

Scope of Fiber Reinforced Polymer (Waste Plastic) in HVAC Field as an Insulator

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Abstract - This research work was carried out to show the application of waste plastic in the HVAC field as an insulative material. As we know that in HVAC field there are many insulative materials available, excluding material which is prepared in this project normally Silicon rubber can be used as an insulative material because of its porous physical structure and low density. In this project efforts have been made insist the use of polymer component made by waste plastic and reinforcement materials like Sorrel fibre, Glass fibre, Thermocol. The polymer itself is having low thermal conductivity. Hardness is high compared to silicon rubber because of that it may fail during its use that is the reason some other insulative materials like Sorrel fibre, Glass fibre, Thermocol are used as reinforcement material. The use of the waste plastic in HVAC field as an insulative material minimizes maximum pollution in the environment. These prepared insulative material are also more cost effective compared to other conventional materials because waste plastic is fully available in environment only few reinforcement have to be purchased in a minimum quantity. This may not add material cost because of its minimum quantity requirement(less than 5% by weight of that material). The result observed from this experiment has shown that the insulative property of the plastic material can be improved by adding sorrel fibres, glass fibres and thermocol effectively

keywords - Thermal Conductivity, Polymer composite, Sorrel Fibre, Glass Fibre, Thermocol, HVAC, Insulative Materia

1) Introduction

We humans always think of our comfort and we want to preserve our daily needs safely for a longer period of time. HVAC is one such technology which creates comfort environment for human as well as it preserves his daily needs and keeps them functional for a longer period of time.

The HVAC field which is related to the human comfort is known as comfort Air Conditioning system and the HVAC field which is used to care of materials and human is called as Clean Room system. Comfort AC mainly used for domestic applications and Cleanroom systems used for industrial applications.

1.1 Insulation

Supply air duct and return air duct have to be insulated to avoid heat losses. For supply air duct more thicker insulation(19mm) have to be applied because of maximum temperature difference between inside air and outside environment. For return air duct insulation have to be applied to avoid heat losses of having less thickness than supply air duct insulation because of minimum temperature difference between inside air and outside environment. Types of insulation available are Silicon rubber, Fibreglass Glass wool, Rock wool, Mineral wool, Cellulose, Polyurethane foam, Polystyrene, Plastic materials, Ceramic materials, Glass fiber.

Ducts are insulated to avoid excessive heat loss or gain. With proper design and installation it reduces the need for energy and increases the efficiency of the material. Insulation reduces the temperature of surface of the materials to a safer level which result in increased worker safety. There are many types of insulation materials and they are insulated depending upon the thickness of insulation. If the ducts are not insulated the heat is absorbed from the air around it and the system performance will be impaired. To keep up the best possible level of operation in a heating or cooling system, the parts are to be insulated.

Mohan Kashyap (May 2013): In this paper the materials of duct design like galvanized steel, aluminium, copper, and fibre glass and carbon fibre are compared with their various properties, heat losses. The dedication of this analysis is to optimization of HVACs system.

Roy M. Broughton, Hasan B. Kocer Idris Cerke(2012):In this paper basic heat transfer in the range of density, thickness, and temperature typically used for home protection and has been marked out by practise for non woven models. A model relating expenditure, density, and thermal effectiveness of nonwoven insulating materials have been progressed to support the insulation materials choosing and development of cost.

Mohan Kashyap and Alok Chauby (June – July 2013):In this research paper, air conditioning duct design is carried out on the material selection, thermal properties and heat addition or heat rejection. The main part of this work is to make high efficiency fibre glass composite material and also obtain composites of low thermal conductivity glass fibre. The major

work of this paper is to minimize the losses in duct system by HVAC’s system and in aircraft system where insignificant does make a difference.

K. Naresh, V. Krishna M. Prasanth kumar, Srinivasa Rao(August 2013):In this paper mostly used composite material are glass fibre reinforced polymer composites. In this paper a method is used for combining coal ash powder(size 52-75 µm) into asphalt and ash reinforced composite of polymer are formulated by using a techninque called hand layup with different proportionate of coal ash composite such as example 0%, 4%, 8%, 12%, 16% and 20%. The coal ash is added to polymer matrix with increase of the overall mechanical strength of the composite material when compared to the polymer composite.

