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# THERMAL CONDUCTIVITY ANALYSIS OF ISOLLAT® THERMAL INSULATION MATERIAL PRESENTED BY NOTERSON ENERGY EFFICIENCY LTD. CO.

**METU Mech. Eng. Department Test Report**

**Heat Transfer and Thermodynamics Laboratory**

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# Thermal Conductivity Test Report

## ISOLLAT® Thermal Insulation Material

The objective of this test is to determine the thermal insulation capability of ISOLLAT material. In order to determine the performance of the material the following test is performed by taking into account the three modes of heat transfer namely, conduction, convection and radiation.

**Test Description:**

In this study, the Hot-Plate steady state thermal conductivity measurement method is used and the set-up employed shown in Figure 1-a has been fabricated and installed at METU, heat transfer laboratory. The test equipment to measure the thermal conductivity of ISOLLAT thermal insulation material, are a cylindrical container, a resistance, power supply, thermocouples, datalogger and a cooling unit, These equipment are placed in a temperature controlled room. The container is made of steel with 395 mm diameter, 355 mm height and 3 mm width. ISOLLAT thermal Insulation material is applied on the surface of the container using airless coating machine with a thickness of 2 mm inside and 2 mm outside. T type thermocouples are used to track the temperature variations during the test. Thermocouples are installed on the inner and outer surface of the container as shown in Figure 1-b. The thermocouples are connected to the data logger device. The mean value recorded by the data logger is taken as the temperature of the plates.

During the experiments, the voltage and current of the power supply is fixed on the specified values of 5, 10, 15, 20 and 40 Watts. The cooling unit keeps the room temperature constant at around -4 °C. After 7-10 hours, the temperature inside the container rises and finally reaches to a steady state condition with the surroundings. The temperatures at the steady state condition are used for thermal conductivity calculations.

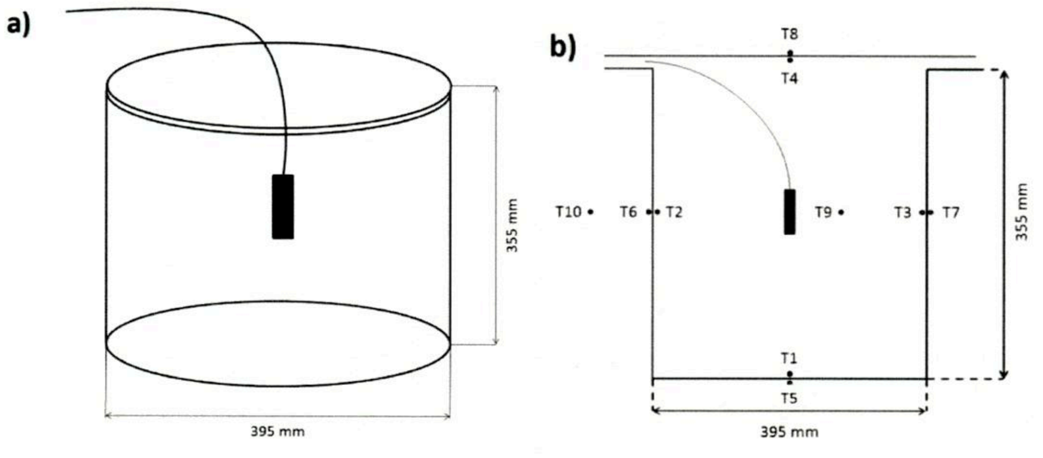


Figure 1. Schematic view a) 3D view; b) Thermocouples $T_1$,$T_2$, $T_3$ and $T_4$ inner surface temperature; $T_5$,$T_6$, $T_7$ and $T_8$ outer surface temperature, $T_9$ inside temperature and $T_{10}$ ambient temperature

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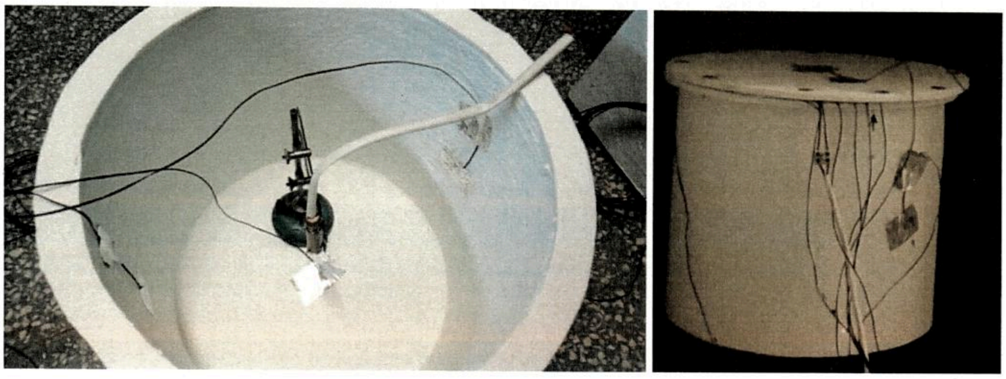

