ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

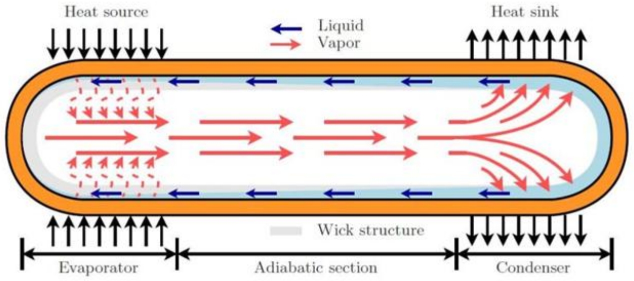
Thermal Analysis of Closed Loop Pulsating Heat Pipe by Using Ansys

Gandreddi Ramesh
NSRIT, Sontyam,
Andhra Pradesh 531173, India.

Dr. Uma Maheswara Rao
NSRIT, Sontyam,
Andhra Pradesh 531173, India.

ABSTRACT

The aim of this project was to the current state of heat transfer forecasting for commonly used CFD software. FINE/Turbo code is used for this software since it has a time accurate advantage. The computational model utilized a conjugate heat-transfer model for solid-fluid interactions with the turbine blade hardware. Current heat-transfer solutions are in the expected range of theoretical values, although the measurement program is still in process. Due to addition of cooling flow to the mainstream flow associated with a high-pressure turbine stage is difficult to model, especially when one is attempting to predict the surface heat-transfer rate. Boundary layer conditions and solid-fluid interactions dominate the region, making accurate computational predictions very difficult. Results of this project have identified areas for which improvement in the current state-of-the-art are required, and have provided a benchmark for computational solutions. Lessons learned from the flat-plate measurement program will be applied to a full-scale rotating turbine stage in the near future, so understanding how to predict the local heat transfer using the CFD code is of major one.



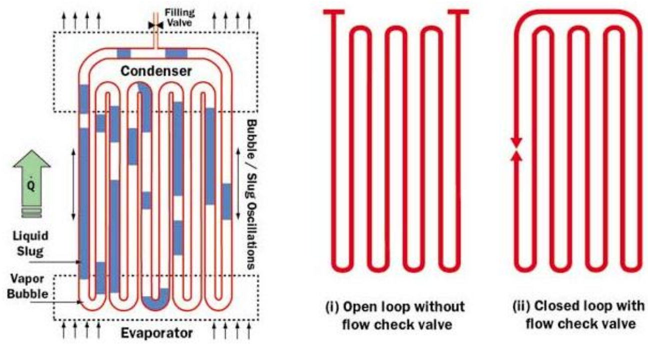
Working principle of Heat Pipe

The heat is absorbed in the evaporator region and is carried out through the pipe by the evaporation of the fluid by absorbing the heat.

The high temperature vapor movies toward the condenser by the action of buoyancy force. At the condenser it rejects the heat by convection and coverts into liquid droplets. These droplets move to the evaporator due to gravity though the wick material.

1.3 Types and classification

- Standard heat pipe
- Variable conductance heat pipe
- Diode heat pipes
- Thermosyphon
- Pulsating(oscillating) heat pipe



There are two type of pulsating heat pipe.

- Closed loop pulsating heat pipe
- Open loop pulsating heat pipe

Closed loop pulsating heat pipe perform better than open loop devices because of the fluid circulation that is superposed upon the oscillations within the loop. By using the check valve within the loop, the performance of the closed loop heat pipe is further improved. The installation of the check valve is very difficult and costly because of the small nature of the device.

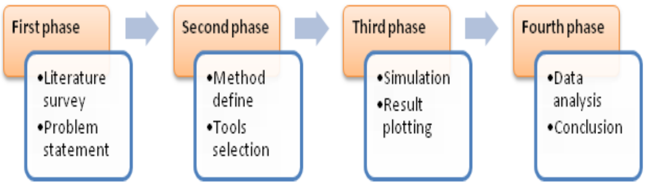
Cite this article as: Gandreddi Ramesh & Dr. Uma Maheswara Rao, "Thermal Analysis of Closed Loop Pulsating Heat Pipe by Using Ansys", International Journal & Magazine of Engineering, Technology, Management and Research, Volume 5, Issue 12, 2018, Page 12-14.

