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Commercializing Usage of Nano-Insulating Materials in Building Industry and Future Architecture

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Abstract

Nowadays sustainable development plays a vital role in management. One of the basic policies in environmental sustainability is related to management of non-reproducible resource. One of the fundamental solutions to reach the sustainability is finding some ways to reduce the consumption of the fossil fuels.

Since building industry plays a very significant role in the resource consumption, using the thermal insulation is one of these major solutions which can help us to construct buildings without consuming energy. Many different materials are designed for thermal insulation, like Nano-insulation, but most of them are not used in building industry. The most important questions about these kinds of materials are: what is the problem of using Nano-insulation and how can these materials be industrialized for the building industry? To answer these questions, after reviewing the current traditional thermal insulation materials and explaining the advantages of the Nano-insulation materials, a model of challenges of commercializing usage of Nano-insulating materials is presented. Studies illustrate that new Nano-materials should get through some specific processes in order to be guaranteed their usage in the building industry.

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Keywords: Insulation; Nano-insulation; Building industry.

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1. Introduction

In contemporary society there is an increased focus on various energy aspects. Buildings constitute a large part of the total energy consumption in the world. In this respect it is important to have the optimum heat balance in buildings, PetterJelle et al. (2010). Designing green buildings and using thermal insulation are useful ways to reduce the amount of energy required to maintain a comfortable environment, Mahdavinejad et al. (2012b). Furthermore, improving on current building insulation could save even more energy as well as decreasing carbon emissions, Mahdavinejad et al. (2012c).

Insulation materials are not independent energy production or conservation systems, but part of the complex structural elements which form a building's shell, Papadopoulos (2005).

Today, new materials and processes brought about by Nanotechnology, Mahdavinejad et al. (2013b). Globally, Nanotechnologies are expected to reduce carbon emissions in three main areas: 1) transportation, 2) improved insulation in buildings, and 3) generation of renewable photovoltaic energy, Elvin (2007). In the field of insulation, the convergence of green building demands and green Nanotechnology capabilities over the next 5-10 years appears very strong, Mahdavinejad et al. (2012a). So in this issue the thermal insulation materials are put into analysis.

2. Some common insulation materials in Iran

The history of thermal insulation is not as long as that of other building constructions, Mahdavinejad et al. (2013c). Long ago thermal insulation did not form a separate layer in building construction because there was no need to build in extra materials to assure the insulating function, Mahdavinejad et al. (2014a). The Process of building activity appeared when prehistoric human beings first created shelters themselves, Nazari et al. (2014). The main reason for this activity was protection against wild animals and the elements (cold winters, hot summers) i.e. insulation from the surroundings. Accordingly we can reasonably assume that one of the most important requirements for building construction is the necessity of adequate thermal insulation which is as old as building activity itself and has existed since prehistoric times, Mahdavinejad et al. (2014b).

Besides the natural products, several artificial materials were also developed during the industrial revolution. They had many advantages over the natural materials (durability, fire and water resistance) gradually taking over by the first third of the 20th century, Bozsaky (2010).

As we know insulation materials are produced from different raw materials, Mahdavinejad et al. (2014c), and apart from their thermal and physical properties, Gholami Rostam et al. (2014e), the choice of insulation material type and form depends on the required application in different building parts or components, YaoAyikoeTettey (2014).

In the table below, there is some information on the specifications of some current insulation materials in Iran's building industry, in brief. (table 1)

Table 1. Some specifications of common thermal insulation materials in Iran.

Material	Advantages	Disadvantages
Fiber Glass	High resistance to fire; High resistance to microbiological attack; Good resistance to most chemicals, Shawyer and Medina Pizzali (2003).	Poor structural strength or compression resistance; Tendency to settle after installation if not properly installed; Permeability to moisture, Shawyer and Medina Pizzali (2003).
rock wool	Non-combustible (suitable for temperatures up to 850º C) Denser than glass mineral wool. High compressive strength, Michael (2014).	Loses effectiveness if the insulation becomes wet; Low deformation resistance; Uneven surface, Michael (2014).
polystyrene	Lightweight Low water absorption	Non-biodegradable in the environment; Made from non-renewable petroleum products, Friend

