Loop Heat Pipe
Sample Model

User Documentation
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LHP Prebuilt Version 5.1

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1.0 Introduction

This document explains the usage of the Loop Heat Pipe (LHP) Sinaps® sample model. This model is setup to perform a single point steady state simulation, a steady state parametric analysis varying input load, or a pseudo-transient of a single step change in the input power. The model can also be used as a starting template for further LHP modeling needs. This software and other supporting documentation are freely distributed. To run this model, you must install Sinaps Version 5.1 or newer

This same model is as the underlying source for the Excel-based LHP sample Model. This model does not require Sinaps to run, rather it uses the SINDA/FLUINT Excel Controller as a user interface.

A basic understanding of SINDA/FLUINT (and Sinaps if using the Sinaps based model) is necessary to utilize these models. Tutorials, training notes, and on-line user's manuals for SINDA/FLUINT and Sinaps are available separately, as are generic descriptions of prebuilt models and their usage. These documents may be accessed via C&R's web page (http://www.crtech.com). Please contact us for more information, or for copies of these documents and software for those lacking Internet access.

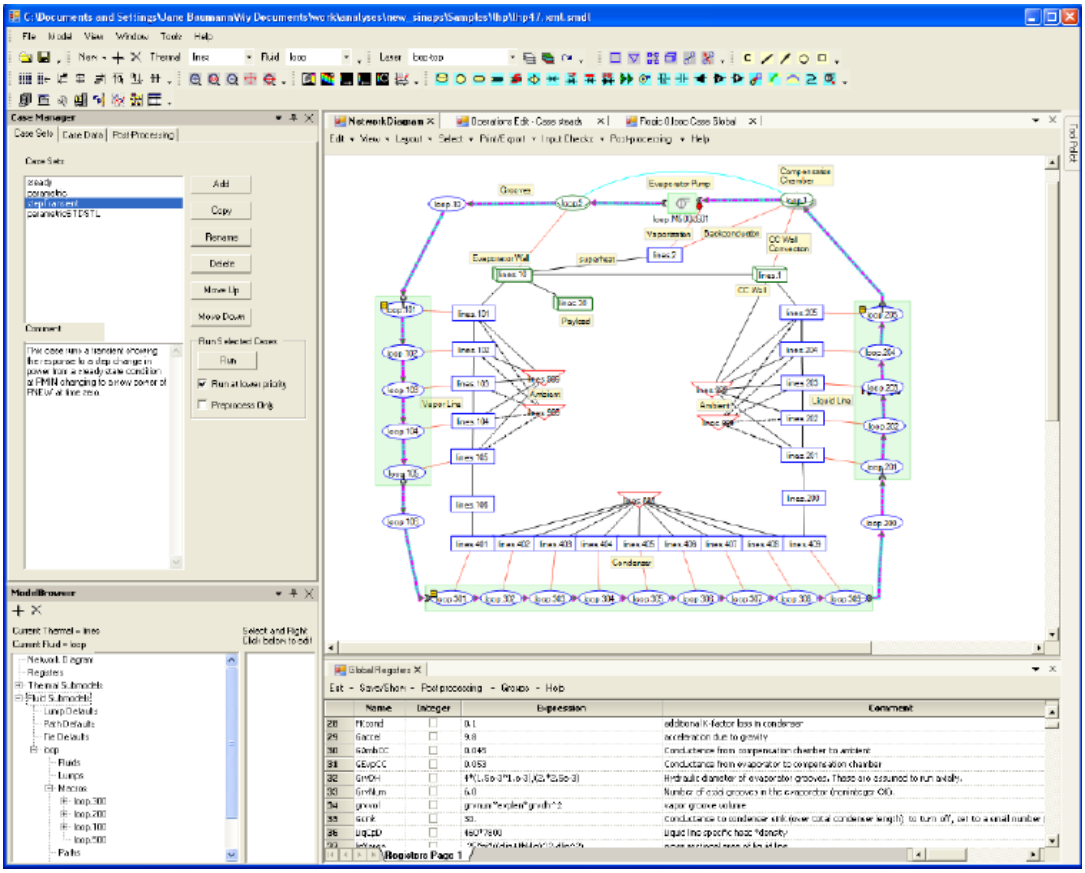
1.1 About This Sample Model

This model performs a thermal/fluid analysis of a generic Loop Heat Pipe (LHP).* LHPs are passive (no moving parts) thermal transport devices that utilize capillary pumping to circulate a working fluid between the heat

