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Heat Transfer Analysis of Composite Wall with Different Thickness of Plaster Materials

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Abstract
The present analysis consists of a heat transfer in composite walls. The materials namely refractory brick, fire brick, and plaster material. In the present analysis, the thickness of plaster materials varied. The wall is maintained at constant temperature. The software used for the analysis is "ansys". First the workbench is created in the ansys. Composite wall will be designed in workbench. Later, it will be divided into number of elements and will created a mesh. After generating mesh, the boundary conditions will be applied to given problem. Therefore, the results will be obtained after giving boundary conditions and input parameters.

Keywords: Composite wall, Plaster materials, Heat flux

1. Introduction

Heat transfer is a discipline of thermal engineering that concerns the generation, use, conversion, and exchange of thermal energy (heat) between physical systems. Heat transfer is classified into various mechanisms, such as thermal conduction, thermal convection, thermal radiation, and transfer of energy by phase changes. Engineers also consider the transfer of mass of differing chemical species, either cold or hot, to achieve heat transfer. While these mechanisms have distinct characteristics, they often occur simultaneously in the same system.

The literature list out the experimental and numerical studies performed on heat transfer on composite wall of various geometries subjected to different boundary conditions.

Vrema et al. [1] investigated flow of heat through a plane wall with a finite fin insulated at a tip by calculus method. Laplace transf0rmation was considered to analyze boundary problems aresing in the area,s of engineering, science and technology. The flow of heat through a Plane wall with equally dotted heat sources between the faces, and through a finite fin with one end attached to a thermal source maintained at set temperature and other end (that is tip) insulated. The results obtained is when both the surfaces of the wall are maintained at unchanged temperature, the temperature is utmost at the mid of the wall which leads to the transmission of heat towards the both of the surfaces of the wall. **Bushan et al. [2]** conducted numerical analysis to calculate and analyze with precision the thermal behaviour of the walls of different materials attached to each other. The study of composite materials thermal behaviour is useful for the determination of heat flux, temperature distribution, heat flow rate and thermal conductivity. For finding heat flux, temperature distribution, heat flow rate and thermal conductivity the finite element program method ANSYS is used. The results obtained that with increase in thermal conductivity, the heat transfer rate found to be increased and temperature got decreased. **Pawar et al. [3]** performed experimental analysis for high heat flux condition. The heat sink mounted on the hot component for cooling the component under forced convection. The CFD simulations are performed for optimization of heat sink parameters with objective of maximization of heat transfer coefficient. It is concluded that better configuration of a heat sink which can work smoothly even after the temperature inside the component exceeds the IGBT permissible temperature is found i.e. best optimised configuration of heat sink is found. **Pakanen et al. [4]** conducted analysis on conduction of heat through slabs and walls based on differential equation of heat conduction which is further modified to a differential- difference equation with continuous space variable and discrete time variable. The results show that in most cases better accuracy is achieved with the differential-difference method when time steps of both methods are equal. **Manoram et. al [5]** In this experimental investigation simply mentioned the method to identify the heat transfer rate per unit area and outside temperature through the mathematical relation with the heat transfer rate, thermal resistance, temperature differences on the furnace wall with inner temperature of 1100OC. The wall have three layers first one created by refractory bricks. Second one consists of fire brick and last layer created with plaster. The layer of plaster increased from 5 mm to 15 mm with 2 mm increment for each consideration. The temperature difference compared with the surrounding temperature.

2. Abbreviations

T- Temperature
t- Thickness of Wall
k- Thermal Conductivity
A-Surface area
Q- Rate of heat transfer
q- Heat flux
R- Thermal Resistance

3. Units

Temperature, K
Thickness of Wall, mm
Thermal Conductivity, W/mK
Surface area, m^2
Rate of heat transfer, W
Heat flux, Wm^2
Thermal Resistance, K/W

4. Equations

$Heat\ flux = Q = \dfrac{T_a - T_b}{\dfrac{1}{h_a A} + \dfrac{L_1}{k_1 A} + \dfrac{L_2}{k_2 A} + \dfrac{L_3}{k_3 A}}$	1
$Thermal\ Resistance = R = \dfrac{L}{kA}$	2

5. Figures and Tables

Table 1: Plaster material 5mm

Sl. No.	Length (mm)	perature (K)
1	0.0	1373.2
2	28.3	1337.5
3	56.7	1301.9
4	85.0	1266.2
5	113.3	1230.6
6	141.7	1103.4
7	170.0	913.4
8	198.3	723.3
9	226.7	533.2
10	255.0	410.0

Figure 1: Temperature for 5mm

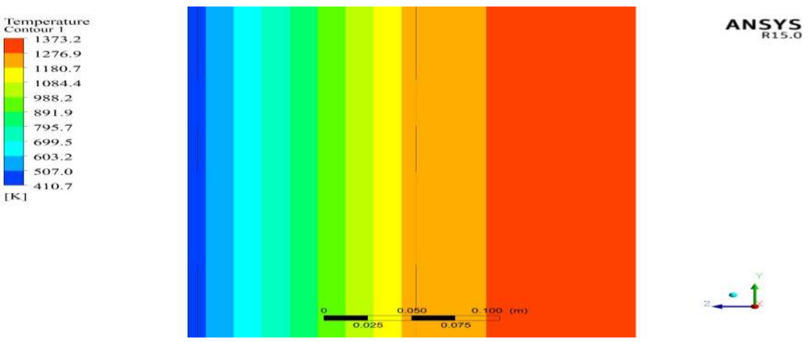


Table 2: Plaster material 7mm

Sl. No.	ength (mm)	perature (K)
1	0.0	1370.0
2	28.6	1340.0
3	57.1	1300.0
4	85.7	1270.0
5	114.0	1230.0
6	143.0	1100.0
7	171.0	917.0
8	200.0	730.0
9	228.0	544.0
10	257.0	304.0

