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Exterior surface insulated panel radiator and energy efficiency analysis

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ABSTRACT

The economic use of nonrenewable energy has become more important in recent years. One of the works done for this purpose is thermal insulation. Thermal insulation is the process of increasing the efficient use of thermal energy. Panel radiator is adjacent to the building wall and direct heat loss occurs from the outer surface to the wall facing surface of the panel radiator. This research was done to minimize the heat loss from the outer surface of the panel radiator. Firstly, the external heat loss from the panel radiator is calculated according to the uninsulated radiator. Then heat loss calculation was made for the panel radiator covered with polyurethane outer insulation material. In calculations with independent variables, the isolated panel radiator was found to provide 122.18 joules of energy per second into the room. This result shows that the outer surface insulated panel radiator provides significant energy efficiency.

1. Introduction

Panel radiator heating system device, transfers the thermal energy in the water to the air. This heat transfer takes place with convection of 80% and radiation of 20%. [1]

Water is heated in the heating boiler and sent to the radiator via connection pipes. The heat is transferred from the radiator and the cooled water returns to the heating boiler. The cold water is reheated in the heating boiler and sent to the radiators. The desired environment is heated with this cycle.

Heat transfer takes place from each surface of the panel radiator. Panel radiator exterior surface adjoins wall and so there is heat loss from the outer surface of the panel radiator. [2] The outer surface of the radiator is covered with polyurethane insulation material, heat loss is reduced and thermal efficiency is ensured.

2. Material and Methods

2.1. Method of analysis

Heat transfer with convection is the continuous displacement of the heated air on the radiator surface with the cold air and heat transfer with conduction is heat transfer from the building to the outside (Figure 3.).

Heat transfer is assumed to be continuous, laminate, two - dimensional, the air assumed Newton type to achieve easier results in analysis. Heat transfer with radiation from the radiator surface can be neglected, because it is a small value.

Figure 1 shows the typical speed and temperature profile for natural convection flow on vertical plate. The velocity of the fluid air in the environment is zero at the outer edge of the velocity boundary layer as well as at the surface of the plate. The radiator temperature drops until it is equal to the ambient air temperature. [3]

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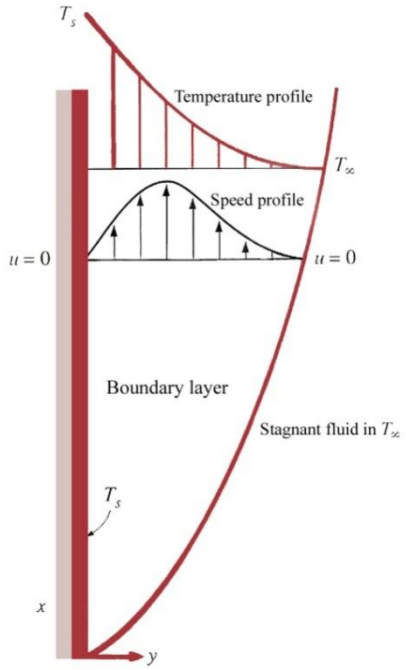

Figure 1. Typical Speed and Temperature Profiles for Natural Convection Flow on Vertical Plate [3]

For the analysis, the radiator surface temperature, the temperature of the fluid air , the temperature of the outside environment, properties of polyurethane insulation material and dimensions of the radiator are determined. The dimensions of the radiator are also shown in Figure 2.

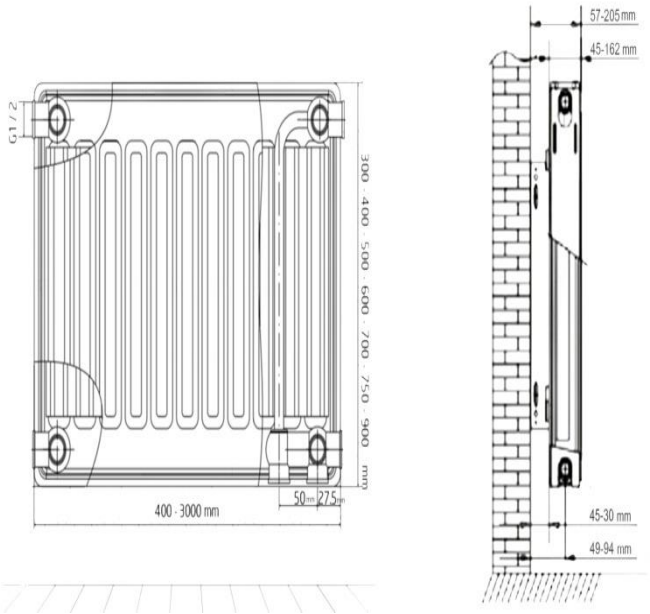

Figure 2. Dimensions of the Radiator [4]

