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A REVIEW ON HEAT TRANSFER ENHANCEMENT USING MAGNETOHYDRODYNAMIC EFFECT

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ABSTRACT
As the world's population is increasing day by day, energy consumption is increasing as well. The main challenge in front of the researchers today is to invent the techniques by virtue of which the energy consumption will be reduced. The easiest way to achieve this goal is by increasing the rate of heat transfer. Numbers of techniques are already available to enhance the heat transfer. Some of them are active techniques and some are passive. It is beneficial to go for passive one as these techniques does not require additional sources of energy. Magnetohydrodynamics is a newly developed passive technique to enhance the heat transfer in a great extent. It can be used in many thermal applications. This paper provides a review on heat transfer enhancement using Magnetohydrodynamic Effect.

KEYWORDS: Heat Transfer Enhancement, Magnetohydrodynamic Effect

1. INTRODUCTION
Heat transfer devices have been used for the conversion and recovery of heat in many industrial and domestic applications. Some examples are boiling of liquid, condensation of steam in power plants, thermal processes, sensible heating and cooling. Enhancing the performance of a heat transfer devices is therefore more important, since it can result in energy, material and cost saving.

Numbers of heat transfer enhancement techniques are there. It can be achieved not only by increasing the effective heat transfer surface area but also by generating turbulence in the fluid flowing inside the device. Rough surfaces or extended surfaces i.e. fins are used for the purpose of increasing the effective surface area. Along with these, magnetic field can be used for generating the turbulence which will lead increase in convectional heat transfer.

2. MAGNETOHYDRODYNAMICS
Fluid dynamics is an important science used to solve many problems arising in aeronautical, chemical, and mechanical and civil engineering field.

The science of motion of heat in which the laws that govern the conversion of energy from one form to another, the direction in which the heat will flow are studied is the subject Thermodynamics.

The study of charge particle in motion, the forces created by electric and magnetic field, and the relationship between them give rise to the subject Electrodynamics.

The combined effects of these three important branches of science namely, Fluid dynamics, Thermodynamics and Electrodynamics give rise to the field Magneto-fluid dynamics (MFD).[1]"The science of motion of electrically conducting fluid in the presence of a magnetic field is called as Magneto-fluid dynamics". It has two sub-branches namely Magnetohydrodynamics (MHD) and Magnetogasdynamics (MGD). MHD deals with electrically conducting liquids whereas MGD deals with ionized compressible gases.

Magnetohydrodynamics deals with study of interaction of magnetic field with moving conducting fluids like gases, liquids two phase mixtures and plasmas.[2] The effect of magnetic field can enhance the circulation of these fluids which can further lead to faster cooling of molten metal and enhanced heat transfer in liquids.[3] Magnetohydrodynamic force greatly influences molten metal which affects the convectional currents in the flow of molten metal.[4] When a strong magnetic field is applied on the moving fluid it generates secondary flow patterns in the fluid as a result of magneto-fluid energy conversion process, in this process magnetic energy influence the fluid particles and move them irrespective of their main flow characteristics.

Magnetohydrodynamic Effect:-
Magnetohydrodynamic effect is the unique phenomenon in which magnetic field when applied to the conducting fluid, can influence the flow characteristics of the fluid.

Magnetohydrodynamic effect has been used for many applications like MHD pumping, MHD propulsion but use of this technique to enhance heat transfer has received less attention. The main reason for this is that magnetohydrodynamic effect is not predominant in many fluids which are used in heat exchanging devices. High amount of magnetic flux is required to generate considerable magnetically driven flow into the water which can lead to heat transfer enhancement.

Studies on Heat transfer enhancement using MHD:-
Sami [5] studied the effect of external magnetic field applied on a fluid. It is seen that it will result into magneto-fluid-mechanical energy conversion process in which energy will first converted into magnetic energy to fluid energy which can be then easily converted into mechanical energy. The magnetic field also influences the fluid properties, and if this technique used properly it can also enhance the heat transfer from different heat exchangers.

Lazarian [6] studied the effect of turbulence on heat transfer within magnetized plasmas for energy injection velocities both larger and smaller than the Alfven speed. Author found that in the latter regime the heat transfer is partially suppressed, while in the former regime the effects of turbulence depend on the intensity of driving. The turbulent motions induce their own advective heat transport because of which there is an increase in heat transfer.

Dessie [7] analyzed the MHD boundary layer flow and heat transfer of a fluid with variable viscosity through a porous medium towards a stretching sheet in presence of heat source or sink. The symmetry groups of corresponding boundary value problem are obtained by using Lie's scaling group of transformations. These transformations are used to convert the partial differential equations into self-similar non-linear ordinary differential equations. Numerical solution is obtained by Runge-Kutta fourth order with shooting method. Numerical results obtained for different parameters such as viscosity variation parameter (A), permeability parameter (k_1),source or sink parameter (λ), magnetic field parameter (M), Prandtl number (Pr), and Eckert number (Ec) are drawn graphically and effects of different flow parameters on velocity and temperature profiles are discussed.

Aktar [8] studied the combined effects of conduction and convection on magneto hydrodynamic (MHD) boundary layer flow with viscous dissipation and heat generation along a vertical flat plate. The governing boundary layer equations with associated boundary conditions for this phenomenon are converted to non-dimensional form. Writer solved resulting non-linear partial differential equations using the implicit finite difference method with Keller–box scheme.

Siddique [9] studied the unsteady free convection flow, with heat and mass transfer, of an electrically conducting viscoelastic fluid, through a porous medium of variable permeability is investigated by the writer. The numerical results obtained show that, if the applied magnetic field is fixed to the plate the fluid flows more slowly than if the magnetic field is fixed to fluid. If the magnetic field strength is high, the fluid moves more slowly than into weak magnetic fields.

3. SUMMARY OF THE REVIEW
From the literature it can be summarized that-

1. If the MHD technique is used properly it can also enhance the heat transfer through heat exchangers.
2. The actual heat transport depends on turbulence which is created by MHD effect and may higher or much lower than the classical one. Hence turbulence can enhance heat conductivity, depending on the plasma magnetization and turbulence driving.

3. The effect of transverse magnetic field on a viscous incompressible conducing fluid flow is to suppress the velocity of fluid which in turn causes the enhancement of the temperature field. The effect of magnetic field is to decrease both dimensionless velocity profiles and also skin-friction coefficient values.

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