So, the closed loop pulsating heat pipe without a check valve is mostly used. The objective of the present work is to study the performance of closed loop pulsating heat pipe with a single turn using ANSYS FLUENT 15.0. This work includes enhancement of the heat transfer rate of a PHP by varying load conditions in evaporator with different filling ratios of working fluid. Also to find the filling ratio that gives minimum thermal resistance and maximum heat transfer rate and the results obtained by CFD analysis are to be compared with experimental paper results of R. Naik, V. Varadarajan , G. Pundarika and K. R. Narasimha et al [23] . Acetone is used as working fluid.

3.2 Methodology

First of all the literature survey is done on the operation and performance of pulsating heat pipe. Relevant recommendations made on the papers and journals are considered to come up with this present work. In this regard, the paper by R. Naik, V. Varadarajan , G. Pundarika and K. R. Narasimha on " Experimental Investigation and Performance Evaluation of a Closed Loop Pulsating Heat Pipe " et al [23] is taken as the reference paper for the basic geometry, operating conditions and performance parameter. This paper has presented on the experimental analysis. Later the tools for solving the model are decided and worked on. After setting suitable schemes, simulation is run till the desired convergence criteria is achieved. The data from the result is categorized and then compared with the experimental work of R. Naik, V. Varadarajan , G. Pundarika and K. R. Narasimha et al [23].

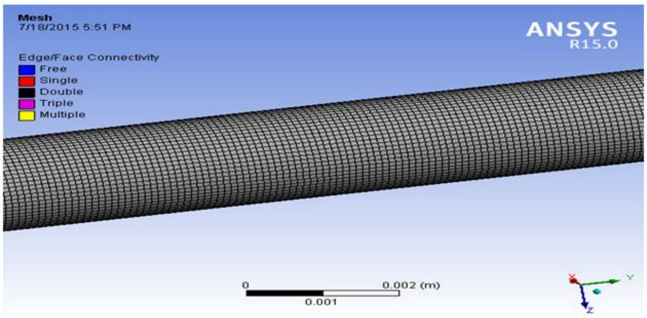
The overall steps used in this research are summarized in a flow chart diagram as shown in figure 3.1.



In this thesis, acetone-acetone vapor is taken as the working fluid for analysis. Fluid properties are assumed to be constant with temperature. The properties of acetone-acetone vapor considered for the analysis is given in table.4.1

Description	Symbol	Acetone liquid	Acetone vapor	Units
Density	ρ	791	2.37	kg/m3
Dynamic Viscosity	μ	0.000331	0.000009	kg/ms
Specific Heat	Cp	2160	1386	J/kg K
Thermal Conductivity	k	0.18	0.0143	W/m K

Table 4.1: Properties of working fluid



Description	Symbol	Acetone liquid	Acetone vapor	Air	Copper	Units
Density	ρ	791	2.37	1.225	8978	kg/m3
Dynamic Viscosity	μ	0.000331	0.000009	0.000017894	-	kg/ms
Specific Heat	Cp	2160	1386	1006.5	381	J/kg K
Thermal Conductivity	k	0.18	0.0143	0.0242	387	W/m K

6 Evaporator thermal boundary conditions given in Problem setup in ANSYS-FLUENT

In momentum boundary condition wall motion is a taken as stationary wall and shear condition is taken as no slip for all three sections. These boundary conditions are shown in table.

