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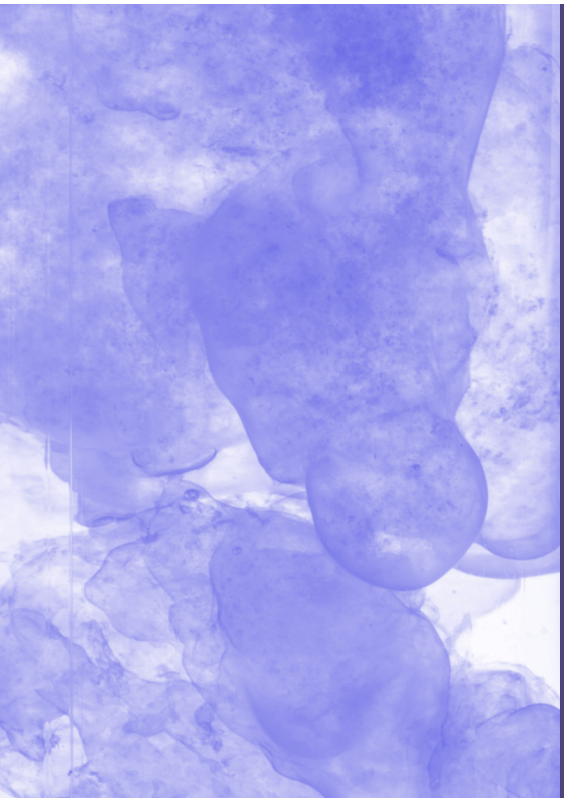
Fluid Science and Technology



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Selected Papers



A Numerical Study of the Effect of Water Speed on the Melting Process of Phase Change Materials Inside a Vertical Cylindrical Container

Authors: Abbas Fadhil Khalaf, Farhan Lafta Rashid, Shaimaa Abdel Letif, Arman Ameen and Hayder I. Mohammed

Abstract: The present work offers a thorough analysis of the impact of water velocity on phase change material (PCM) melting in a vertical cylindrical container. A detailed quantitative analysis uses sophisticated numerical techniques, namely the ANSYS/FLUENT 16 program, to clarify the complex relationship between enthalpy and porosity during the melting process. The experimental focus is on phase transition materials based on paraffin wax, particularly Rubitherm RT42. This study's primary goal is to evaluate the effects of different water velocities (that is, at velocities of 0.01 m/s, 0.1 m/s, and 1 m/s) on the PCM's melting behavior at a constant temperature of 333 K. This work intends to make a substantial contribution to the development of thermal energy storage systems by investigating new perspectives on PCM behavior under various flow circumstances. The study's key findings highlight the possible ramifications for improving PCM-based thermal energy storage devices by revealing significant differences in melting rates and behavior that correlate to changes in water velocities. Future research is recommended to explore the impact of temperature variations, container geometries, and experimental validation to improve the accuracy and practicality of the results and to advance the creation of sustainable and effective energy storage solutions.

https://doi.org/10.3390/app14083212



Saturated Boiling Enhancement of Novec-7100 on Microgrooved Surfaces with Groove-Induced Anisotropic Properties

Authors: Ho-Ching Lin, Cheng-Hsin Kang, Hui-Chung Cheng, Tien-Li Chang and Ping-Hei Chen

Abstract: The effects of the anisotropic properties (wettability and roughness) of microgrooved surfaces on heat transfer were experimentally investigated during pool boiling using Novec-7100 as a working fluid. The idea for introducing the concept of anisotropic wettability in boiling experiments draws inspiration from biphilic surfaces. The investigation is also motivated by two-phase immersion cooling, which involves phase-change heat transfer, using a dielectric liquid as a working fluid. Very few studies have focused on the effects of surfaces with anisotropic properties on boiling performance. Thus, this study aims to examine the pool-boiling heat transfer performance on surfaces with microgroove-induced anisotropic properties under the saturation condition. A femtosecond-laser texturing method was employed to create microgrooved surfaces with different groove spacings. The results indicated that anisotropic properties affected the heat transfer coefficient and critical heat flux. Relative to the plain surface, microgrooved surfaces enhanced the heat transfer performance due to the increased number of bubble nucleation sites and higher bubble detachment frequency....

https://doi.org/10.3390/app14020495



On the Hard Boundary Constraint Method for Fluid Flow Prediction based on the Physics-Informed Neural Network

Authors: Zixu Xiao, Yaping Ju, Zhen Li, Jiawang Zhang and Chuhua Zhang

Abstract: With the rapid development of artificial intelligence technology, the physics-informed neural network (PINN) has gradually emerged as an effective and potential method for solving N-S equations. The treatment of constraints is vital to the PINN prediction accuracy. Compared to soft constraints, hard constraints are advantageous for the avoidance of difficulties in guaranteeing definite conditions and determining penalty coefficients. However, the principles on the formulation of hard constraints of PINN currently remain to be formed, which hinders the application of PINN in engineering fields. In this study, hard-constraint-based PINN models are constructed for Couette flow, plate shear flow and stenotic/aneurysmal flow with curved geometries. Particular efforts have been devoted to assessing the impact of the model parameters of hard constraints, i.e., degree and scaling factor, on the prediction accuracy of PINN at different Reynolds numbers. The results show that the degree is the most important factor that influences the prediction accuracy, followed by the scaling factor. As for the N-S equations, the degree of hard constraints should be at least two, while the scaling factor is recommended to be maintained around 1.0. The outcomes of the present work are of reference value for the development of PINN methods in fluid mechanics.

https://doi.org/10.3390/app14020859



A Study of Cavitation Erosion in Artificial Submerged Water Jets

Author: Haonan Li, Jiawang Chen, Jin Guo, Hai Zhu, Yuan Lin and Han Ge

Abstract: The artificially submerged cavitation water jet is effectively utilized by ejecting a high-pressure water stream into a low-pressure water stream through concentric nozzles and utilizing the cavitation phenomenon generated by the shear layer formed between the two streams. In this study, we investigated the cavitation characteristics of artificially submerged cavitation water jets by combining numerical simulations and erosion experiments. The results indicate that an appropriate standoff distance can generate more cavitation clouds on the workpiece surface, and the erosion characteristics of the artificially submerged cavitation water jet are most pronounced at a dimensionless standoff distance of SD = 30. The shear effect formed between the two jets plays a crucial role in generating initial cavitation bubbles within the flow field of the artificially submerged cavitation water jet. Moreover, increasing the convergent angle between the two jets can significantly enhance the cavitation effect between them and lead to a more substantial cavitation effect. Simultaneously, increasing the pressure of the high-pressure inner nozzle also contributes to enhancing the cavitation effect of the artificially submerged cavitation water jet.

https://doi.org/10.3390/app14114804

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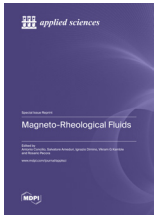

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