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Research Article

Energy gain during cold season using mat insulation in buildings in Tehran

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Abstract

This paper describes how to measure conductivity of a new insulator. Mat is made up of Agave plans which are now produced in Iran; it can be used in walls of buildings to reduce energy loss in cold season. In this work the thermal conductivity for mat is to be 0.06949 J/s.m°c and also from temperature gradient curve it was found that the temperature changes uniformly with thickness of the mat. Finally the difference of the energy gain in the brick buildings with & without the mat was estimated to be 1.9656×10^3 kcal in the cold season in Tehran.

Keywords: Temperature gradient, Mat, Thermal conductivity

Introduction

Prior to World War II in the 1940s, coal and wood were important. As we begin the new century the challenges we face as building designers increase daily. In criticism of energy due to the increasing oil and energy price, the main consumption of energy is usually used in residential and commercial buildings.

Mat is made up of plant fibres which are produced in many countries in the world. Both sisal and henequen come from the leaves of species of Agave (*Agavaceae*). Sislana has sharp spines on the ends of its leaves that have been used by native people as needles. The provision of both the fibre and a sewing utensil gave rise to the common name needle and thread plant. Today the fibres are used for sacking, mats and teabags and as reinforcements for materials such as rubber. Fibres are removed from Agave species in the same way. The outer, mature leaves are cut at the base, to the factory and fed between rollers that squeeze out most of the water and turn the soft tissues into an amorphous mush that is scraped away from the fibres. The fibres are then washed and hung in the sun to dry. They can be dyed or used directly since they are naturally a creamy white if properly washed and dried [1]. This work tries to consider mat as one of the desirable insulators.

Methodology

Instrumentation

In order to find the thermal conductivity for the mat, an insulation chamber of dimensions 0.75×0.6×1m³ was constructed at Shahed University, Physics Department which consists of three thermometers in which the heat flows through the mat and plywood from the warmer inside to cooler outside (both regions are inside the chamber). The area of the insulation is 0.75×0.60 m², thickness of 0.076m and of 0.01m thick plywood as shown in Table 1.

Table1. Dimensions of the insulation chamber.

Materials	Dimensions	
	Area	Thickness
Chamber	0.7*0.6m²	1m (height)
Mat	0.7*0.6m²	0.076m
Plywood	0.7*0.6m²	0.01m

Figure 1. The insulation chamber and temperature controller.

Figure 2. Brick chamber with the mat.

The inside of the chamber was blackened and the outside whitened to avoid penetrating heat into the chamber from outside, as shown in Fig. 1. A temperature controller was used to control temperature. This system has been constructed from the following different parts: 1) water container, 2) set of pump, heater and fan, 3) digital thermometer, 4) temperature sensor and 5) digital timer. The system was located in an insulation chamber.

Two chambers made up of brick on the veranda of the Physics Department, both of them with thickness of 10cm, area of walls are 64×62 cm², one of them without the mat and other with the mat with thickness of 0.0261 cm. Figure 2 shows the brick chamber covered with the mat and the temperature controller.

Measurements

Twenty observations were taken in different days and the average temperature inside the chamber shown by temperature controller to be 37°C, the interface temperature to be 30.4°C while the temperature at outside surface to be 29.6°C. The thermal conductivity [2, 3] is given by:

$$Q = \frac{KAt\Delta T}{L}$$

Where Q the number of J/s.m°c, Δt is the temperature difference between the ends of the insulation material and K is the thermal conductivity of mat, L is the thickness of insulation, cross-sectional area is A and t is the time in hours. From the temperature gradient along mat, the temperature drops per unit length is constant, as shown in Fig. 3 [3]. Thermal conductivity of plywood at 0.08 J/s.m.c was used in the calculations [4] The energy gain for one cold season in Tehran is given by [5]:

$$Q = \frac{24(hr) \times A(m^2) \times (\deg days)}{R(hr.m^2.^\circ C/J)}$$

Where $R = \frac{1}{K}$, Q is for the number of degree days for 150 days and every day nine hours observations have been taken, it was found that the difference of energy gain between two brick chambers with and without mat to be 1.9656×10^3kcal.

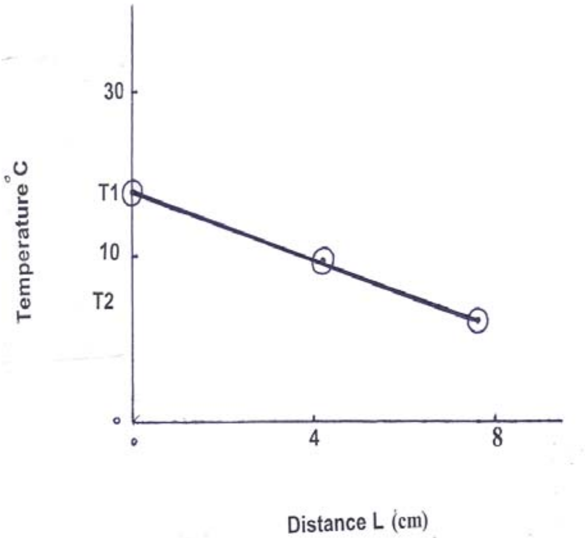

Fig3 Temperature Gradient.

Conclusions

By using mat in brick chamber for 150 days 1.956×10^3 kcal was estimated. The measured thermal insulation of mat proved to be more desirable compared with thermal insulation of wood. From temperature gradient, the temperature falls uniformly along its length from T1 to T2, and the data points are arrayed in linear fashion. So the heat energy per second reaching the cooler end is less than that energy per second which flows from the hot end. On this basis, it is concluded that for reducing the energy consumption such as coal, natural gas, oil etc, to the lowest level, mat can be considered as the best choice. It is cheaper when compared to other insulators; it is available everywhere and can be used easily. It has no side effects at all.

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