Location	Boundary condition	Momentum Tab	Thermal Tab
Adiabatic section	Wall	Wall motion – Stationary wall Shear condition – No slip	Heat Flux - 0
Condenser section	Wall	Wall motion – Stationary wall Shear condition – No slip	Constant Temperature
Evaporator section	Wall	Wall motion – Moving wall Shear condition – No slip	Constant heat flux

Fig. 6.11 Acetone-liquid contours of 80% volume fraction at 9W heat load

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

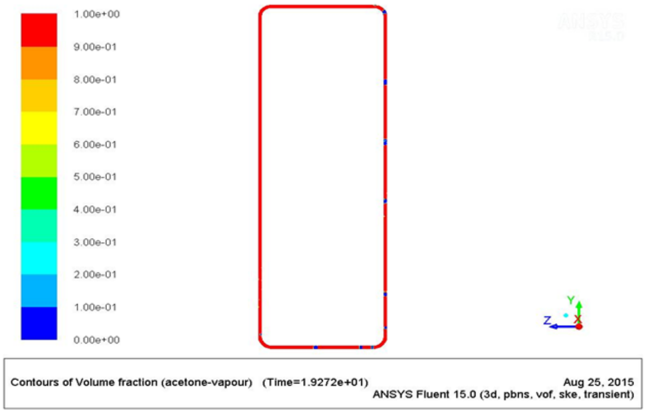


Fig. 6.12 Acetone-vapour contours of 80% volume fraction at 9W heat load

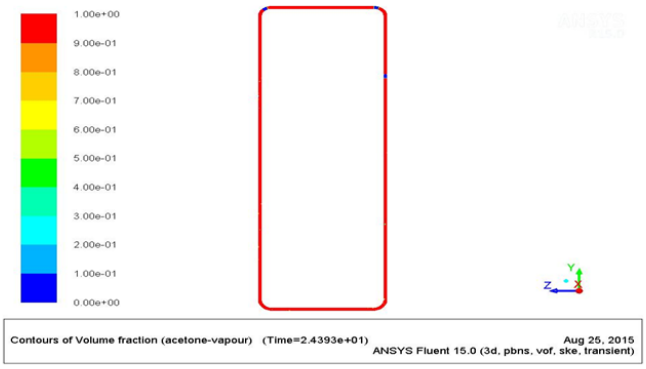


Fig. 6.13 Acetone-vapour contours of 80% volume fraction at 12W heat load

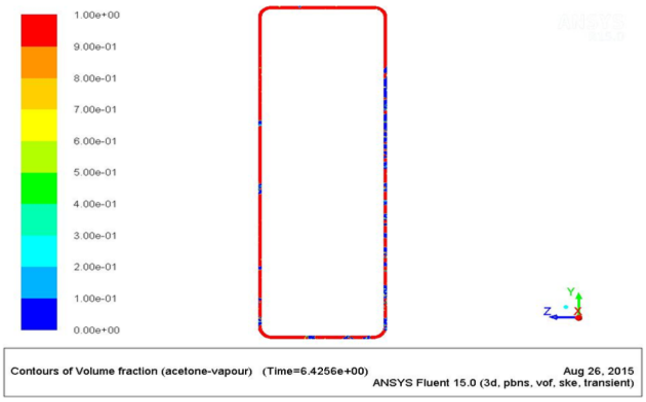


Fig. 6.14 Acetone-vapour contours of 80% volume fraction at 15W heat load

6.3 Temperature Contours of PHP:

CONCLUSIONS

- In this present work based on CFD analysis of PHP it can be concluded that three phase flow is successfully simulated in FLUENT 15.0.
- From the results it is concluded that all working fluids are carrying heat from evaporator region to the condenser region by observing temperature change and flow of working fluids. Thus it can be concluded that the performance of PHP is primarily based on the phase change phenomenon.
- In CFD analysis the variation in evaporator and condenser wall temperatures with flow time is observed.
- It is observed that the thermal resistance decreases and heat transfer coefficient increases with increase in heat flux.
- CFD results are compared with available experimental base paper results. And acetone at 60% volume fraction is observed to be more suitable for PHP operation under different heat loads.