NUMERICAL INVESTIGATION OF THE PHASE CHANGE IN TRANSPERSION COOLING WITH THE VOF METHOD

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Transpiration cooling with phase change is numerically investigated in the present work. As shown in Figure 1, a liquid coolant flow is injected into a porous medium from the bottom side. The porous medium receives heat from the hot gas on the top surface and heats the coolant. Thus, phase change can occur in this porous medium. The surface temperature, the heat flux received by the porous medium, the phase distribution and the flow and cooling characteristics are the most important unknowns on this topic.

A two-dimensional model coupling the heat transfer and flows in porous media and the hot gas zones is developed to simulate the above phenomenon. With the assumptions of local thermal equilibrium and the clear interface between the liquid and gas phases, the volume-of-fluid (VOF) method can be used in this model. This clear interface is tracked by the VOF method and divides the computed zone into the liquid phase region and the gas phase region. On this liquid-gas interface, a phase change model should be applied in this modeling. Thus, the modified Lee’s phase change model is proposed and used to insure the phase change flow in porous media can be converged.

The porous medium surface temperature distributions were compared between the numerical results and our experimental data and they had good agreements.

Figure 1 – Schematic diagram for transpiration cooling with phase change