Spring 5-14-2018

Application of Sharp- and Diffuse-Front Models for Predicting Mass Gain and Saturation in Fibrous Wicks

Amin Zarandi
University of Wisconsin-Milwaukee, faghihi2@uwm.edu

Krishna M. Pillai
University of Wisconsin - Milwaukee, krishna@uwm.edu

Contribution ID : **594**

Type : **Oral 15 Minutes**

Application of Sharp- and Diffuse-Front Models for Predicting Mass Gain and Saturation in Fibrous Wicks

Monday, 14 May 2018 11:54 (15)

Wicking as imbibitional flow of a liquid driven by capillary pressure has been an important topic in different areas from simple applications like air refreshers and lightening torches to high-tech one such as Propellant Management Devices (PMD)[1, 2]. In this research, wicking of a liquid into porous wicks made parallel fibers is investigated. In the first step, we developed a model for predicting the height of liquid front during the wicking process as a function of time using Darcy's law based on the assumption of single-phase flow behind a clear sharp front. Then the theoretically developed model was evaluated by performing mass-gain experiments where it revealed satisfying agreement for the majority of tested wicks. However, the model failed to account for partial saturations in the wicks. Therefore, we tried Richard's equation to predict liquid saturation. The adapted Richard's equation for our specific porous wicks is solved numerically in 2-D using COMSOL and analytically in 1-D using Mathematica where we treated the porous wicks as transversely-isotropic porous media. We determined capillary pressure and relative permeability directly from pore-scale simulations in wick microstructure using GeoDict. Also, in order to evaluate the numerical and analytical results for Richard's equation, we used a new liquid-N2 based freezing technique to determine the saturation level along the wick length experimentally. After including the gravity effect, good agreements between the numerical/analytical predictions and experimental results were achieved in saturation distributions.

References

1. Fries, N., et al., The effect of evaporation on the wicking of liquids into a metallic weave. Journal of colloid and interface science, 2008. 321(1): p. 118-129.
2. Jaekle Jr, D. Propellant management device conceptual design and analysis: Galleries. in 33 rd Annual AIAA Joint Propulsion Conference. 1997.

Acceptance of Terms and Conditions

Click here to agree

Primary author(s) : FAGHIHI ZARANDI, Mohammad Amin (University of Wisconsin Milwaukee); PILLAI, Krishna (University of Wisconsin-Milwaukee)

Presenter(s) : FAGHIHI ZARANDI, Mohammad Amin (University of Wisconsin Milwaukee)

Session Classification : Parallel 1-F

Track Classification : MS 4.14: Wicking of Liquids in Porous Materials