tested to simulate linear wave oscillation in X, and X-Y oscillations. The results show that the scheme is significantly less dissipative especially in X-Y oscillation. For simulation along X direction only, the scheme shows significantly reduce dissipation when Courant number is less than 0.5. Simulations of more complex wave (two waves of different length) oscillations in X-Y-T space were conducted at low resolution. The longer wave is represented by 16 grid points whilst the shorter is represented only by 8 grid points. The results indicate that the scheme is superior when compare to the previous characteristic schemes. After even 20 oscillations of the longer wave (40 oscillations of the shorter wave), the group can still be easily recognized. On the other hand, the shorter wave dies out after 20 oscillations with the original quadratic interpolation scheme. The difference of the numerical wave speed between the longer wave and the shorter one is easily observed. It is concluded that the new interpolation scheme in X-Y-T space is convergence at appropriate value of K and f. It also improves the performance of the characteristic scheme in X-Y-T space.

M-2G-3. AN INVESTIGATION AND COMPARISON OF ROE UPWIND METHODS WITH CUSP CENTRAL DIFFERENCE SCHEMES

Mahmood P. FARD, *Ferdowsi University of Mashhad, Iran*, M. SALARI, M. MANSOOR, M. Malek JAFARIAN, *Birjand University, Iran,* In this paper, Euler equations have been solved for the internal compressible flows. In order to have such a solution, at first, the equations were written into the integrated form, and then in CUSP and Scalar schemes, by means of the central difference method, and in Roe scheme, by means of the upwind difference method, they were made into the discritized form. The main problem in the central difference method for solving these equations that occurs as a result of the shock phenomenon is instability and discontinuity of the solution, which is due to the misuse of the information related to the both sides of the shock. In order to solve this problem, we have to apply the artificial dissipations. However, the upwind methods based on the distribution of the flow information along the defined directions in the physical domain; do not have such a problem. In this paper, these schemes will be introduced, and the results of these methods will be compared and then the CUSP scheme will be amended and we will study the performance of central and upwind schemes in solving Euler and Navier-stoks equations. Since, the central difference schemes do not imply enough dissipation, the artificial dissipation, which has an important effect on the accuracy of the solutions, should be added to the equations. The second group is the upwind methods. These methods are based on the distribution of the flow information along the defined directions in the physical domain. So, these methods have a good coincidence with the physics of the flow information all over the field of the fluid flow. After representing Roe and CUSP schemes, we will compare them and their results in solving Euler equations in a nozzle. The results of these methods will be represented for flows with different Mach numbers. The results which have been obtained show that CUSP scheme for low supersonic flows, comparing with the other methods, leads to more accurate results to capture the shock. However, for the higher Mach numbers, it seems it needs some corrections. Thus the modified CUSP scheme which is based on the CUSP itself, reveals more accurate results the high Mach numbers in the vicinity of shock.

M-2G-4. NON-LINEAR MIXED-OBERBECK ELECRTOCONVEC TION IN A POORLY CONDUCTING FLUID THROUGH A VERTICAL CHANNEL

B. S. SHASHIKALA, *Department of Mathematics, Siddaganga Institute of Technology, India*, N. RUDRAIAH, *Centre for Advanced Studies in Fluid Mechanics, Department of Mathematics, Bangalore University, Bangalore,* The study of combined free and forced convection called mixed convection (MC) in a vertical channel has received considerable attention because of its wide range of applications from cooling of electronic devices, gas-cooled nuclear reactors to that of solar energy collectors. In contrast to MC due to variation of density with temperature discussed above there is another type of MC arising in a poorly conducting alloys like nickle-titanium(N_i-T_i), aluminum oxides and so on in a vertical channel due to variation of electrical conductivity, σ ,with temperature in the presence of an electric field, $\vec{E}$,called mixed electroconvection (MEC). The variations of σ with temperature releases the charges forming distribution of charge density, ρ_e. These charges in turn induce the electric field, $\vec{E}_i$ called thermal or induced electric field. In addition there may be an applied electric field, $\vec{E}_a$, due to embedded electrodes of different potentials at the boundaries. The total electric field $\vec{E}(=\vec{E}_i+\vec{E}_a)$ in a poorly conducting fluid produces a current, which acts as sensing. In addition this $\vec{E}$ together with ρ_e produces an electric force $\rho_e\vec{E}$ which acts as actuation. These two properties are the two important properties required a material to be a smart material. Therefore the control of MEC plays a significant role to synthesize smart materials for practical use in science, engineering and technology. Is spite of these importances much attention has not been given to the study of MEC in a vertical channel and is studied in this paper. The nonlinear-coupled momentum and energy equations are solved numerically using finite difference technique and analytically using regular perturbation method with B_r as the perturbation parameter. The analytical and numerical solution are in good agreement. These results in the presence of total electric field, viscous and Joulean dissipations obtained are useful in the effective control of heat transfer in many industrial problems.

