Thermal Study of Transfer in an Exchanger Made up of Two Cylindrical Tubes

Dr.E.Thanigaivelan, N. Naresh gupta,

Associate Professor, Research scholar,

Department of Mechanical engineering, Chhatrapati Shahu Ji Maharaj University, Kanpur

***ABSTRACT**: A tentative study is prepared to establish the thermal output by convection and radiation inside a closed enclosure, crossed by two cylindrical tubes. The main idea about this paper to conclude the quantity of energy essential, then to model it for current applications that is drying, solar collectors etc. A quantity of dry biomass is burned in two interdependent hearths with two cylindrical tubes which crosses a closed enclosure. The determination of the quantity of energy emitted by radiation and convection in the closed enclosure and which constitutes the useful energy in the case of drying , accounts for 33% of the natural energy contained in the fuel (wood).*

***Keywords:** Thermal transfer, Explosive, cylindrical tubes, convection and radiation.*

I. INTRODUCTION

Heat transfer is an obedience of thermal engineering that concerns the generation, conversion, and exchange of thermal energy and heat between physical systems. Heat transfer is to classify the various mechanisms, such as thermal conduction, thermal convection, thermal radiation, and transfer of energy by phase changes. A suitable energy storage unit cannot only recover the total efficiency of the energy translation and utilization system but also assist to balance or regulate the variance between energy supply and energy demands in quantity, location and time. For example, the availability of solar energy depends largely on time, weather condition and latitude, the electricity demands vary with time. Consequently, the energy originally from solar energy and off peak electricity desires to be stored. There are many thermal energy storage (TES) methods such as sensible TES, latent TES, and chemical TES and, more recently, ionic liquid TES. Latent TES is getting more and more concentration because of its large energy storage density and the major decrease in storage volume and most importantly, the isothermal behavior during the charging and discharging process compared with sensible heat storage systems. Therefore, latent thermal energy storage is extensively used in the conversion and utilization of solar and other renewable energies, various heat recovery systems, off peak electricity storage, air conditioning and heat pump systems. Since the importance of thermal energy storage in energy systems, different latent thermal energy storage devices have been developed.

Heat exchanger with latent thermal energy storage that uses an array of cylindrical tubes as the fluid passage and outside of the tubes is the phase change material (PCM). A numerical analysis was performed of the unit by using a two dimensional formulation. The components consist of narrow vertical parallel plates of PCM estranged by rectangular flow passages. In order to enhance the heat transfer process among the PCM and the working fluid. Latent thermal energy storage system that consist of spherical capsules filled with PCM placed inside a cylindrical tank fitted with a working fluid circulation system to charge and discharge the storage tank. There are still many other types of thermal energy storage units in the literature. Though as we can see, all these latent thermal energy storage devices use the wall of the heat transfer fluid passage as the heat transfer surface of the PCM. This means the heat transfer area on the PCM side is entirely resolute by the heat transfer area on the working fluid side; while these two heat transfer areas may not be equal. However, as we know, most PCMs are poor heat transference media, and therefore, the dominant thermal resistances in the heat transfer process among the PCM and the working fluid is on the PCM side. Therefore, according to heat transfer theory, the most proficient way for civilizing the heat transfer process is to enhance the heat transfer on the PCM side. A variety of methods for PCM thermal conductivity enhancement have been proposed and studied by many researchers. Some of the most general methods are attaching fins to heat transfer walls, dispersing metal particles or rings or carbon fibers of high conductivity into PCMs, etc.

Mode of Heat Transfer: On a microscopic scale, heat conveyance occurs as hot, hastily moving or vibrating atoms and molecules act together with neighboring atoms and molecules, transferring some of their energy to these neighboring particles. In other words, heat is transferred by conduction when nearby atoms vibrate against one another, or as electrons move from one atom to another. Convective is the transfer of heat from one place to another by the movement of fluids, a process that is basically the transfer of heat via transfer. Thermal radiation is electromagnetic radiation generated by the thermal motion of exciting particles in matter. Tubular heat exchangers are widely used, and they are manufacture in many Sizes, flow planning, and types. They can contain a wide range of operating Pressures and temperatures. The ease of industrialized and their relatively low cost have been the principal reason for their wide spread using engineering applications. A Commonly used design, called the shell-and-tube exchanger, consists of round tubes Mounted on a cylindrical shell with their axis parallel to that of shell.

