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Research paper

Analysis of blood flow through a viscoelastic artery using the Cosserat continuum with the large-amplitude oscillatory shear deformation model

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ABSTRACT

In this investigation, semiempirical and numerical studies of blood flow in a viscoelastic artery were performed using the Cosserat continuum model. The large-amplitude oscillatory shear deformation model was used to quantify the nonlinear viscoelastic response of blood flow. The finite difference method was used to solve the governing equations, and the particle swarm optimization algorithm was utilized to identify the non-Newtonian coefficients (k_v and γ_v). The numerical results agreed well with previous experimental results.

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1. Introduction

The behavior of blood in the arteries is one of the most important problems in biomechanical engineering. Accordingly, various analytical, numerical, and experimental studies of blood behavior have been performed (Monson et al., 2011; Rossmann, 2010). The investigation of blood flow parameters has a long historical background, even engaging such pioneer scientists as Aristotle, and the nonlinear behavior of blood was unknown until the second

half of the last century (Schneck, 1990). From a rheological perspective, blood is a water-based solution comprised of organic and inorganic substances and various suspended cells, including mainly red cells. These properties strongly affect the dynamics of blood flow and render blood as a non-Newtonian fluid (Silber et al., 1998).

The fluctuating state and non-Newtonian characteristics of blood flow as well as the flexibility of the arterial walls make the theoretical analysis of blood very difficult. Experimental studies have revealed that the blood's viscosity

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