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USAGE OF BIODEGRADABLE NATURAL INSULATION IN DOMESTIC REFRIGERATOR

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Abstract — *To maintain ecological balance with industrial growth is prime motive of any nation. All nations are concerned with impact on environment due to industrialization. Everyone tries to find out way for alternate solution or technology to improve the environment. All new development and modification in existing technology primarily focused its effect on environment. Refrigerator industry uses insulation to prevent heat in leak. Earlier refrigerator manufacturer were using glass wool, but due to side effect of glass wool, refrigerator industries are using polyurethane foam (PUF) as an insulating material. Polyurethane is non biodegradable material. Though it is non toxic but it pollutes the environment. Perlite is the biodegradable material which is available naturally through crude perlite rock. It is light in weight and has low thermal conductivity. Perlite can be used as an insulation material in refrigerator.*

Keywords- *polyurethane foam(PUF), insulation, heat in-leak, biodegradable, perlite, thermal conductivity.*

I. INTRODUCTION

As we become more technologically advanced, we produce materials that can withstand extreme temperatures, are durable and easy to use. Plastic bags, synthetics, plastic bottles, tin cans, and computer hardware- these are some of the things that make life easy for us. But what we forget is that these advanced products do not break down naturally. When we dispose them in a garbage pile, the air, moisture, climate, or soil cannot break them down naturally to be dissolved with the surrounding land. They are not biodegradable. However natural waste and products made from nature break down easily when they are disposed as waste. Environment friendliness and sustainability play a key role in today's business. Increasingly, consumers ask for products that guarantee safety and high quality. This requires a balanced interaction between the ecological uses of materials, profitable economic growth. The continuous improvement and optimization of processes with focus on the sustainable use of resources and the limiting of raw materials, waste and airborne emissions is the goal of all industries.

II. POLYURETHANE FOAM – GENERAL INTRODUCTION

Polyol is a macro molecule of poly hydric alcohols with molecular weights ranging from 200 – 20000 with functionalities ranging between 2 and 8. The polyol when reacted with isocyanate, which contains a NCO functional group, reacts with the OH functionality of the polyol in the presence of suitable catalysts to form urethane/urea linkages. The catalysts accelerate the reaction to the required level. The blowing agents blow the cells increasing its volumes to form the light weight polyurethane foam. The surfactants promote and stabilizes the polyurethane cells and helps to retain the shape into which it has been blown to. Blowing agents are produced in situ as well as externally added into the reaction mixture. Non-foaming applications normally do not contain blowing agents.

Figure 1 Polyurethane Foam

III. EFFECT OF POLYURETHANE FOAM ON ENVIRONMENT

Health problem: Polyurethane is widely used in many applications like bedding, building insulation, footwear and paints. ESP energy research shows that polyurethane releases toxic fumes that are not healthy to inhale. People who are over exposed to polyurethane experience health problems including allergic reactions, rashes, difficulty breathing, loss of

consciousness and even blindness. If your eyes or skin come in contact with polyurethane form, lean and rinse them thoroughly to avoid health problems.

Environmental issues: polyurethane form emits toxic fumes if burned. Some blowing agents in polyurethane produce greenhouse gases that have negative effects on atmosphere. Some polyurethane foam contains non-renewable fossil fuels that adversely affect the environment. Though it is not as toxic as many other chemicals, it still harms the environment. Polyurethane insulation is a closed cell form that contains a low conductive gas in its cells. The gas is usually hydro-chlorofluorocarbons (HCFC). Polyurethane insulation comes in spray foam and rigid foam board.

R-value per inch: Polyurethane insulation has a relatively high R-value per inch. Generally averages around R-7 or R-8 per inch.

R-value drops: As polyurethane insulation ages, however, the R-value drops, because the gas escapes from the cells. The insulation can drop as much as two R-values in two years before stabilizing.

Chemical Release: While hydro-chlorofluorocarbons (HCFC) are not as bad for the ozone layer as chlorofluorocarbons, they still do damage it. Alternative chemicals, such as carbon dioxide, also damage the ozone when released, impacting the climate.

IV. BASIC FACTS ABOUT PERLITE

Perlite is not a trade name but a generic term for naturally occurring siliceous rock. The distinguishing feature which sets perlite apart from other volcanic glasses is that when heated to a suitable point in its softening range, it expands from four to twenty times its original volume.

This expansion is due to the presence of two to six percent combined water in the crude perlite rock. When quickly heated to above 1600°F (871°C), the crude rock pops in a manner similar to popcorn as the combined water vaporizes and creates countless tiny bubbles which account for the amazing light weight and other exceptional physical properties of expanded perlite.

Figure2 Perlite size

Figure 3 perlite

This expansion process also creates one of perlite's most distinguishing characteristics: its white color. While the crude rock may range from transparent light gray to glossy black, the color of expanded perlite ranges from snowy white to grayish white.

Expanded perlite can be manufactured to weigh as little as 2 pounds per cubic foot making it adaptable for numerous applications.

Since perlite is a form of natural glass, it is classified as chemically inert and has a pH of approximately 7.

Perlite is mined and expanded all over the world. The United States is estimated to be the largest consumer and producer of crude and expanded perlite. However, there is very strong worldwide production and consumption of perlite. Other leading countries producing perlite include China, Greece, Japan, Hungary, Armenia, Italy, Mexico, Philippines, and Turkey.

