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Nanocomposite Materials Used in Heat and Sound Insulation

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Abstract –The use of composite materials, which are widely used in many areas of industry, in heat and sound insulation is increasing rapidly. In this study, primarily composite and nanocomposite material definitions were made. In addition, composite and nanocomposite application examples and different solution examples in heat and sound insulation are mentioned. The advantages and disadvantages of nanocomposite structures are presented in the study.

Keywords – Composite, Nanocomposite, Heat, Sound, Insulation

I. INTRODUCTION

Composite materials are new materials created by combining at least two different materials at the macro level [1]. Composite, although it means mixture, is not soluble and does not consist of soluble components. If any of the components that make up the composite material is in particle size and these particles are at the nanometer level, these composite materials are called nanocomposites.

Nanocomposite materials are materials obtained using nanotechnology. These materials have gained importance especially with their properties such as high strength, super flexibility, thermal stability.

Nanocomposites of polymer, ceramic and metal materials are produced. Due to the production of these materials and the superiority of their obtained properties over other materials, they are of great interest both in industry and in the scientific community.

II. MATERIALS AND METHOD

In this research, nanocomposite materials used as insulation materials were examined under two main headings as heat and sound insulation.

Evaluation of insulation application examples and comparison of the advantages and disadvantages of these applications with other options were made.

A. *Thermal Insulation and Nanocomposite Material Applications*

Nanomaterials, which have an important place in thermal insulation applications, provide thermal insulation in buildings by preventing heat transfer from the material surface due to their pores in nano sizes (20nm-100nm).

Examples of nanomaterials that provide thermal insulation are aerogel thermal insulation materials, vacuum thermal insulation panels and gas filled panels.

The choice of insulation material is an important issue. When choosing, you need to evaluate more than one feature. It is not possible to achieve the desired results with a thermal insulation material selected only by looking at the thermal conductivity value.

Due to the moisture and condensation problems in the structure, the thermal insulation material must have other properties.

When choosing a thermal insulation material, in addition to thermal performance, many features such as durability, cost, compressive resistance, water vapor absorption and conduction, fire resistance, ease of application and thermal conductivity should be considered [2].

Aerogels:

It is obtained by the principle of separating the liquid from the solid silica component by drying the gel called alcogel, which consists of a liquid solvent containing silica and etonol. It is usually produced by drying a gel containing silica at a supercritical temperature [3].

The fact that the majority of the structure of aerogels consists of air makes it a lightweight and transparent material. In addition, it provides light transmission due to its translucent. In this way, energy savings can be achieved by eliminating the need for artificial lighting.

Although they can carry much more of their own mass, aerogels can break when subjected to minor impacts. But, with various processes, their fragility can be eliminated.

Aerogel particles are used with materials such as composite and plaster in the structure and increase the thermal insulation.

Due to its high thermal insulation feature, it significantly reduces heating and cooling costs. While providing sufficient illumination, it filters out unwanted infrared ray and prevents excess heat removal by reducing heat gain.

Vacuum Heat Panels:

Vacuum heat panels (VHP) are formed by means of a core material covered by a multi-layer coating around which a degasser, dehumidifier and mattizer are mounted. The vacuum created inside the panel increases thermal resistance.

Due to their low heat conduction coefficient, they have a high resistance to heat transfer. Vacuum heat panels basically consist of four sections. These; core part, inner envelope part, outer envelope part and vacuum.

The material should be characterized by small pores (diameter 10 nm), open cell structure, sufficient compression resistance and impermeability to infrared radiation [4].

Coating design is one of the most important issues. Because it is desirable to have good mechanical strength to maintain the vacuum inside the core and limit the heat bridge effects. In addition, the coating profoundly affects the service life and the global insulation performance of the panel.

The VHP can achieve a service life of between 60 and 160 years and a heat conduction coefficient of less than 0.004 W/m.K. Studies and technological advances are necessary to optimize the real-life performance of VHPs [4].

Especially the panels are very vulnerable to puncture. Because a simple nail hammered into a wall with panels can significantly reduce the heat transmission coefficient and cannot be cut and sized on the construction site during construction.

