Numerical investigation of unsteady flow and heat transfer from a porous square cylinder

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Newtonian fluid past a porous square cylinder in an unbounded domain. The flow past permeable bodies is a topic that manifests itself in several practical situations such as heat transfer enhancement of porous inserts in flow field (Martin et al, 1998), the instability of segmented solid propellant rocket motors (Couton et al., 1997), and the use of porous plates as motion damping devices (Downie et al., 2001).

A one-domain approach of (Basu and Khalili, 1999) has been adopted in the present study to numerically simulate the flow and heat transfer characteristics of a porous square cylinder in the Reynolds numbers (based on the height of the cylinder and the incident stream at the center-line of the cylinder) range $50 \leq Re \leq 250$. The Darcy numbers (*Da*) is varied from 10^{-6} to 10^{-2} while the porosity (ε) varies from 0.68 to 0.997. Numerical simulations are performed using a finite volume method SIMPLE to solve the governing equations of fluid flow and heat tranfer. With these flow parameters, vortex shedding and its subsequent effect on the heat transfer from a porous square cylinder is investigated. The change of unsteady vortex shedding flow to the steady flow regime at high *Da* can be viewed from the vorticity contours. The drag coefficient of the porous cylinder reduces considerably with increase permeability compared to an impermeable cylinder as more and more fluid oozes through it at high *Da*. The Nusselt number increases with increase in *Da* for a fixed *Re*.

References

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