Mathematical Modelling Flow Through Thin Curved Pipes with Application to Hemodynamics

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ABSTRACT

The problem of mathematical modelling of incompressible flows with low velocities through narrow curvilinear pipes is addressed in this paper. A two-dimensional model describing the elastic behaviour of the wall of a thin, curved, flexible pipe is presented. The wall is assumed to have a laminate structure consisting of several anisotropic layers of varying thickness. The width of the channel is allowed to vary along the pipe. The two-dimensional model takes the interactions of the wall with any surrounding material and the fluid flow into account and is obtained through a dimension reduction procedure. Examples of canonical shapes of pipes and their walls are provided with explicit system of differential equations at the end. A one-dimensional model describing the blood flow through a moderately curved, elastic blood vessels is presented. The two-dimensional model presented in the first is used to model the vessel wall while linearized. Navier-Stokes equations are used to model the flow through the channel. Surrounding muscle tissues and presence of external forces other than gravity are taken in to account. The model is again obtained via a one-dimensional reduction procedure based on the assumption of thickness of the vessel relative to its length. results of numerical simulations are presented to highlight the influence of different factors on the blood flow.

Keywords: Incompressible flows; anisotropic; Navier-Stokes equations; blood flow

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