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Numerical study of the natural -draft flow and heat transfer in a biomass plancha-type cookstove

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Statement of the Problem: Biomass cookstoves are important in the developing world and have room for improvement since a large percentage of people living in rural areas still satisfy their cooking and heating needs using local biomass fuels. Different types of biomass cookstove are used around the world and the vast majority involve natural-draft combustion of wood; big efforts to study their performance from an experimental point of view have been conducted. The purpose of this study is to model the fluid flow, heat transfer and gas-phase chemical reactions for a natural-draft biomass plancha-type cookstove that represents a new portable design of the Patsari stove for rural areas in Mexico and to be used for domestic activities. Methodology: A 3D CFD model is set up in ANSYS Fluent v19, using the module of species transport for modelling combustion, a turbulence viscous model and energy equation enabled; whereas, the solver configuration is pressure based type and the simple algorithm is used for steady state solutions. Findings: Power rates in the range of 2.5 and 7.5 kW and two injection areas of 50 and 100 cm^2 are analyzed. Contours for the flow, temperature and species mass fractions are obtained; additionally, Nusselt number at the comal surface, air fuel ratio and thermal efficiency are calculated as a function of power rate. Conclusion & Significance: A better combustion and thermal efficiency for the higher power rate cookstove are observed since the percentage of volatiles not burned decreases with the power rate. Authors would like to acknowledge SENER-CONACyT for the financial support through Project 246911.

Recent Publications

1. Palacios-Morales C A, Guzman J E V, Beltrán A, Ruiz-Huerta L, Caballero-Ruiz A, Zenit R (2018) On the maximum operating frequency of prosthetic heart valves. Biomedical Physics and Engineering Express (BPEX), 4, 047007: 1-6.
2. Núñez J, Beltrán A (2018) On the onset of natural convection in a partially cooled cylinder. Heat Transfer Research, 49 (8): 773-786.
3. Beltrán A, Chávez O, Zaldivar J, Godínez F A, García A, Zenit R (2017) A new model for the computation of the formation factor of core rocks. Journal of Structural Geology, 97: 189 - 198.
4. Beltrán A(2017) MHD Natural convection in a liquid metal electrode. Applied Thermal Engineering, 114: 1203-1212.
5. Domínguez D R, Beltrán A, Román J J, Cuevas S, Ramos E (2015) Experimental and theoretical study of the dynamics of wakes generated by magnetic obstacles. Magnetohydrodynamics, 51 (2): 215 – 224.

Biography

Alberto Beltrán has his expertise in numerical simulations of hydrodynamic, thermal and magnetohydrodynamics flows. His recent work on plancha-type cookstoves is focused on improving the actual designs based on CFD calculations and to compare them with experimental results. He is also interested in renewable energy and grid scale energy storage systems and their applications. He is the head of the Laboratory for design, modelling and simulations of biomass cookstoves at the CBS CEMIE-Bio project in Mexico.

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