Heat and Mass transfer through porous media separating two fluids flowing in opposite direction

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Abstract :

In this paper, we are interested by two fluids at different temperatures and different concentrations flowing in opposit directions and separeted by a porous media (Fig. 1). Heat and Mass are transfered from canal 1 to 2 is conditioned by the caracteristics of porous media.
The whole transfer is described by the Naviers –Stokes, Energy and Concentration equations, including the Darcy-Brinkmen-Forchheimer formulation.
The Boussinesq approximation, the vorticity (Ω) and stream function (Ψ) are used.
The set of coupling equations are solved using a difference finite scheme with a good accuracy: $O(h)^4$ for Ψ and $O(h^2)$ for Ω, T, C.The whole components of the system represented by only one domain of resolution instead considering multi-domain approch.
The A.D.I (Alternaty Direction Implicit) technique is used to integrate the parabolic equations.
The flow behaviour depens on the caracteristics of porous media: porosity and darcy number and on the adimensionneles parameters: Reynolds, Richardson, Peclet, Lewis.
Simulation were carried out using different values of the above parameters.
It was found that:

- the flow is caracterized by a single vortex wich is elongated in horizontal direction then broken-down into two vorticies located at each side of the porous media when porosity ε increases from 0.1 to 0.8.
- when Reynolds value increases from 20 to 100, the vorticies increase in size for ε=0.4 and 0.8 and in number (from 1 to 2) for ε=0.1 while Nusselt and Sherwood increase.

Keywords:
Heat and mass transfer, Porous media, Darcy-Brinkman-Forchheimer, Numerical Simulation

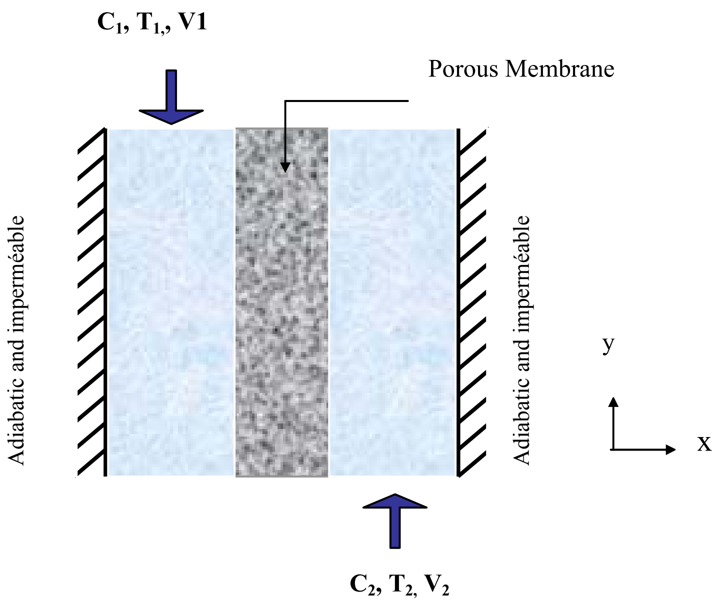
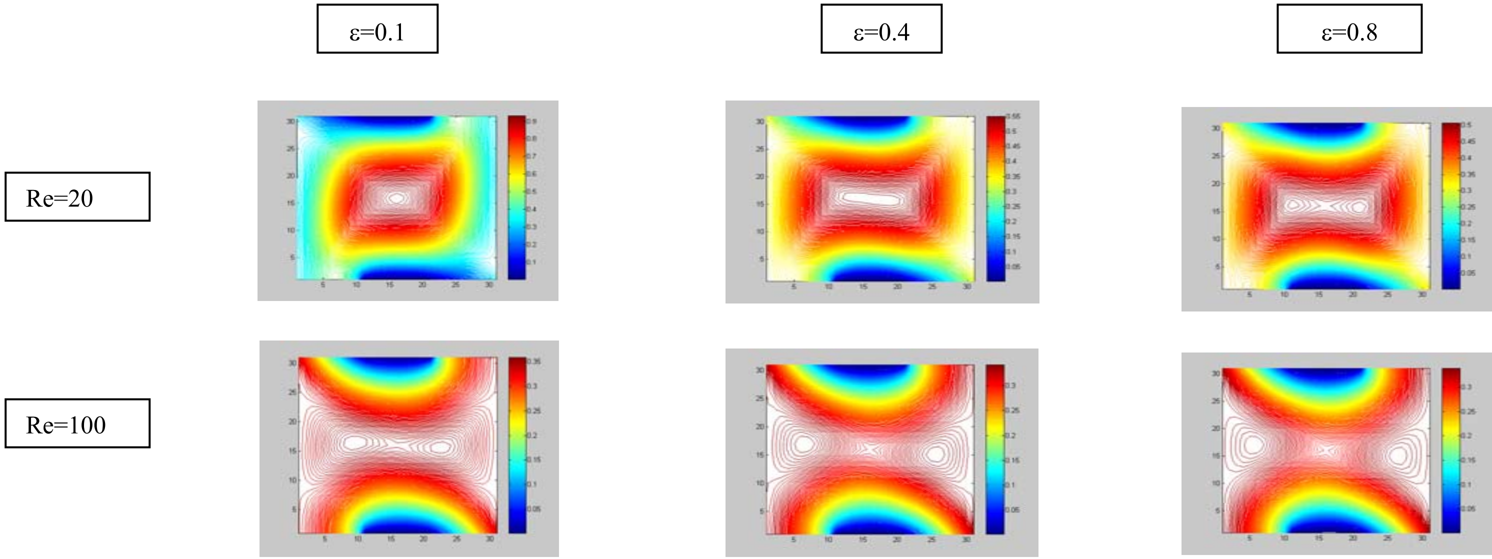


Fig.1 : Physical Model

Streamlines at t=33.33, for Pr=5.362, Le=86.74, N=0.295, Da=10^{-3}, Ri=41 and Reynolds=20-100



Average Sherwood (Sh) and Average Nusselt (Nu) at the hot (—) and the cold (----) sides for t=33.33, for Pr=5.362, Le=86.74, N=0.295, Da=10^{-3}, Ri=41