2.2. Analysis

H=1m L=0.6m T_s=70˚C T_∞=10˚C

T_2= -10˚C P_{atm}=101.3 kPa g=9.807 m/s^2

k=0.02662 W/mK

$$T_f=(T_s+T_\infty)/2 \quad (1)$$

$$B=1/T_f \quad (2)$$

$$Gr=\frac{gB(Ts-T\infty)L^3}{v^2} \quad (3)$$

$$Ra=Gr \times Pr \quad (4)$$

$$Nu=\left(0.825+\frac{0.387Ra^{1/6}}{(1+(0.492/Pr)^{9/16})^{8/27}}\right)^2 \quad (5)$$

$$h=(k/L)Nu \quad (6)$$

$$A_s=HxL \quad (7)$$

$$Q=hA_S(T_s-T_\infty) \quad (8)$$

[3]

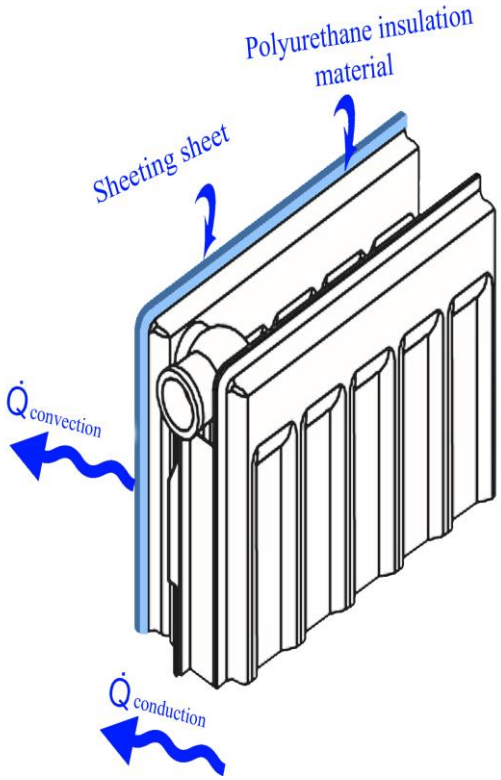

Figure 3. Insulated Construction of Panel Radiator

In Figure 3 shows the construction of the insulated panel radiator [5] and direction of heat transfer. Outer surface of panel radiator covered with polyurethane insulation material and insulation material covered with protective plate. Equations 1, 2, 3, 4, 5, 6, 7 and 8 are solved with fixed H, L ,T_s, T_∞, T_2, P_{atm} , g, k values. Insulated and non-insulated panel radiator calculations are made.

3. Conclusions

As a result of calculations with independent variables; 197.78 j/s of energy was transferred from the uninsulated panel radiator to the building wall and 75.6 j/s of energy was transferred from the insulated panel radiator to the building wall. The insulated panel radiator provides energy gain of 197.78 - 75.6 = 122.18 joules per second. With this result it is clear that the insulated panel radiator has improved its energy efficiency with polyurethane thermal insulation material.

When it is thought that the use of an insulated panel radiator in every building, the gain of nonrenewable energy around the world will be very large.

Nomenclature

H	:	Width of panel radiator
T_f	:	Film temperature
Pr	:	Prandtl number
B	:	Volumetric expansion coefficient
Ra	:	Number of rayleigh
Nu	:	Nusselt number
h	:	Heat transfer coefficient
P_{atm}	:	Atmospheric pressure
T_∞	:	Indoor temperature
Q	:	Transfer energy
L	:	Height of panel radiator
k	:	Thermal conductivity coefficient of polyurethane insulation material
v	:	Kinematic viscosity
T_s	:	Surface temperature of panel radiator
A_s	:	Surface area of panel radiator
Gr	:	Grashof number
T_2	:	Outdoor temperature
g	:	Acceleration of gravity

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