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Study on Relationship between Heat and Mass Transfer and Magneto Hydrodynamic Fluid Flow

Ankur Bhatia[1]* Dr. Subhash Bhatia[2]

[1] Department of Mechanical Engineering, Shri Satya Sai University of Technology and Medical Studies, Pachama, Sehore (MP)

[2] Department of Chemical Engineering, Shri Satya Sai University of Technology and Medical Studies, Pachama, Sehore (MP)

Abstract – Because there are a lot of various applications in the manufacturing industries and technological processes such as wire drawing, paper production and glass-fiber, processing industries of metal and polymer, and so on, movement of incompressible sticky solutions by stretching sheets appealed a significant focus of the investigators. Using the magnetic field of high power in the ionic liquid with low density, conduction normal to magnetic field is transformed to bending of the atomic particles and ions associated with magnetic force lines prior to arising in conflict and a current induced perpendicular with electric and magnetic field which is called Hall Effect. It is measured through the heat or mass transfer analysis in the conditions in which effect of electromagnetic force is powerful. Research of the electrically conducting solution applies in numerous engineering issues like MHD generators, plasma researches, nuclear reactors, geothermal energy extraction and boundary layer control in aero dynamics. Procedure of heat and mass transfer in the free convection movement applies in numerous chemical engineering procedures, cooling device aeronautics and nuclear reactors. Here we will do the exploratory research on the Theory of Heat and Mass Transfer in Magneto hydrodynamics (MHD).

Keywords: Heat and Mass Transfer, Magneto Hydrodynamic, Fluid Flow etc.

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I. INTRODUCTION

Research of the hydro magnetic boundary layers on the stretching surface appealed a significant amount of interest as it had broad implications, particularly in the engineering and industrial process. Issue related to boundary layer movement over a constant surface with hydro magnetic field is research. Two-dimensional gradual movement of an electrically conducting viscid incompressible liquid past a constant and consistent moving surface with a constant magnetic field is studied. It is considered that magnetic Reynolds number is small and thus the induced magnetic field is avoided. Range of cooling and stretching can be regulated in the metallurgical procedure by design of strips in the electrically conducting solution vulnerable to a magnetic field with which an ultimate product of necessary features can be accomplished.

The impacts of radiation on heat transfer over an exponentially extending surface with Magneto hydrodynamic flow have been considered. The flow of thick incompressible liquid over an extending sheet has numerous uses in assembling enterprises and mechanical procedure, for example, glass-fiber generation, wire drawing, paper creation, creation of sheeting material and so forth. The investigation of magneto-hydrodynamic flow of an electrically directing liquid is interesting for current metallurgical and metal-working procedures.

2. HEAT AND MASS TRANSFER

Heat transfer and mass transfer are the kinetic procedures which might arise and are examined independently or mutually. Examining both separately is less difficult, yet the two procedures are demonstrated by comparative scientific conditions on account of dispersal and convection (mass-transfer cannot be found similitude to heat emission), and it is in this manner progressively proficient to think of them as together. Additionally, heat and mass transfer should be together considered sometimes such as evaporative cooling and removal [1]. In depicting heat transfer issues, we frequently commit the error of reciprocally utilizing heat and temperature. A particular contrast between the two. Temperature is a proportion of the measure of vitality controlled by atoms of a

substance. It is an overall proportion of hot or cold a substance would be able to get utilized to foresee course of heat transfer. Standard image representing temperature is T. Scales of estimating temperature in SI units are Celsius and Kelvin temperature scales. Then again, heat is energy in transit. Energy transfer as heat happens at sub-atomic dimension because of a temperature contrast. Typical formula for heat is Q. Normal units for estimating heat are Joule and calorie in SI framework.

