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4th *WEEK'S* SUBMISSION

1. SUMMARY ABOUT RADIATION AND RADIATIVE HEAT TRANSFERT

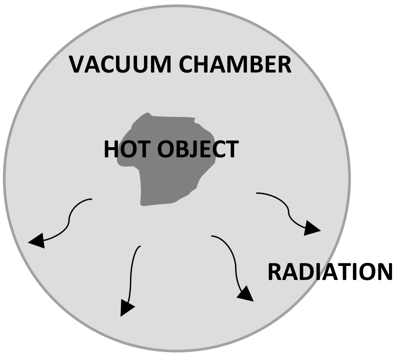
- INTRODUCTION

In addition to convection and conduction there is another type of way in which heat is transmitted and it is the **radiation**.

This mode of heat transfer occurs even in the **absence of matter**.

Consider a warm body placed in an environment where a vacuum has been created, the walls of which are at a temperature lower than that of the body; after a while you will see that the body has cooled down and has reached the thermal balance with the walls.

Given the absence of matter in the space between the body considered and the walls, the heat exchange did not occur either by conduction or convection, but through another mechanism of heat transmission that is called radiation.



It must be kept in mind that the variation of current within an electric field gives rise to electric and magnetic fields that propagate in space, these are called **electromagnetic waves**.

Like all wave phenomena, electromagnetic waves are also characterized by a **frequency v** and a **wavelength λ**, properties linked to each other through the **speed of propagation c** by the relationship.

$$\lambda = \frac{c}{\nu}$$

- THERMAL RADIATION

The type of electromagnetic radiation that is pertinent to heat transfer is the **thermal radiation**, and the rate of thermal radiation emission increases with increasing of temperature. Thermal radiation is continuously emitted by all matter whose temperature is **above absolute zero**.

Electromagnetic waves of various types differ greatly in their behaviour as the wavelength varies. These differences are described by the **electromagnetic wave spectrum**. **Light** for example **is simply the visible portion** of the electromagnetic spectrum that lies between 0.40 and 0.76 μm.

- BLACKBODY RADIATION

A **blackbody** emits the maximum amount of radiation by a surface at a given temperature. It is an object that **doesn't exist** in the real life, but we suppose that to make more simply the amount of energy emitted by a body.

$$E_b\,(T) = \sigma T^4$$

Blackbody emissive power

$$\sigma = 5{,}670 \times 10^{-8}\ W/m^2 x K^4$$

Stefan–Boltzmann constant

We can also add that the spectral blackbody emissive power as the amount of radiation energy emitted by a blackbody at a thermodynamic temperature T per unit time, per unit surface area, and per unit wavelength about the wavelength λ

2. EXERCISE

DETERMINE THE OVERALL UNIT THERMAL RESISTANCE (THE *R*-VALUE) AND THE OVERALL HEAT TRANSFER COEFFICIENT (THE *U*-FACTOR) OF **A WOOD FRAME WALL** THAT IS BUILT AROUND 38-MM 90-MM WOOD STUDS WITH A CENTER-TO-CENTER DISTANCE OF 400 MM. THE 90-MM-WIDE CAVITY BETWEEN THE STUDS IS FILLED WITH **URETHANE RIGIF FOAM**. THE INSIDE IS FINISHED WITH 13-MM **GYPSUM WALLBOARD** AND THE OUTSIDE WITH 13 MM **PLYWOOD** AND 13-MM 200-MM **WOOD BEVEL** LAPPED SIDING. THE INSULATED CAVITY CONSTITUTES 75 PERCENT OF THE HEAT TRANSMISSION AREA WHILE THE STUDS, PLATES, AND SILLS CONSTITUTE 21 PERCENT. THE HEADERS CONSTITUTE 4 PERCENT OF THE AREA, AND THEY CAN BE TREATED AS STUDS.

FIND THE TWO R_{unit} VALUES.

AT THE END, DETERMINE THE RATE OF HEAT LOSS THROUGH THE WALLS OF A HOUSE WHOSE PERIMETER IS 50 M AND WALL HEIGHT IS 2,5 M IN LAS VEGAS, NEVADA, WHOSE WINTER DESIGN TEMPERATURE IS - 2 °C. TAKE THE INDOOR DESIGN TEMPERATURE TO BE 22 °C AND ASSUME 20 % OF THE WALL AREA IS OCCUPIED BY GLAZING.

	Wood	Insulation
Outside air	0.03	0.03
Wood bevel (13x200mm)	0.14	0.14

Plywood (13mm)	0.11	0.11
Urethane rigif foam (90mm)	no	(0.98x90)/25 = 3.528
Wood studs (90mm)	0.63	no
Gypsum board (13mm)	0.079	0.079
Inside surface	0.12	0.12

$R_{withwood}$ = 0.03 $m^2 \frac{°C}{W}$+0.14 $m^2 \frac{°C}{W}$+0.11 $m^2 \frac{°C}{W}$+0.63 $m^2 \frac{°C}{W}$+0.079 $m^2 \frac{°C}{W}$+0.12 $m^2 \frac{°C}{W}$= 1.109 $m^2 \frac{°C}{W}$

$R_{withinsulation}$= 0.03 $m^2 \frac{°C}{W}$+0.14 $m^2 \frac{°C}{W}$+0.11 $m^2 \frac{°C}{W}$+3.528 $m^2 \frac{°C}{W}$+0.079$m^2 \frac{°C}{W}$+0.12$m^2 \frac{°C}{W}$= 4.007 $m^2 \frac{°C}{W}$

$$U_{wood} = \frac{1}{R'withwood} = \frac{1}{1{,}109} = 0{,}902\ \frac{W}{m2\ °C}$$

$$U_{insulation} = \frac{1}{R'withinsulation} = \frac{1}{4{,}007} = 0{,}25\ \frac{W}{m2\ °C}$$

We know that R' = R x A so R = R′/A, also we know that $R_{overall}$ = 1/$U_{overall}$ and 1 / R' = U

$$\frac{1}{\frac{R'total}{Rtotal}} = \frac{1}{\frac{R'wood}{Awood}} + \frac{1}{\frac{R'insulation}{Ainsulation}} \quad \rightarrow\rightarrow\rightarrow \quad \frac{Atotal}{R'total} = \frac{Awood}{R'wood} + \frac{Ainsulation}{R'insulation}$$

$$U_{total} = U_{wood} \times \frac{Awood}{Atotal} + U_{insulation} \times \frac{Ainsulation}{Atotal} = 0{,}902 \times 0{,}25 + 0{,}25 \times 0{,}75 = 0{,}413\ \frac{W}{m2\ °C}$$

$$R_{value} = \frac{1}{Utotal} = \frac{1}{0{,}413} = 2{,}421\ \frac{m2\ °C}{W}$$

$\dot{Q}_{total} = U_{total} \times A_{total} \times \Delta T$ = 0,413 x [50 x 2,5 x (1 - 0,25)] x [22 - (-2)] = 0,4126 x 93,75 x 24

= 928,35 W