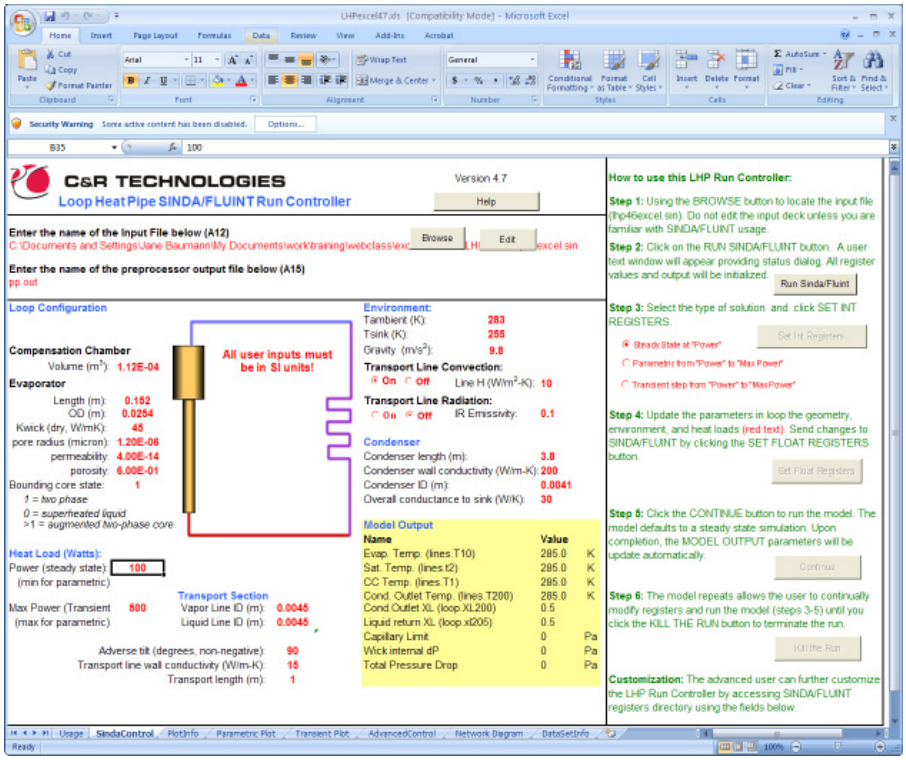
* The initial description of the LHP in this prebuilt corresponds to a DTX/NASA demonstration unit. See Section 9.0.

acquisition location (evaporator) and the heat rejection location (condenser). LHPs are described in more detail in the next subsection.

This model was generated in Sinaps (SINDA Application Programming System), a graphical SINDA/FLUINT pre- and postprocessing system. This model provides a tool for thermal designers to easily apply specific system and design requirements to the generic LHP model. This model has been defined in a manner which allows the user to quickly perform either a single point steady state, a parametric analysis on heat load, or a transient response to a step change in power. There are all performed through the use of pre-defined calculator registers.



The Excel-based LHP model is based on a text export of the Sinaps model. Once exported a model can no longer be reimported to Sinaps and can only be modified through a text editor. The Excel interface provides an alternate user interface for working with the LHP model. It is designed to allow the user to modify the model through registers and rerun the basic model, and either query or plot the results from the save file in Excel.



1.2 Introduction to Loop Heat Pipes

1.2.1 LHP Design and Operation

The loop heat pipe (LHP) is a two-phase thermal transport loop which is capable of transporting heat loads up to 1200W over long distances up to 4 meters, including upwards (against gravity). The technology was developed for spacecraft thermal control but is easily adapted to terrestrial applications with gravity limitations. The loop heat pipe technology was first developed in Russia by Y. Maidanik and his team during the 1980s, parallel to the development of capillary pumped loops (CPLs) in U.S.

The LHP shown in Figure 1 is a hermetically sealed loop with no moving parts, which typically contains ammonia or propylene as the working fluid. Like traditional heat pipe technology, the heat is acquired through the vaporization of the working fluid within the evaporator section of the loop. Internal to the evaporator is a porous wick which provides capillary pumping of the fluid in the loop. In the loop heat pipe, the heat is applied to the outside of the evaporator body. This heat is conducted inward to the interface between the porous wick and the vapor grooves where it is vaporized. The vapor is collected in the grooves and flows outward through the vapor removal channels to the vapor line. The vapor is condensed in the condenser section of the loop which is typically attached to a radiator where the heat can then be rejected. The condensed working fluid is pushed along the liquid return line to the evaporator.

Unlike heat pipes, the LHP and CPLs have separate transport lines for the vapor and the liquid returning to the evaporator. While heat pipes typically have axial grooves or slab wicks running the length of the pipe, LHPs and CPLs have a flow-through wick located in the evaporator only. The transport lines and condenser are wickless: they normally consist of small diameter plain stainless steel tubing. Since the transport lines are simple