There are mind boggling issues in which heat and mass transfer forms are joined to chemical reactions, like combustion; yet commonly chemical procedure is too quick or too moderate through which it can be very well be decoupled and thought about separated, like significant diffusion-controlled combustion issues of gas-fuel flies, and dense fills (drops and particles), that get secured in Combustion kinetics. There is very less reference about heat transfer in micrometric extend and underneath, or regarding the biomedical heat transfer (see Human warm solace). The standard method to make the better of the two methodologies is to initially consider heat transfer without mass transfer, and present at a later stage an instruction of likenesses and contrasts between heat transfer and mass transfer, that has a few particular instances of mass transfer applications [2]. With such system, we overlook for the minute about mass transfer (managed independently under Mass Transfer), and focus on less difficult issue of heat transfer.

A. Heat Transfer Fundamentals

Heat-transfer issues emerge in numerous mechanical and natural procedures, especially in energy usage, thermal handling, and thermal control. Energy can't be made or demolished, yet so-normal it is to utilize energy as synonymous of energy, or the nature of energy, than it is generally said that energy use is worried about energy age from essential sources (for example petroleum derivatives, sunlight based), to end-client energy utilization (for example power and fuel utilization), through all conceivable middle strides of energy valorisation, energy transportation, energy stockpiling, and energy change forms. Heat transfer is the progression of thermal energy driven by thermal non-harmony (for example the impact of a nonuniform temperature field), generally estimated as a heat motion (vector), for example the heat stream per unit time (and more often than not unit ordinary zone) at a control surface. The reason for thermal preparing is to constrain a temperature change in the framework that empowers or cripples some material change (for example nourishment purification, cooking, steel treating or toughening). The reason for thermal control is to manage inside fixed built up limits, or to control in time inside a specific edge, the temperature of a framework to verify its right working [3]. As a model issue, consider the thermal issue of heating a slim metallic pole by getting a handle on it toward one side with our fingers for some time, until we pull back our hold and let the pole chill off in air; we might need to foresee the advancement of the temperature toward one side, or the heat move through it, or the pole conductivity expected to heat the contrary end to a given extent.

Heat transfer hypothesis depends on thermodynamics, physical transport wonders, physical and chemical energy dissemination marvels, space-time displaying, extra numerical demonstrating, and exploratory tests. Everyone has been constantly presented to heat transfer issues in ordinary life (putting on coats and keeping away from winds in winter, wearing tops and searching for breezes in summer, modifying cooking power, etc.), with the goal that specific experience can be expected. Be that as it may, the point of examining an order is to comprehend it inside and out; for example, to recognize thermal-conductivity impacts from thermal-limit impacts, the significance of thermal radiation close room temperatures, and to have the capacity to make sound expectations [4]. Commonplace heat-transfer gadgets like heat exchangers, condensers, boilers, solar collectors, heaters, heaters, etc. should be considered in a heat-transfer course, yet the focus must be on essential heat-transfer models, which are all inclusive, and not on the horde of subtleties of over a significant time span gear.

Mass transfer happens in numerous procedures, for example, refining, ingestion, dehumidification, fluid extraction, filtering and drying. Some normal instances of mass transfer process are the vanishing of water from lake, filtration of blood in kidney and liver and refining of liquor. In industry the mass transfer process happens in the safeguards, for example, scrubbers, safeguards including enacted carbon beds and fluid extraction. Numerical demonstrating of mass transfer has broad application in chemical building issues. The laws of mass transfer demonstrate the connection between the motion of the diffusing substance and the focus inclination in charge of this mass transfer. Shockingly, the quantitative depiction of sub-atomic diffusion is impressively more mind boggling than the closely resembling portrayals of the sub-atomic transfer of force and energy that happen in one-part stage.