Figure 2. View of the container with thermocouples

**Results and Discussion**

The obtained temperatures are used in the steady state heat flow equation to calculate the effective thermal conductivity values.

$$Q = \frac{\lambda . A . \Delta T}{L} \tag{1}$$

Where $\Delta T$ is the inner and outer surface temperature difference at the steady state condition and $Q$ is the amount of heat transfer in watts flowing through a cross-sectional area $A$. The heat power is calculated by multiplying the values for voltage and current:

$$Q = P = V.I \tag{2}$$

Table 1 shows the experimental data and calculated results for the thermal conductivity tests. The results demonstrate that most of the heat from resistance heater is transferred through the surface at the top due to convection heat transfer. In order to accurately calculate the amount of heat transfer, the container geometry is divided into top ($T_4$ and $T_8$), bottom ($T_1$ and $T_5$) and middle surfaces ($T_2$ and $T_6$). Thermal conductivity is calculated using equation 3.

Table 1. Temperature variations in steady state condition

| Power W | $T_1$ (°C) | $T_2$ (°C) | $T_3$ (°C) | $T_4$ (°C) | $T_5$ (°C) | $T_6$ (°C) | $T_7$ (°C) | $T_8$ (°C) | $T_9$ (°C) | $T_{10}$ (°C) | $\lambda$ W/mC |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 5.03 | -2.94 | -2.83 | -2.96 | 15.92 | -2.91 | -3.64 | -3.41 | -0.20 | -1.13 | -3.81 | **0.008** |
| 9.85 | -3.11 | -2.82 | -2.78 | 29.90 | -3.08 | -3.80 | -3.49 | 1.92 | -0.23 | -3.87 | **0.010** |
| 14.30 | -2.65 | -2.26 | -2.25 | 39.50 | -2.73 | -3.68 | -3.13 | 4.10 | 1.09 | -4.30 | **0.011** |
| 21.34 | -1.89 | -1.29 | -1.26 | 57.23 | -2.12 | -3.33 | -2.50 | 6.99 | 3.28 | -4.17 | **0.012** |
| 40.53 | 0.50 | 1.53 | 1.54 | 88.76 | -0.11 | -2.02 | -0.71 | 11.87 | 8.81 | -3.91 | **0.014** |

$$Q = Q_1 + Q_2 + Q_3 = \frac{\lambda}{L}\left(A_1 . \Delta T_1 + A_2 . \Delta T_2 + A_3 . \Delta T_3\right) \tag{3}$$

Thermal conductivity variations with temperature are shown in Figure 3. According to the results the thermal conductivity of ISOLLAT material is between **0.008 to 0.014 W/mC** which is almost 4 times lower than the conductivity of glass wool in the same temperature range according to the literature.

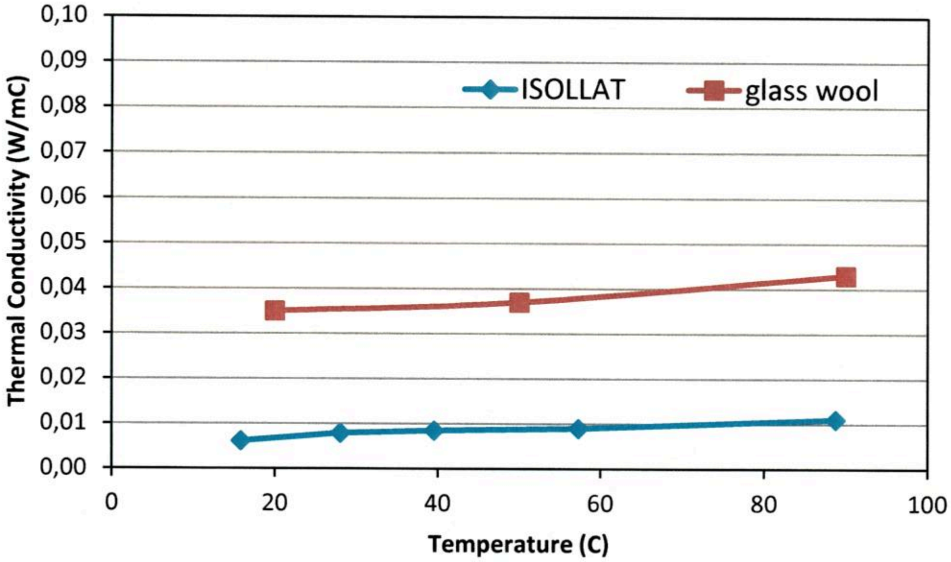


Figure 3. Thermal conductivity variations with temperature for ISOLLAT and glass wool

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