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MICROPOLAR NANOFLUIDS USING B-SPLINE DIVERGENCE CONFORMING SPACES

Adel Sarmiento[1*], Daniel Garcia[2], Nathan O. Collier [3], Lisandro A. Dalcin[4] and Victor M. Calo[5]

[1] Center for Numerical Porous Media and Applied Mathematics & Computational Science, King Abdullah University of Science and Technology (KAUST), Thuwal, Saudi Arabia, adel.sarmientorodrguez@kaust.edu.sa
[2] Center for Numerical Porous Media and Mechanical Engineering, King Abdullah University of Science and Technology (KAUST), Thuwal, Saudi Arabia, daniel.garcalozano@kaust.edu.sa
[3] Center for Numerical Porous Media, King Abdullah University of Science and Technology (KAUST), Thuwal, Saudi Arabia, nathaniel.collier@kaust.edu.sa
[4] CCT CONICET, Santa Fe, Argentina, dalcinl@gmail.com
[5] Center for Numerical Porous Media, Applied Mathematics & Computational Science, and Earth Science & Engineering, King Abdullah University of Science and Technology (KAUST), Thuwal, Saudi Arabia, victor.calo@kaust.edu.sa

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Micropolar fluids are a subclass of simple microfluids presented by Eringen [1, 2], that have gained attention from researchers because they are expected to succesfully model the behavior of non-Newtonian fluids like ferro liquids, liquid polymers, and any fluid with suspended particles in it. One of many applications is to model nanofluids, where inserting nanoparticles can change physical properties in a desired way depending on the concentration of this. Like is the case of fluid heat transfer systems where nanoparticles are inserted to increase heat conductivity for numerous applications. Nanofluids are better modeled using the micropolar fluids theory. This takes into account the conservation of angular momentum of the nanoparticles that are not described by the regular Navier-Stokes equations.

Micropolar fluids consist of randomly oriented particles submerged in a viscous fluid where the deformation of the particles is neglected. Here we present the results for an incompressible nanofluid to represent natural convection in the heat driven cavity, using Boussinesq approximation for buoyancy effects. To evaluate the effect of nanoparticles over fluid properties a variation of model parameters will be computed and compared againts conventional Navier-Stokes results. We modelled the system using the finite element method with B-splines basis functions, where to overcome the incompressibility constraint we used a divergence conforming space discretization [3, 4], obtaining pointwise divergence free results.

REFERENCES

[1] Eringen, A., *Simple Microfluids*. Journal of Mathematics and Mechanics 1964

[2] Eringen, A., *Theory of Micropolar fluids*. Journal of Mathematics and Mechanics 1966

[3] John A. Evans and Thomas J.R. Hughes, *Isogeometric Divergence-conforming B-splines for the Darcy-Stokes-Brinkman Equations*. ICES REPORT 12-03, The Institute for Computational Engineering and Sciences, The University of Texas at Austin, January 2012

[4] John A. Evans and Thomas J.R. Hughes, *Isogeometric Divergence-conforming B-splines for the Steady Navier-Stokes Equations*. ICES REPORT 12-15, The Institute for Computational Engineering and Sciences, The University of Texas at Austin, April 2012