3. FLOW OF FLUID THROUGH POROUS MEDIUM

A porous medium is a solid comprising of void spaces (pores), either associated or detached, scattered inside it in either a customary or arbitrary way. These purported pores may contain an assortment of liquids, for example, air, water, oil and so on. In the event that the pores speak to a specific bit of the mass volume, a perplexing system can be framed which can convey liquids. Just these penetrable and porous media are contemplated in this volume. Different precedents

can be named where porous media assume a significant job or where the innovation requires them as an apparatus. Liquid stream frameworks through porous media and the idea of limit control are exhibited in this starting segment. Further, the connection to a significant application territory, oil repository frameworks [5]. Liquid course through porous media has been a significant research subject for quite a long time particularly in the regions of groundwater development, oil building, topography, and geophysics. Liquid stream models through porous media can be portrayed by the Boussinesq equation. This equation depicts an uncommon instance of porous media liquid stream with quadratic nonlinearity. The Boussinesq equation can be written in the accompanying structure

$$\frac{\partial}{\partial t}\omega(x,t) = \frac{\partial}{\partial x}\left(\omega(x,t)\frac{\partial}{\partial x}\omega(x,t)\right),$$

The fluid flow relies on features of fluid like viscidness and density, along with permeable medium features like absorbency and porousness. Moreover, viscidness and density rely on the arrangement of molecules in the fluid itself along with the temperature and force. The permeability is an isotropic feature thus is the interstitial velocity associated with the exterior velocity. Evidently the fluid current resistance via permeable medium is associated with the particle density existent in the media known as permeability.

Speedy exhaustion of fossil fuel resources causes the growth of substitute novel power origins. Among the majorly prospective novel power sources is geothermal power that is quite sustainable along with being clean. The reserve of geothermal energy is deemed as being the result of the actions of volcanoes or tectonic activities [6]. Consequently, interferences of magma can take place at superficial depths under the crust of the earth. Permeable resources like rock, sand under the ground are inundated with water or fluids of different kind. These fluids seep across the permeable media because localized stress slopes and conveyance power from a particular area to a different one.

The speedy exhaustion of non-renewable power resources like reserves of fossil fuel has offered the push for the pursuit for fresh energy resources. Hinted by this, the study as well as advancement of region of geothermal power has caused vast progress. The penetrability, that is reverse resistance for flowing of fluid, governed by the permeability as well as the exterior area each unit volume of the particles inside the medium.

4. MAGNETO HYDRO DYNAMIC FLUID FLOW

Magneto hydrodynamics (MHD) research the interface of electromagnetic fields having fluids that conduct electricity. The phrase 'magneto hydrodynamics' was primarily coined in 1945, by Hannes Alfven with regards to the solar system cosmogony. The fluid is believed to be plasma – ionized fume, in astrophysics. The ionization is disregarded in calculations of MHD that results in declarations like "MHD is the humble counterpart of plasma physical science. Magneto hydrodynamics includes thus an amalgamation of magnetic as well as electrical fields for inducing power-driven current in a fluid that is formed to conduct through liquefying an electrolyte within that. As the flow of ions within the magnetic field is the reason for the moving of the conductive fluid, thus it is essential to comprehend the features of the electromagnetic powers in function. The interface of this plasma confinement magnetic field with the fluid metal poses a contest for the pattern of layers of fusion reactor, because the rise of MHD forces: amplified reductions in pressure, heat transfer repression, and so on [7]. For overcoming such problems, a dielectric fluid may be implemented for cooling in the producing area. An archetypal alignment includes tubes crosswise to the fluid metal course of flow.

Flowing of MHD concerns several manufacturing functions, comprising the creation of breeder blankets for nuclear fusion reactors. As lithium is the substance for tritium breeder, amalgams of eutectic such as LiPb were deliberated previously for their outstanding thermal features as functioning fluids. For ensuring the essential chilling of the breeding area, a strategy that is adopted among many is the insertion of tubes crosswise to the core current path. Forces of MHD (Magneto Hydrodynamic) are a fundamental portion of specific procedure implement such as fusion reactors. Successful elimination of heat that is generated volumetrically is vital thus requiring improvement of transfer of heat. In different utilizations, MHD may as well be employed superficially for reducing or enhancing the diffusion of heat [8]. The key features influencing the transfer of heat comprise the material traits of the fluid denoted by its Prandt figure, the magnetic field's power and alignment denoted by the Hartmann numeral, the flowing situation inside the fluid categorized by the Raleigh numeral, if convection occurs naturally and the Reynolds numeral for artificial convection, the fluid carrier's wall conductivity (enclosure, canal, tube or vessel) that might have diverse conductivities along with having additional particular functioning constraints.

