air-conditioning is the main reason for the rise in energy consumption, and the reason for this is that the building materials used in most buildings is a block concrete for the walls of a thickness not exceeding 20 cm and concrete roofs at a thickness of 30 cm without any heat insulating or delaying materials and this makes the level of the temperature inside the buildings roughly affected by with the external change, and this would lead to increase the air conditioning loads and to the rise in energy consumption.

And to reduce reliance on air conditioning to achieve the appropriate thermal environment for the population, there are many ways that must be taken care of, starting with the building design and selection of appropriate materials for construction and ending by the daily operation to achieve the proper thermal performance at the lowest cost.

### **Rationalization of Energy by Using Thermal Insulation**

Studies have indicated that the buildings' electric power consumption rate in one of the Gulf countries exceeds 72% of the electrical energy's total consumption, while the industrial sector consumes only about 26%, and therefore it was found that the use of thermal insulation in buildings is the best way to save electrical energy to the

consumer and the government where the use of insulations in roofs and walls lead to prevent the access of more than half of the expected heat and thus such use leads to a large amount of energy savings ranging from 30-50%.

As for the benefits of energy conservation in economic terms, studies have indicated that the cost of installing thermal insulation (rock wool) in residences ranging in size from 450-600 m<sup>2</sup> does not exceed US\$ 3000, and made by building two walls with the insulator between them.

### **Heat Transferred Through Natural Ventilation Slots**

The heat penetrating the ceilings and in summer ranges between 60-70% of the heat to be dislodged by air conditions, as for the rest, it comes out of the windows and vents.

## **EASE OF CONSTRUCTION LOADS**

By replacing some of the traditional constructions materials we can ease the high percentage of loads, for example, we can use the lightweight Styrene Concrete Hollow Blocks to save more than 95% of the weight of the hollow block used in ceilings, and by using the oblique insulation panels, we can replace the regular or light concrete tendencies, thus saving more than 95% of the weight of concrete tendencies.

## **CONCLUSIONS AND RECOMMENDATIONS**

From the foregoing we conclude that the desert architecture did not fit with the surrounding weather conditions which led to highlighting the need for using adaptive devices for cooling buildings, which led to the consumption of electric power, and that through using thermal insulation

materials we can prevent or reduce heat leakage from the outside of the building to the inside, thus reducing the size of air-conditioners and hours of operation and then saving the energy consumption used to secure the upper limit of comfort to individuals inside the building as well as to protect the building from cracks and prolong its shelf life. And to achieve the aforesaid, it is necessary to follow the following recommendations:

- The need to identify the thermal insulation materials appropriate and proper for desert environment.
- The used thermal insulation materials should be with low thermal conduction coefficient as the less is the conduction coefficient, the greater the resistance to heat transfer and the more its efficiency in the insulation.
- The importance of recognizing the insulation material's capacity to absorb water impermeability and because the presence of water reduces isolation and thermal resistance.
- The insulation material used should have the ability to be heat-insulated largest possible period of time to maintain a relatively constant thermal coefficient.
- The used insulation material should have the capacity to resist fire or to have a self extinguishing property.
- The importance of placing the insulating layer in the right place at the building and preferably

in the outer surface of the walls and ceilings.

- The need to use the intermediate walls insulation methods as it has a high capacity for heat isolation.

## REFERENCES

1. Energy Capacity in Annex
  2. Joint UNEP, ILO, ITUC 2007 Report, *Op. cit*, p. 30-48
  3. Joint UNEP, ILO, ITUC 2007 Report, *Op. cit*, p. 91-116
  4. Green Peace Organization Report titled "Concentrated Solar Thermal Energy" October 7, 2005, available on line [www.greenpeace.org](http://www.greenpeace.org), accessed on 20/10/2008.
  5. "Green Economy" The Future, Dr. Mohammad Al-Asoumi, Ph.D. in Economy 1982 – 1983, May 1985.
  6. Production of Biofuels in the World in 2009, in Annex
  7. Solar brightness in MENA Countries in annexes.
  8. The United Nations Environment Program Report, United Nations, New York, July 1, 2007.
  9. The United Nations Environment Program Report, United Nations, New York, 2006.
- World Green Building Council



**International Journal of Engineering Research and Science & Technology**

**Hyderabad, INDIA. Ph: +91-09441351700, 09059645577**

**E-mail: editorijerst@gmail.com or editor@ijerst.com**

**Website: www.ijerst.com**