Figure 2: Temperature for 7mm

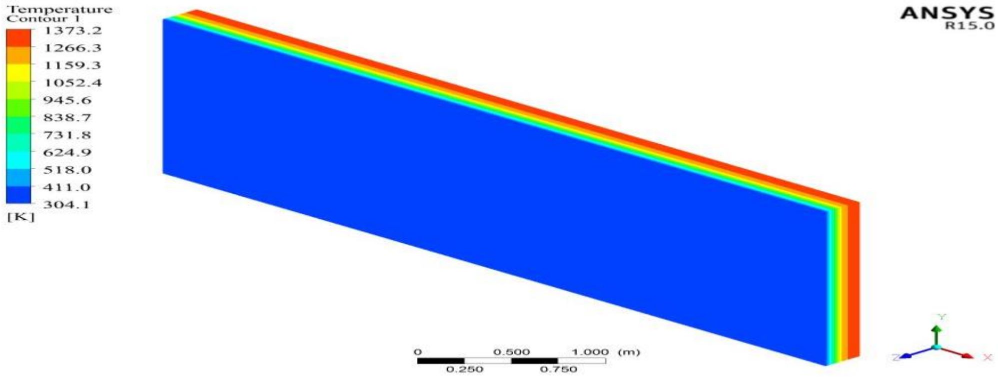


Table 3: Plaster material 9mm

Sl. No.	Length (mm)	perature (K)
1	0.0	1370.0
2	28.8	1340.0
3	57.6	1300.0
4	86.3	1270.0
5	115.0	1240.0
6	144.0	1100.0
7	173.0	920.0
8	201.0	737.0
9	230.0	553.0
10	259.0	304.0

Figure 3: Temperature for 9mm

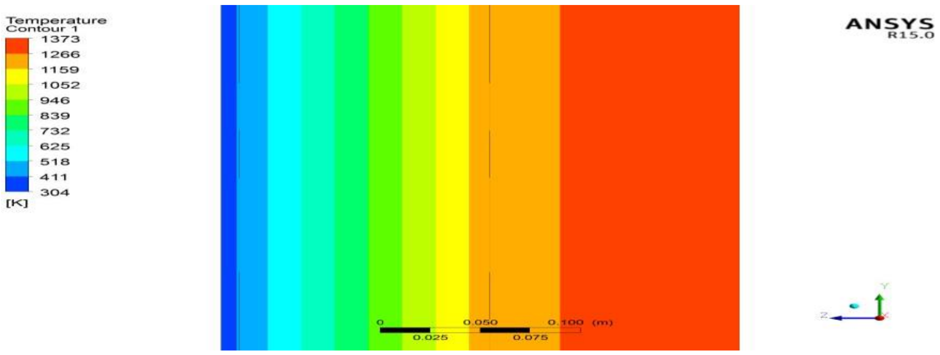
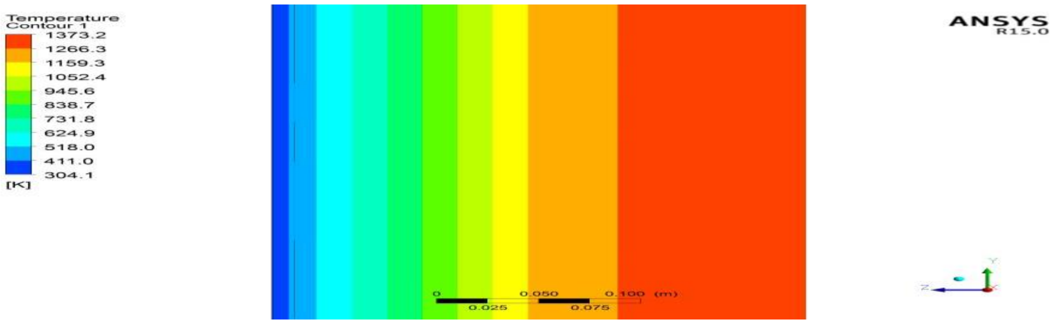


Table 4: Plaster material 11mm

Sl. No.	Length (mm)	perature (K)
1	0.0	1373.2
2	29.0	1339.4
3	58.0	1305.6
4	87.0	1271.9
5	116.0	1238.1

6	145.0	1102.9
7	174.0	922.9
8	203.0	742.8
9	232.0	562.8
10	261.0	304.1

Figure 3: Temperature for 11mm



6. Conclusion

By this analysis study about the heat transfer rate and intermediate surface temperature analysis through traditional method of composite wall heat transfer produced the subsequent conclusions when maintaining the same temperature differences.

Thermal resistance create major role in heat transfer.

Thickness of insulation is directly proportional to the thermal resistance of the corresponding material.

The heat transfer rate per unit area is inversely proportional to the thickness of insulation.

The heat flux for theoretical versus ansys shows good results.

7. References

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