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Melting heat transfer influence on nanofluid flow inside a cavity in existence of magnetic field

Mohsen Sheikholeslami [a,*], Houman B. Rokni [b]

[a] Department of Mechanical Engineering, Babol Noshirvani University of Technology, Babol, Iran
[b] Department of Mechanical and Materials Engineering, Tennessee Technological University, Cookeville, TN 38505, USA

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ABSTRACT

In this research, influence of melting heat transfer on magnetohydrodynamic nanofluid free convection is analyzed by means of CVFEM. KKL model is taken into account to obtain viscosity and thermal conductivity of CuO-water nanofluid. Roles of melting parameter (δ), CuO-water volume fraction (ϕ), Hartmann (Ha) and Rayleigh (Ra) numbers are illustrated in outputs. Results depict that temperature gradient enhances with rise of Rayleigh and melting parameter. Nusselt number decreases with increase of Lorentz forces.

1. Introduction

Melting process has various uses such as application in thermocouple, heat exchangers and heat engines. Jin et al. [1] presented the melting and solidifying process of PCM. They found that super cooling is significant reason for energy asymmetry. Wang et al. [2] investigated the melting process in pipe with internal fins. Khan et al. [3] investigated the influence of melting and heat generation on unsteady nanofluid flow over a wedge. Sheikholeslami and Rokni [4] utilized Buongiorno Model for nanofluid flow in presence of magnetic field. Sheikholeslami and Shehzad [5] utilized LBM for simulating nanofluid convective flow in a porous enclosure. Sheikholeslami and Sadoughi [6] employed the mesoscopic method for presenting the effect of shape factor on nanofluid MHD flow. Sahota et al. [7] investigated the coiled heat exchanger by means of nanofluid. Das [8] reported the radiative flow in existence of melting heat transfer. Hayat et al. [9] illustrated the melting of the plate in stagnation point flow. Sheremet et al. [10] illustrated the free convective flow of ferrofluid in a rotating enclosure. Wavy duct in existence of Brownian forces has been examined by Shehzad et al. [11]. Sheikholeslami and Ganji [12] illustrated different uses of nanotechnology in their article.

Feng et al. [13] examined melting of NEPCM in a bottom-heated rectangular cavity. Influence of nonlinear radiative heat transfer was presented by Hayat et al. [14]. Chamkha and Rashad [15] reported the nanoparticle migration on porous cone. Sheikholeslami [16] reported the non-Darcy nanofluid free convection in existence of magnetic field. Sheikholeslami and Bhatti [17] studied the impact of shape factor on nanofluid forced convection in existence of magnetic field. Sheikholeslami and Zeeshan [18] examined the nanofluid flow in a permeable media with heat flux condition. Mesoscopic method has been utilized by Sheikholeslami and Ellahi [19] for a three dimensional problem. Sheikholeslami and Shamlooei [20] investigated thermal radiation effect on ferrofluid convective heat transfer. Nanoparticle movement in a channel in existence of Lorentz forces has been demonstrated by Akbar et al. [21]. Heat flux boundary condition has been utilized by Sheikholeslami and Shehzad [22] to investigate the ferrofluid flow in porous media. In recent decade, nanofluid behavior has been studied by several researchers [23–43].

This research intends to present the impact of melting heat transfer on free convection of nanofluid in presence of Lorentz forces. CVFEM is selected to find the outputs. Roles of Melting parameter, CuO-water volume fraction, Hartmann and Rayleigh numbers are presented.

2. Problem statement

Fig. 1 depicts the geometry, boundary condition and sample element. The bottom wall is hot wall ($T = T_h$) and the top one is melting surface ($T = T_m$). Other walls are adiabatic. Horizontal magnetic field has been applied. The enclosure is field with nanofluid.

* Corresponding author.
E-mail addresses: mohsen.sheikholeslami@yahoo.com (M. Sheikholeslami), Houman.Babazadehrokni@alumni.du.edu (H.B. Rokni).

