BIFURCATION PHENOMENA IN THE FLOW OF NON-NEWTONIAN FLUIDS IN A SYMMETRIC CHANNEL WITH A SUDDENLY EXPANDED AND CONTRACTED PART

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In a present study, the steady and laminar flow of a generalized Newtonian fluid through two-dimensional channel with a suddenly-expanded and suddenly-contracted part for various Reynolds numbers was studied numerically using finite volume method. For the testing the following fluids are used, Newtonian, pseudoplastic (shear thinning) and dilatant (shear thickening). For such flows, above the critical Reynolds value, three solutions can appear: a symmetric and two non-symmetric. Our goal is to investigate the differences between Newtonian and power-law fluid for a 3:1 expansion ratio and for various aspect ratios (length of expanded part to height of expanded part).

As Reynolds number was increased symmetry-breaking bifurcation occurs at a critical Reynolds number and separation bubbles of different sizes form on the lower and upper walls. The asymmetries become stronger with increasing Reynolds number till a second critical Reynolds number is reached and the flow regains symmetry, therefore, two critical Reynolds numbers exist for this work. The first critical Reynolds number, Re_{cr1}, is for the symmetry breaking bifurcation and the second critical Reynolds number, Re_{cr2}, is for the return from asymmetric flow to stable symmetric flow.

Stream function, mean axial velocity contours; pressure, normal and shear stresses profiles distributions along the centerline were calculated. Axial velocity, normal and shear wall stresses distributions along the upper and lower walls were also calculated for flow of a Newtonian and Power Law Fluids.

Influence of the channel geometry (aspect ratio) on the flow patterns also was studied. The length of expanded part has a strong influence on changing the flow field from an asymmetric flow to a stable symmetric flow.

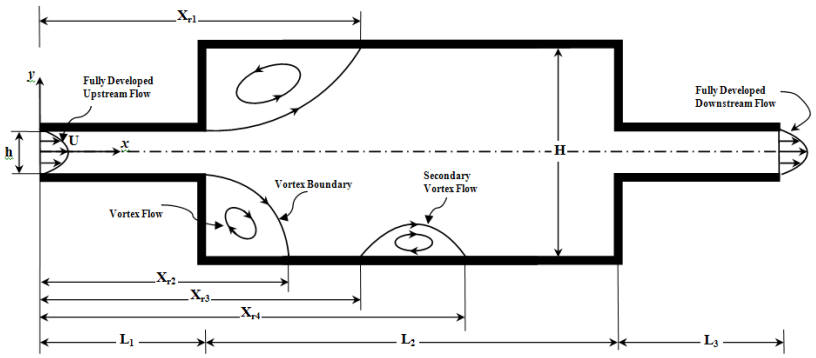

Figure 1: Schematic representation of the planar sudden expansion-contraction geometry.

References

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