2.2 Polymer Composite Material Preparation Reinforced with Glass fibre

We have taken waste plastic in a container and heated to a 150°c temperature. In that molten polymer reinforcement are added like Glass fibre of size 3mm to 5mm and the mixture has been stirred upto 5minutes then it has been poured into die to get required shape and it has been kept for cooling upto 1hour. Finally the required material is machined to get required shape circular disc of smooth surface finish.

Table.2 Glass Fibre Reinforcement Polymer Matrix Composite Material Composition.

Material	Quantity (weight %)				
	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5
Waste Plastic	99.5%	99%	98.5%	98%	97.5%
Glass Fibre	0.5%	1%	1.5%	2%	2.5%

2.3 Polymer Composite Material preparation Reinforced with Thermocol Grains

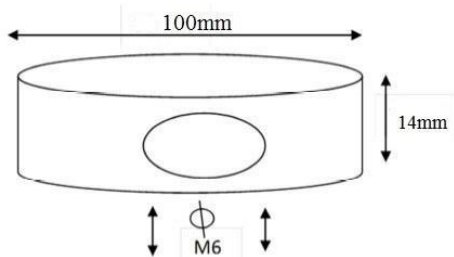
We have taken waste plastic in a container and heated to a 150°c temperature. In that molten metal polymer reinforcement are added like thermocol grains of size 3mm to 5mm and the mixture has been stirred upto 5minutes then it has been kept for cooling upto 1hour. Finally the material is machined to get required shape of circular disc of smooth surface finish.

Table.3 Thermocol Reinforcement Polymer Matrix Composite Material Composition.

Material	Quantity (weight or %)				
	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5
Waste Plastic	99.5%	99%	98.5%	98%	97.5%
Thermocol Grains	0.5%	1%	1.5%	2%	2.5%

3. Specimen Preparation

The chief source of aluminium is bauxite which is a hydrated oxide of aluminium. It occurs in abundance on the surface of the earth. It is a very good conductor of heat and electricity it melts at 660°c and boiling point is 2056°c. The metal was chosen because of its good electrical and thermal conductivity. The size of the aluminium is machined to 100mm in diameter and 14 mm thick. The specific heat capacity of aluminium is 921.096 JKg⁻¹ K⁻¹ the faces were also smoothed for good thermal contact.



The metal disc with dimension



Figure – 1 Polymer Matrix Specimens

4. Experimental setup



Figure – 2 Lee’s Disc Apparatus

Elements of lee’s disc apparatus are as follows

Aluminium disc
Aluminium cylinder
Steam generator
Heat source
Stand
Two thermometer
Aluminium disc

a) Aluminium disc

Two aluminum disc have been used for making lee’s disc apparatus of having following dimensions radius- 5cm, thickness- 1.4cm ,3Holes- 0.6cm and one, hole- 2cm which is shown in figure 2. One hole for thermometer installation and three holes for fixing purpose. Out of two disc, one disc is hanged with the help of three supporting screws one more hole is provided of 6mm diameter for installing thermometer. One more disc has been used in the aluminium box of dimensions 2cm holes for installing thermometer.

b) Aluminium cylinder

Aluminium cylinder of the above dimensions has been used to the top disc uniformly.

c) Steam generator

Steam generator has been used to generate the steam and pass to the steam chamber which is above the top disc.

d) Heat source

LPG gas cylinder has been used to supply heat to the steam generator.

e) Stand

The stand is made up of cast iron has been used to support top and bottom disc, steam chambers and specimen.