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Nomenclature

B	magnetic field
T	fluid temperature
Nu	Nusselt number
Ra	Rayleigh number
$\vec{g}$	gravitational acceleration vector
Ha	Hartmann number

Greek symbols

Θ	dimensionless temperature
α	thermal diffusivity
Ω & ψ	dimensionless vorticity & stream function
δ	melting parameter
β	thermal expansion coefficient
σ	electrical conductivity
μ	dynamic viscosity

Subscripts

f	base fluid
loc	local
nf	nanofluid

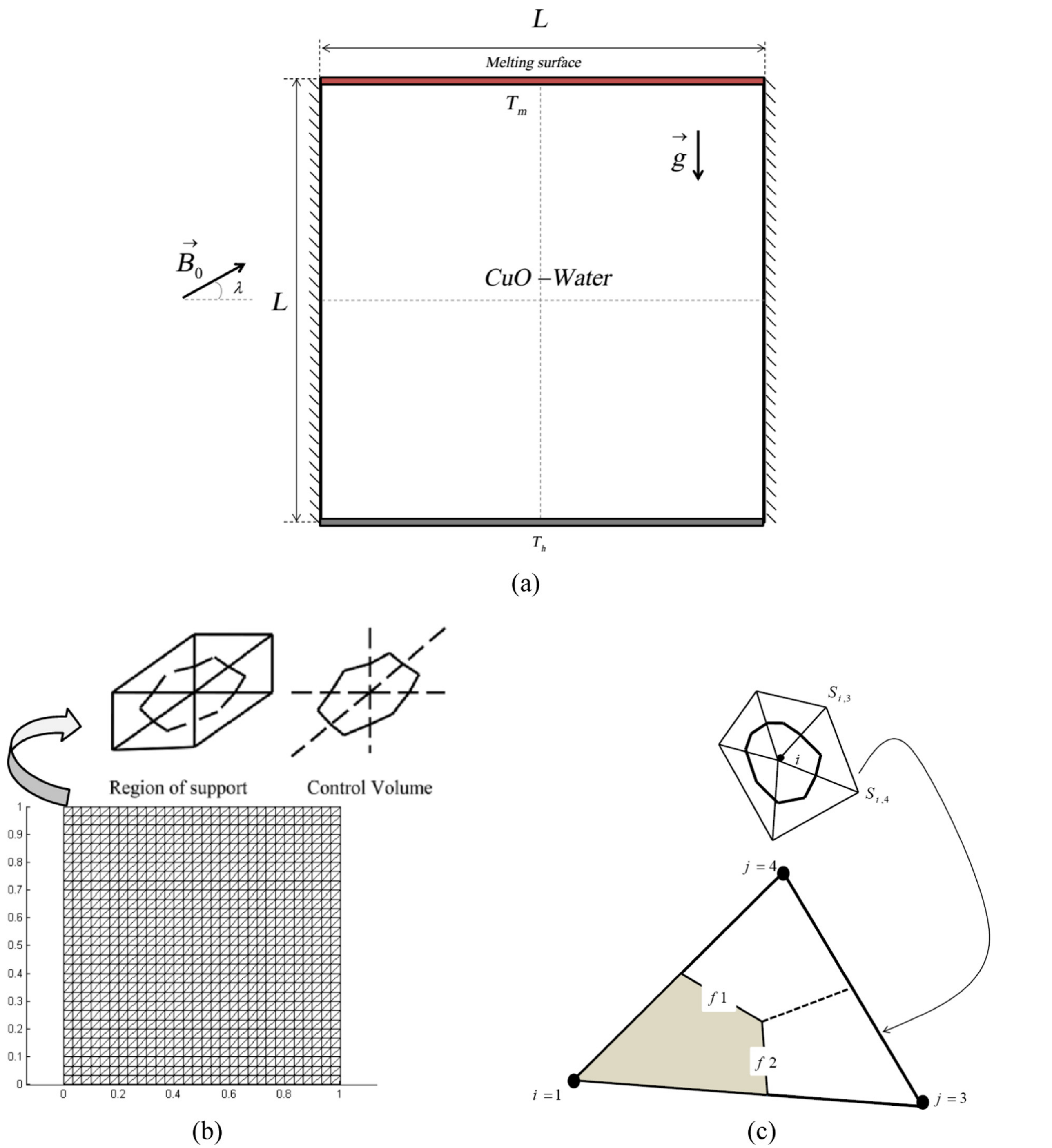

Fig. 1. (a) Geometry and the boundary conditions with (b) the mesh of Geometry considered in this work; (c) A sample triangular element and its corresponding control volume.