CHAPTER 1
ABSTRACT

Heat Transfer accompanied by melting and / or solidification has numerous thermal engineering applications. Phase-change processes are considered to be very efficient in maintaining the system temperature within an operating range. The study of mixed convection boundary layer flow from a vertical surface embedded in a non-Newtonian fluid saturated porous media has gained a lot of interest, since it occurs in many physical phenomena and has considerable industrial applications in a variety of fields such as magma solidification, permafrost melting, frozen ground thawing etc. In Chapter 1 the topic of study of the thesis is introduced quoting relevant earlier works.

In early studies on porous media, Darcy's law is employed which is a linear empirical relation between the velocity and the pressure drop, across the porous medium. Subsequently, Darcian law has been modified to include the effects of inertia. When the inertia effects are prevalent, thermal dispersion effect is significant. The study of the thermal dispersion effects on mixed convection boundary layer flow from a vertical surface embedded in fluid saturated porous media has received considerable attention in recent times. The interest, in such studies, was motivated by numerous thermal engineering applications in many areas such as geothermal engineering, thermal insulation systems, petroleum recovery, packed bed reactors, sensible heat storage beds, ceramic processing and ground water pollution. In Chapter-2 melting with thermal dispersion effect on non-Darcy mixed convective flow from a vertical plate embedded in a non-Newtonian fluid saturated porous medium for a non-Darcy flow field, is examined extensively.

Many processes, in modern engineering, occur at high temperatures. Knowledge of radiation and convective heat transfer is very important for the design of the pertinent equipment. Nuclear power plants, gas turbines and the various propulsion devices are few examples of such emerging areas. Therefore the combined effect of thermal dispersion-radiation with melting on non-Darcy mixed convective flow from a vertical plate embedded in a non-Newtonian fluid saturated non-Darcy porous medium is studied in Chapter-3.

In the case of certain porous media applications such as those involving heat removal from nuclear fuel debris, underground disposal of radioactive waste material,
storage of food stuffs, and exothermic and/or endothermic chemical reactions and
dissociating fluids in packed-bed reactors, the working fluid heat generation(source)
or absorption(sink) effects are important. Thus the problem of heat transfer by mixed
convection from a vertical plate in a non-Newtonian fluid saturated porous medium in
the presence of melting with thermal dispersion-radiation, heat generation and
absorption effect for non-Darcy flow is considered and discussed in chapter-4 of the
present work.

There is a necessity of studying MHD flow with dispersion effect in porous
medium in plasma physics, liquid metal flow, magneto hydrodynamic accelerators
and power generation systems. The study of an electrically conducting fluid, in
engineering applications, is of much interest- especially in metallurgical and metal
working processes or in the separation of molten metals from non metallic inclusions
by the application of a magnetic field. Phase change problems occur in casting,
welding, melting, and purification of metals and in the formation of ice layers on the
ocean as well as on air-craft surfaces. Hence, in Chapter-5 a study of the effect of
melting with thermal dispersion-radiative heat transfer from a vertical plate embedded
in a non-Newtonian fluid saturated porous medium for non-Darcy flow field in the
presence of MHD mixed convection is adopted.

In the present work a few situations are considered in which a change of phase
occurs for example, melting upon heating and solidification or condensation upon
cooling. These problems are analyzed under various parametric conditions in both
aiding and opposing flows. Numerical work is carried out for all the problems studied
in this work and is provided at appropriate places. Illustrations are drawn and
interpretation of the results acquired is carried out based on the numerical results and
illustrations drawn. It is observed that the reduction in the heat transfer rate due to
increase in melting parameter can be augmented with increase in dispersion and
radiation parameters with and without applied magnetic field in both aiding and
opposing flows.

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