Material	Advantages	Disadvantages
	Low combustibility	(2005).
	High resistance to microbiological attack	
	Recyclable, Foamex (2012).	
polyurethane	High Load Bearing Capacity;	Emits toxic fumes if burned.
	Resistance to abrasion & impact;	
	Resistance to water, oil & grease;	
	Resistance to harsh environmental conditions and many chemicals;	
	High resistance to microbiological attack;	
Perlite	Non-combustible, TIASA (2001).	Poor abrasion resistance, TIAC (2013).
	Ideal for filling odd-shaped spaces (expanded perlite);	
	Lightweight;	
	Useful for a wide range of temperatures.	

3. Some Nano insulation materials

New materials with extremely low thermal conductivities –like Nano materials- are interesting because they can have architectonic, technical and possibly economic benefits in buildings. Application of Nano insulation materials (NIMs) to limit the wall thickness, while still achieving a satisfactory thermal resistance, is an important strategy on the pathway to sustainable buildings, Dahl Schlanbusch (2013).

The table below presents some specifications of some Nano thermal materials used in building industry in Iran. (table 2)

Table 2. Some specifications of common Nano thermal insulation materials in Iran.

Material	Advantages	Disadvantages
Aerogel	Useful for windows because of its transparency, Berkeley (2015);	
	Lightweight;	
	Very effective insulation, Woods (2011).	
Vaccum insulated panel	Has very slim profile, GSA (2014);	Cannot be cut on site;
	High-performance thermal insulation, Wegger et al. (2011);	Fragile towards damaging, Baetens et al. (2010).
	Ideal for upgrading insulation during refurbishment;	
	Fits in tight spaces for new builds, Kingspan (2014).	
nansulate	Forming a thin layer insulation	
	Non-toxic, Ias group;	
	High resistance to microbiological attack, Industrial Nanotech (2013).	

4. Conclusion

In continues, after choosing some important properties of thermal insulation materials- form diversity, ease of installation, thermal range, water resistance, fire resistance, microorganism resistance and cost- these specifications were compared in both traditional and Nano thermal insulation materials by A.H.P method. Conclusions are shown in table below. (Table 3)

Table 3. The priority of analyzed thermal insulation materials.

Priority	Material	point
1	Fibre Glass	0.05084
2	Rock wool	0.0341
3	Nansulate	0.01915
4	Aerogel	0.00905
5	Vaccum insulated panel	0.00729
6	Polystyrene	0.00625
7	Polyurethane	0.00554
8	Perlite	0.00225

As the table shows, Nano thermal insulation materials, after glass wool and rock wool, are the third priority for choosing and other materials are much more popular than these applicable Nano materials. This attitude can be the result of the lack of awareness of the masses about the useful features of these new products. Furthermore, the absence of the sufficient number of manufacturers is the other reason. Hence, governments should support the new thermal insulation industries and raise the awareness of people about new insulation materials.

The figure below is the proposed model for challenges of commercializing usage of Nano-insulating materials in building industry. (model 1)

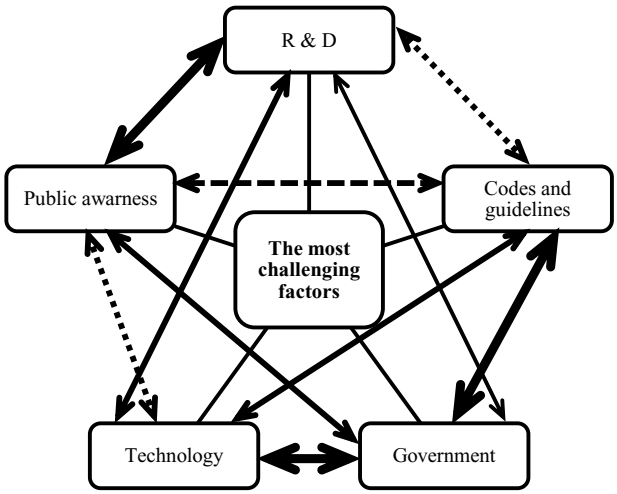

Fig. 1. Model of challenges of Commercializing Usage of Nano-Insulating Materials in Building Industry.

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