V. PROPERTIES OF PERLITE

Typical Elemental Analysis	
Silicon	33.8
Aluminum	7.2
Potassium	3.5
Sodium	3.4
Iron	0.6
Calcium	0.6
Magnesium	0.2
Trace	0.2
Oxygen (by difference)	47.5
Net Total	97.0
Bound Water	3.0
Total	100.0

* All analyses are shown in elemental form even though the actual forms present are mixed glassy silicates. Free silica may be present in small amounts, characteristic of the particular ore body. More specific information may be obtained from the ore supplier involved.

Typical Physical Properties	
Color	White
Refractive Index	1.5
Free Moisture, Maximum	0.5%
pH (of water slurry)	6.5 - 8.0
Specific Gravity	2.2 - 2.4
Bulk Density (loose weight)	As desired but usually in the range (32-400 kg/m^3)
Mesh Size Available	As desired, 4-8 mesh and finer
Softening Point	(871-1093°C)
Fusion Point	(1260-1343°C)
Specific Heat	(387 J/kg·K)
Thermal Conductivity at (24°C)	(0.04-0.06 W/m·K)
Solubility .....Soluble in hot concentrated alkali and HF Moderately soluble (<10%) in 1N NaOH Slightly soluble (<3%) in mineral acids (1N) Very slightly soluble (<1%) in water or weak acids	

Table 1 Perlite properties

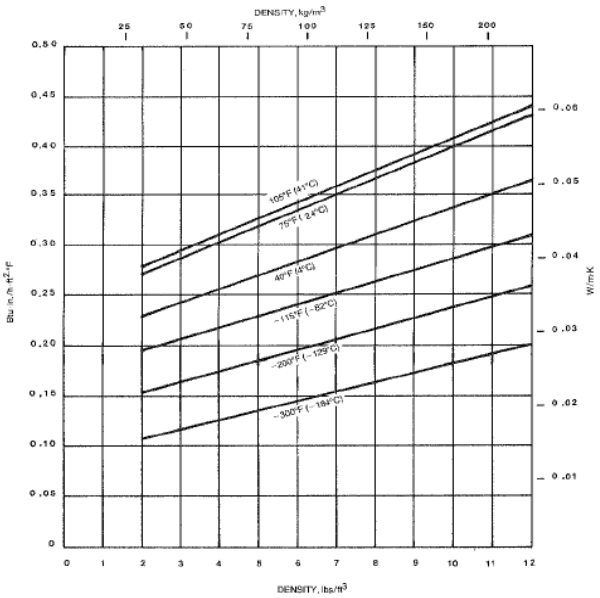

Figure 4 Thermal Conductivity of perlite

VI. APPLICATION OF PERLITE

There are many uses for perlite. These uses can be broken down into three general categories: construction applications, horticultural applications, and industrial applications.

1) Construction Applications

Because of perlite's outstanding insulating characteristics and light weight, it is widely used as a loose-fill insulation in masonry construction. In this application, free-flowing perlite loose-fill masonry insulation is poured into the cavities of concrete block where it completely fills all cores, crevices, mortar areas and ear holes. In addition to providing thermal insulation, perlite enhances fire ratings, reduces noise transmission and it is rot, vermin and termite resistant. Perlite is also ideal for insulating low temperature and cryogenic vessels. When perlite is used as an aggregate in concrete, a lightweight, fire resistant, insulating concrete is produced that is ideal for roof decks and other applications. Perlite can also be used as an aggregate in Portland cement and gypsum plasters for exterior applications and for the fire protection of beams and columns. Other construction applications include under-floor insulation, chimney linings, paint texturing, gypsum boards, ceiling tiles, and roof insulation boards

2) Horticultural Applications

In horticultural applications, perlite is used throughout the world as a component of soilless growing mixes where it provides aeration and optimum moisture retention for superior plant growth. For rooting cuttings, 100% perlite is used. Studies have shown that outstanding yields are achieved with perlite hydroponic systems. Other benefits of horticultural perlite are its neutral pH and the fact that it is sterile and weed-free. In addition, its light weight makes it ideal for use in container growing. Other horticultural applications for perlite are as a carrier for fertilizer, herbicides and pesticides and for pelletizing seed. Horticultural perlite is as useful to the home gardener as it is to the commercial grower. It is used with equal success in greenhouse growing, landscaping applications and in the home in house plants.

3) Industrial Applications

Industrial applications for perlite are the most diverse, ranging from high performance fillers for plastics to cement for petroleum, water and geothermal wells. Other applications include its use as a filter media for pharmaceuticals, food products, chemicals and water for municipal systems and swimming pools.

Additional applications include its use as an abrasive in soaps, cleaners, and polishes; and a variety of foundry applications utilizing perlite's insulating properties and high heat resistance. This same heat resistant property is taken advantage of when perlite is used in the manufacture of refractory bricks, mortars, and pipe insulation.

VII. COMPARISON OF PUF WITH PERLITE

S/n	Porperties	PUF	PERLITE
1	Thermal conductivity	0.023 to 0.032 W/(m·K	(0.04-0.06 W/m·K
2	Density-non evacuated	30-40 kg/m^3	32-80 kg/m^3
3	Biodegradable	No	Yes

Table 2 Comparison of PUF & Perlite

From the above table, Perliet is at par with Polyurethane foam in terms of thermal performance. Perlite is the biodegradable material hence it is eco-friendly in nature. Refrigeration industry uses polyurethane foam as an insulating material in all refrigerators, bottle cooler and deep freezer. PUF is non biodegradable material. This is the drawback of PUF.

VIII. CONCLUSION

Looking to the thermal and physical properties of Perlite, refrigerator industry can use it as an insulating material. It matches all thermal requirements. Perlite is being widely used in cryogenic engineering. In the same way without evacuation, perlite can be used in Refrigeration industry. Its unique biodegradable nature will definitely help to preserve nature and will keep earth green.

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