Gas Filled Panels:

Gas filled panels (GFP) are made of a reflective structure containing a gas insulated with coating that is as less permeable as possible from the external environment. The gas may be air, but gases with a lower heat conduction coefficient are preferred. The gas filled into the panel is selected taking into account the cost, environmental impact, toxicity, fire resistance and dew point temperature. Baetens et al. built and tested two prototypes of the GFP, filled with air and argon, respectively [5].

The heat conduction coefficient between the two systems was 0.046 W/m.K for the air-filled panel and 0.040 W/m.K for the argon-filled other. But the use of inert gas has doubled the cost of a 45 mm panel. Better thermal insulation performance has been observed in different studies [6].

The thickness of the sample affects the cost of the panel and the heat transmission coefficient The thicker the GFP, the higher the amount of gas and the higher the cost, the lower the heat transmission coefficient [7]. The image of the gas filled panel is given in Figure 1.

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Fig. 1 Gas filled panel structure

B. *Sound Insulation and Nanocomposite Material Applications*

Some insulation materials used in sound insulation are;

Acoustic Sponges: It is used for reducing the reverberation in the environment to reasonable levels rather than sound insulation. It is aimed to absorb and distribute the sound evenly within the room.

Rubber Group Products (Vibration Insulators): Rubber group products are used a lot, especially in vibration and impact induced insulation. Acoustic rubbers are produced in various densities and thicknesses.

Heavy Sound Barrier: It is a very dense product with its EPDM based raw material. Despite its thickness of 3 mm, the weight of m^2 can be up to 7 kg.

Techno silence: It is a composite product. The biggest difference is produced by gluing 3 different products together. The product of different layers and intensity works effectively at noises of different frequencies. It is laminated with a heavy barrier and the desired insulation is carried to the highest level.

Barrier Rebounded: Sound insulation materials, also called intermediate partition plates, are produced by laminating sponge-derived products with heavy barriers. It is a composite product, its main place of use is drywall, partition, used as a filler material between profiles on partition walls.

Phonestar Tri Sound Insulation Plate: Qualified sound insulation materials in the special production product group are also phonestar sound insulation plates. It consists of a combination of cardboard and sand. Sand is a building block used in sound insulation for many years. Its density and crystallized structure play an active role in sound insulation. The sheet consists of corrugated channels, in which sand is contained, which has undergone special treatment. Plates, cut with the help of jigsaw or electric jigsaw, are taped from the point where they were cut. Although it has a thickness of 15 mm, it is a very good sound insulation material. It is used in neighboring wall insulation and under-parquet applications.

Sound insulation materials differ according to the place where they will be used and the desired insulation values. In addition, these products can be combined in themselves to provide good sound insulation.

The materials used together with the thermal insulation materials are made of partial sound insulation as well as thermal insulation.

Although nanocomposite products are produced in thermal insulation, sound insulation and acoustics issues have not gone beyond composite materials. Nanocomposite material applied in sound insulation has not been studied. There are different academic studies, but the suitability of these studies for the application and the results obtained have not been found sufficient. Academic studies on this subject will make important contributions. When sufficient results are obtained in the study on sound, it will make a positive contribution to the economy in this area.

III. Results

Both heat and sound insulation are available in many different materials and structures. There are different options for composite materials. However, nanocomposite materials are either very few or absent. In some studies, its suitability in terms of insulation and the results obtained were not found sufficient.

Advantages of preferring nanocomposite material as insulation material;

1. Lightness,
2. Fine structures
3. Small footprint,
4. Durability,
5. Energy efficiency,
6. Features such as long service life can be counted.

Disadvantages of preferring nanocomposite material as insulation material;

Requires application competence,

1. Negative impact of mistakes made in practice on efficiency
2. Restriction of use in open areas,
3. Sizing problems,
4. Reasons such as not being economically viable

For these reasons, there is a need for new nanocomposite materials in insulation. Research and development of nanocomposite materials with both sound and heat insulation properties can be done.

IV. CONCLUSION

As a result, there is a need for easy-to-apply insulation materials for environments that provide sustainable, reliable, healthy living conditions, energy efficiency, acoustic comfort properties, low heat transmission coefficient, innovative and economical production and designed heat and sound insulation. Academic studies on this subject will make important contributions. The production of nanocomposite materials that can provide both heat and sound insulation will also make a positive contribution to the economy.

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