5. RELATIONSHIP BETWEEN HEAT AND MASS TRANSFER AND MAGNETO HYDRODYNAMIC FLUID FLOW

Fluid is an element which distorts incessantly once it gets exposure to extreme pressure, irrespective of the dimension of the extreme pressure [9]. The fluid according to the viscidness is separated into non-Newtonian as well as Newtonian fluid. The non-Newtonian instance fluid being visco-elastic fluid and the Newtonian fluid sample being a nano fluid. A fluid containing of a simple fluid comprising a diffusion of nano elements is known as Nano Fluid. Simple fluid utilized may be oil, water etc. Nano fluids are utilized in several key productions that urgently require role of heat transfer. Productions which utilize nano fluids are conveyance businesses, power supply, and electrical, paper, fabric businesses. Too much of Nano fluid may amplify the efficiency of the thermal conductivity along with amplifying the basic fluid viscidness. Thus, nano fluid is deemed to be a novel chief technology. Several studies exist regarding nano fluid in permeable form yet scarce concern have been offered regarding the flow of magneto hydrodynamic nano fluid via the permeable tube. As is common knowledge, that this fluid having the physiognomies of MHD (magneto hydrodynamic) has the capacity of controlling disjointing flow, for manipulating the fluid current along with optimizing the transfer of heat from the electrically conductive fluid. Thus, the movement of MHD is vital studies to be applied in commerce and manufacturing. The instances of creating MHD are accelerator of magneto hydrodynamic power as well as power generator, crystal development and cooler for nuclear reactor [10].

The occurrence of unobstructed convection emerges within the fluid once the temperature alteration as well as intensity causes disparity in density resulting in forces of buoyancy exerting on the fluid features. The research of fluid flow is of supreme significance within engineering. As an instance, the erratic unrestricted convection flow across a perpendicular platter has been offered substantial concern, due to its implementation in machines that are ventilated through naturally occurring convection, like in transformers as well as electric heaters. The procedure of heat as well as mass transfer in unrestricted convection flow has gained the interest several of academics because of their functionality in several scientific divisions as well as engineering, that is, in the primary phases liquefying near a hot exterior, in procedures of chemical engineering that are categorized as a procedure of mass transfer, in a chilling machinery, aeronautics as well as nuclear reactors.

6. CONCLUSION

Exchangers of heat are broadly implemented in productions for freezing as well as warming extensive manufacturing procedures. The kind and extent of exchangers of heat implemented may be adapted to be suitable to a procedure according to the kind of fluid, its stage, temperature, thickness, viscidness, pressures, chemical constitution in addition to several extra thermodynamic features. The research of fluid conducting electricity, that affects several ordinary and artificial courses, has several uses in engineering difficulties like MHD (Magneto Hydro Dynamic) generators, plasma researches, nuclear reactors, abstraction of geothermal power along with the peripheral stratum regulator in the subject of aerodynamics. During the last few decades, MHD peripheral stratum current using mass and heat transfer of nano-fluids has turned out to be a huge subject of contemporary concern. There's a momentous part played by Nano-fluids in improving the fluids' heat transfer features. The majorly significant features of nano-fluids are improved operational fluid thermal conductivity as well as constant of heat transfer.

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Corresponding Author

Ankur Bhatia*

Department of Mechanical Engineering, Shri Satya Sai University of Technology and Medical Studies, Pachama, Sehore (MP)

bhatiaankur1982@gmail.com