The optimization of the heat balance of an energy converter depends on the control which one can have on chiefly radiative heat exchange and convective. If the statement of an isothermal hot surface makes it possible to appropriately consider the total consequence of the thermal transfers of convective and radiative origin inside a field, the taking into account of the distribution of the temperatures of this surface is necessary for the control and the evaluation of the various heat flows emitted. Whatever its use, a heat exchanger cannot function constantly in steady operation. Intermediary stages intervene in particular for the period of startup or stop of the system. Varied modes are to be measured since a flow or an inlet temperature varies in the course of time. Extensive increases in transfer of heat are due to the increase in turbulence. In order to better evaluate the number of energy transmitted in the enclosure by the exchanger we put forth the following assumptions,

- Constant water content in fuel or wood

- The phenomena of thermal inertia linking to the air and the thermal losses in the pipes of connection are insignificant

- An approach of the flow of smoke in the pipe is turbulent and the flow rate of is constant

- The air is transparent with the infra-red radiation

- The inlet temperature of the smoke in the pipe is equal to each period of introduction of wood into the hearths.

The first step is conduction, which is distinct as transfer of heat happening throughout prime matter without bulk motion of the matter. Figure shows the process pictorially. A solid has one surface at a high temperature and one at a lower temperature. This type of heat conduction can occur, for example during a turbine blade in a jet engine. The outside surface, which is uncovered to gases from the combustor, is at a higher temperature than the inside surface, which has cooling air next to it. The level of the wall temperature is dangerous for a turbine blade.

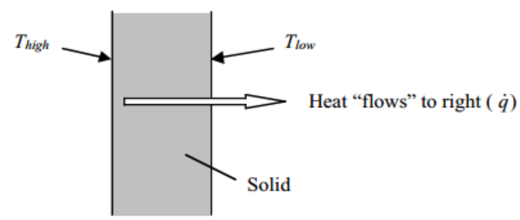

Fig 1.Conduction heat transfer

The second heat transfer method is convection or heat transfer owing to a graceful fluid. The fluid can be a gas or a liquid both have applications in aerospace technology. In convection heat transfer, the heat is enthused throughout bulk transfer of a non-uniform temperature fluid. The third step is radiation or transmission of energy throughout the space without the necessary presence of matter. Radiation is the only method for heat transfer in space. Radiation can be essential even in situations in which there is an overriding medium a familiar example is the heat transfer from a shining piece of metal or from a fire.

II. MATERIAL AND METHOD

2.1. Material: The blocked enclosed space of dimension 3 m X 2 m X 1, 2 m, is built in small ground bricks of 22 cm X 11 cm X 6, 5 cm. It is the structure of a drier. Every heat exchanger consists of two galvanized steel pipes of external diameter 134mm and internal diameter 125mm. And the entire pipe measures 3m length. One of the ends of the pipe emerges in the hearth and the other closed end, allows the drain of smoke in the chimney of racking. The material used for measurements consists of a mechanical balance or spring balance of maximum loading of 10 kg and which is used to weigh wood in heaps of 1, 2, 4, and 6 kg. An electronic thermometer makes it probable to measure the temperatures of smoke inside the pipes and on surfaces of the pipe through the thermocouple. The temperature in the enclosure is measured by a thermocouple. A ventilated aeration oven is used to determine the anhydrous mass of wood. An electronic balance Sartorius is used for the measurement of the losses of mass of wood during the purpose of the anhydrous mass. Type K thermocouples makes it possible to measure the temperature of the smoke, of the surface of pipe and the enclosure. An electronic chronometer makes it possible to follow the evolution of the range of parameters in time.

2.2. Experimental method: The wood before hand was weighed and put in heaps and introduced in equivalent quantity into the two hearths. The different temperatures and the air velocity at the opening are recorded with regular interval that is 15 to 20 min. As soon as the temperatures in the enclosure drops up to 55 °C, the two hearths are in accuse of the same quantity of wood as earlier and the cycle starts again. The same trial procedure is taken again for several flow rates of wood. The temperature measurement of the smoke is made on only one pipe. In parallel, a sample of wood is put in the drying ventilated oven to determine its anhydrous mass in order to deduce the water content of wood.

