World Academy of Science, Engineering and Technology
International Journal of Computer and Systems Engineering
Vol:13, No:12, 2019

A Transient Coupled Numerical Analysis of the Flow of Magnetorheological Fluids in Closed Domains

Authors : Wael Elsaady, S. Olutunde Oyadiji, Adel Nasser

Abstract : The non-linear flow characteristics of magnetorheological (MR) fluids in MR dampers are studied via a coupled numerical approach that incorporates a two-phase flow model. The approach couples the Finite Element (FE) modelling of the damper magnetic circuit, with the Computational Fluid Dynamics (CFD) analysis of the flow field in the damper. The two-phase flow CFD model accounts for the effect of fluid compressibility due to the presence of liquid and gas in the closed domain of the damper. The dynamic mesh model included in ANSYS/Fluent CFD solver is used to simulate the movement of the MR damper piston in order to perform the fluid excitation. The two-phase flow analysis is studied by both Volume-Of-Fluid (VOF) model and mixture model that are included in ANSYS/Fluent. The CFD models show that the hysteretic behaviour of MR dampers is due to the effect of fluid compressibility. The flow field shows the distributions of pressure, velocity, and viscosity contours. In particular, it shows the high non-Newtonian viscosity in the affected fluid regions by the magnetic field and the low Newtonian viscosity elsewhere. Moreover, the dependence of gas volume fraction on the liquid pressure inside the damper is predicted by the mixture model. The presented approach targets a better understanding of the complicated flow characteristics of viscoplastic fluids that could be applied in different applications.

Keywords : viscoplastic fluid, magnetic FE analysis, computational fluid dynamics, two-phase flow, dynamic mesh, user-defined functions
Conference Title : ICCFD 2019 : International Conference on Computational Fluid Dynamics
Conference Location : London, United Kingdom
Conference Dates : December 09-10, 2019