f) Thermometers

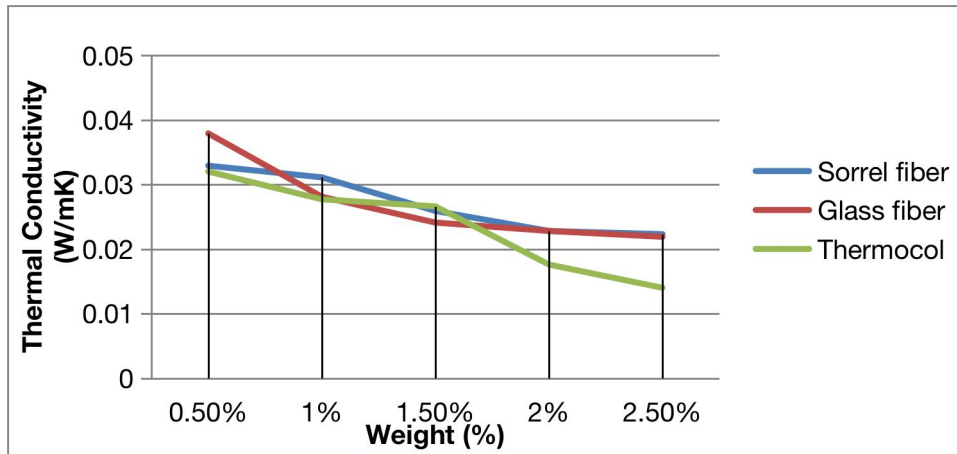
Two thermometers are used to measure the temperature of top and bottom disc with respect to time.

5.Results And Discussion

Table.4 Variation of Thermal conductivity of Polymer composite with the variation of reinforcements like Sorrel Fibr,Glass fiber and Thermocol.

Weight (%)	Thermal Conductivity		
	Sorrel Fibre	Glass fiber	Thermocol
0.5%	0.0329 W/m K	0.0379 W/m K	0.0320 W/m K
1%	0.0311 W/m K	0.0281 W/m K	0.0277 W/m K

1.5%	0.0259 W/m/K	0.0241 W/m K	0.0266 W/m K
2%	0.0228 W/m K	0.0228 W/m K	0.0176 W/m K
2.5%	0.0223 W/m K	0.219 K	0.014 W/m K



Graph 1 - Variation of Thermal conductivity of Polymer composite with the variation of reinforcements like Sorrel Fibr, Glass fiber and Thermocol.

Thermal Conductivity of sorrel fibre reinforced with plastic material decreases with increases with weight % of Sorrel fibre this indicates sorrel fibre addition increases thermal resistivity of the composite material and also it increases strength of the composition because of the addition of sorrel fibre (Journal of environmental science and technology Sorrel fibre as reinforcement in bio composite by Ashish chauhan et.al.)

Thermal conductivity of plastic reinforced with Glass fibre decreases with increases in weight % of glass fibre this indicates glass fibre addition increases thermal resistivity of the composite material and also it increases strength of the composition because of the addition of glass fibre.(ref: Mechanical properties of polymeric composites reinforced with high strength glass fibres by Michael Kinsella et.al.)

As per the above graph it has been observed that the thermal conductivity of the thermocol reinforced composite reduces with addition of reinforcements to the plastic matrix material. Because thermocol is having more air pockets, they itself act as an insulative material that is the reason with increases in weight % of thermocol thermal resistivity increases.

6.CONCLUSION

In this research work waste plastic has been taken to produce insulative material which may reduce environment pollution. Adding sorrel fibre and glass fibre increases strength of material which is needed to avoid material failure during its usage. From the above table.4 we can say that thermal conductivity of polymer composite materials is less than the silicon rubber. Hence these materials can be used for insulation in the HVAC filed. The thermal conductivity of thermocol is 0.0141 W/m K which is less than thermal conductivity of silicon rubber which is 0.0537 W/m K.

Polymer composite (97.5%) + Sorrel fibre (2.5%) = 0.0223 W/m K
Polymer composite (97.5%) + Glass fibre (2.5%) = 0.0219 W/m K
Polymer composite (97.5%) + Thermocol (2.5%) = 0.0141 W/m K
Silicon Rubber = 0.0537 W/m K

As per the above table the thermal conductivity of silicon rubber is higher compared to all polymer composite materials hence it can be used in HVAC field as an insulating material. In HVAC field the material having high insulative property are more preferable. Hence the prepared specimens have the desired property and the above three materials can be used for future work.

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