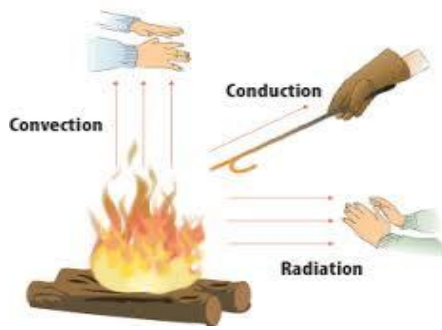

Fig 2. Modes of heat transfer

2.3 Convective Heat Transfer: The convection heat transfer mode is, where a key problem is formative the limit conditions at a surface showing to a flowing fluid. An example is the wall temperature in a turbine blade since turbine temperatures are critical as far as creep and thus blade life. There are three dissimilar types of cooling indicated; all meant to make sure that the metal is reserved at a temperature much lower than that of the combustor exit flow in which the turbine blade operates. In this case, the turbine wall temperature is not well-known and must be found as part of the solution to the problem. To discover the turbine wall temperature, we require considering the convective heat transfer, which means we need to examine some features of the fluid motion near a surface. The conditions near a surface are illustrated schematically in Figure 3.

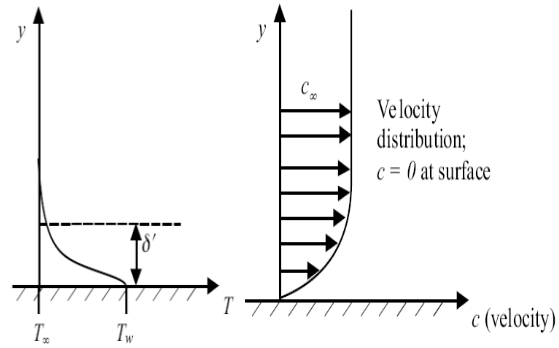

Figure 3. Temperature and velocity distributions near a surface

2.4 Radiation Heat Transfer: All bodies radiate energy in the appearance of photons moving in a random direction, with random phase and frequency. When radiated photons reach another surface, they may be absorbed, reflected or transmitted. The actions of a surface with radiation occurrence upon it can be described by the subsequent quantities,

α = absorptance (it is fraction of incident radiation absorbed)
ρ = reflectance (It is fraction of incident radiation reflected)
τ = transmittance (It is fraction of incident radiation transmitted)

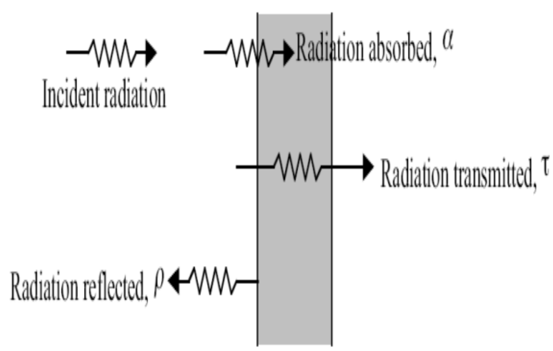

Fig 4.Radiation Surface Properties

From energy considerations the three coefficients must sum to unity,

$\alpha + \rho + \tau = 1$

Reflective energy may be either diffuse or specular. Diffuse reflections are autonomous of the event radiation angle. For specular reflections, the reflection angle equals the angle of incidence.

Flow rate of wood (kg/h)	Qb	Qt	h (%)
6	354.7	121.5	34.25
4	202.5	68.4	33.8
2.7	125.1	37.6	30.05

Table 1. Energy and output for various flows of wood

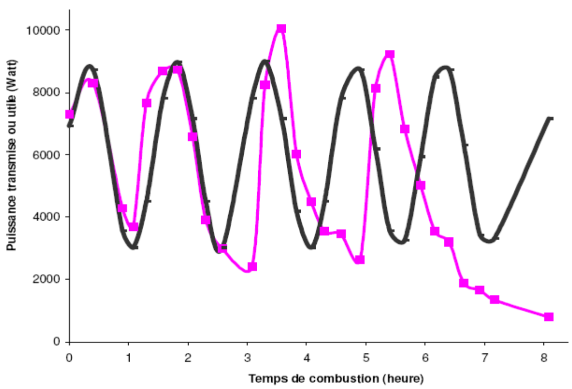

Figure 5. Modeling of the useful output for a wood flow rate of 6 kg/h

III. CONCLUSION

The main idea about this paper to study the thermal transfer in a congested enclosure made it possible to resolve the mixture of heat flows exchanged in the enclosure and the heat exchanger composed of two galvanized steel pipes. The fortitude of the useful output or the useful energy by two different methods of calculation made it possible to obtain a thermal efficiency of the exchanger of about 33%. This result can be used for the modeling of the drier in load.

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