16:30 ~ 17:50 (Room101)

Flows in Porous Media (II)

Session Chair : Prof. J. Zhou, CAS/China

M-3A-1. REQUIRED HEAD FOR LOOSE-FINE MATERIAL FLUIDIZER SYSTEM

R. TRIATMADJA, *Gadjah Mada University, Indonesia*, A. THAHA, *Hasanuddin University, Indonesia*, N. YUWONO, *Gadjah Mada University, Indonesia*, NIZAM, *Gadjah Mada University, Indonesia,* Maintenance dredging and channel protections using coastal structures may solve the problem of sedimentation although they may not always be cost efficient. An alternative approach namely fluidization technique may be used to fluidize the sediment and flush the sediment out in to the sea. In this paper, the required head for full fluidization stage is studied using one dimensional, two dimensional and three dimensional fluidizer system models. The one dimensional model is used to study the initial and full fluidization in a tube. Two dimensional models are utilized to study the required head for full fluidization at various condition of sediment height (d), water depth (h), diameter of the perforation holes (D_f), and the distance of the perforation holes (a). Finally three dimensional full scale models are constructed to study the required head for full fluidization. The scale model is designed so that the scale effect of the model is minimized. The study shows that the distance of perforation holes and the diameter of the perforation holes play important roles. The longer is the distance between the perforation holes the less is the sharing of the jets and hence, higher required pressure head. Smaller perforation holes require higher head to maintain effective jets' strength. The required head for full fluidizations h_f/d_b is found to be strongly correlated with $D_f/(a.d_b)^{0.5}$ a. The head requirement at full fluidization may also be shown as a function of D_f/a. When plotted together with data from previous results it is apparent that all the data have similar trend where h_f/d_b is decreasing with increasing D_f/a. The theoretical line agrees quite well with the present experiment. Finally it may be concluded that the required head for full fluidization may be represented by the following equation: $\frac{h_f}{d_b} = p\frac{\sqrt{a\,d_b}}{D_f}$, where p is approximately 0.23.

M-3A-2. DOUBLE DIFFUSIVE CONVECTION IN A NON-NEWTONIAN FLUID SATURATED POROUS LAYER WITH THROUGHFLOW

S. SURESHKUMAR, *Department of Mathematics, Siddaganga Institute of Technology, India,* I. S. SHIVAKUMARA, *Department of Mathematics, Bangalore University, India,* The effects of quadratic drag and vertical throughflow on the onset of double diffusive convection in a non-Newtonian fluid saturated horizontal porous layer are investigated. The study finds its applications in chemical engineering, geothermal systems, enhanced recovery of petroleum reservoirs, underground spreading of chemical wastes, sea bed hydrodynamics and more importantly in the directional solidification of alloys, where a mushy zone exists which is regarded as a porous layer with double diffusive origin. Many practical problems cited above involve non-Newtonian fluid flow through porous media which is based on a generalized Darcy equation. There exist many different types of non-Newtonian fluids. However, some oil sand contains waxy crude oil at shallow depths of the reservoirs which are considered to be viscoelastic fluids. In such situations, a viscoelastic model of a fluid will be more realistic than inelastic non- Newtonian fluids. Also, many geophysical and technological applications involve non-isothermal flow of fluids through porous media, called throughflow. A modified Forchheimer-extended Darcy model which takes inertia into account and viscoelastic effects is employed to describe the flow in a porous medium. The boundaries are considered to be impermeable and perfect conductors of heat and solute concentration. Conditions for the occurrence of stationary and oscillatory convection are obtained analytically using the Galerkin technique. It is shown that oscillatory convection occurs even if Λ, the