APPLICATION OF MICRO-HEAT PIPES FOR THE THERMAL CONTROL OF SEMICONDUCTOR DEVICES

A Senior Honors Thesis

By

BRIAN PATRICK CORBETT

Submitted to the Office of Honors Programs
& Academic Scholarships
Texas A&M University
In partial fulfillment of the requirements of the

UNIVERSITY UNDERGRADUATE
RESEARCH FELLOWS

April 2000

Group: Engineering

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Approved as to style and content by:

G. P. 'Bud' Peterson
(Fellows Advisor)

Edward A. Funkhouser
(Executive Director)

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ABSTRACT

Application of Mini-Heat Pipes for the Thermal Control of

Semiconductor Devices. (April 2000)

Brian Patrick Corbett
Department of Mechanical Engineering
Texas A&M University

Fellows Advisor: G. P. 'Bud' Peterson, Ph.D., P.E.
Department of Mechanical Engineering

Electronic components produce heat that hinders their performance and reliability. Heat pipes, two-phase heat transfer devices, may be used to effectively cool electronic components. This project focuses on two different heat pipe designs that may potentially be used to cool electronic components. One heat pipe design being studied uses metal wires to form its wicking structure. This simple wick design may result in reduced manufacturing costs. The second heat pipe has a wick pattern formed in a copper plate. The wick pattern is designed to separate the flow of vapor and liquid within the heat pipe. To evaluate both heat pipe designs, test articles were fabricated and tested to determine their heat transfer performance. Tests performed in this study indicated that both heat pipe designs offered no performance benefits when compared to comparable solid conductors. Errors in the charging process and use of improper amounts of working fluid are believed to cause the negligible performance gains.

ACKNOWLEDGMENTS

I would like to thank Dr. Peterson for introducing me to this project and for his role as my advisor

Special thanks to 3M and MER Corp. for providing the test articles used for this project

TABLE OF CONTENTS

Page

LIST OF FIGURES

INTRODUCTION

Heat generated by electronic components adversely affects their performance and reliability. This study focuses on the fabrication and testing of two different micro-heat pipe designs: a metal wire heat pipe and a loop heat pipe plate. Heat pipes, two-phase heat transfer devices, allow for high heat transfer rates with small temperature differences because heat is transferred by a liquid-vapor phase change within the heat pipe.

The original focus of this project was to design, fabricate, test, and model a micro-heat pipe for the application of cooling semiconductor devices. Industry sponsors proposed the heat pipe designs that were eventually adopted for this project. The use of predetermined and manufacturable designs eliminated most of the design and modeling aspects of the project. Part of the fabrication process was performed by the industry sponsors. They provided the wicking structures for the heat pipes to be tested. To complete the fabrication process, the heat pipes were sealed and charged with working fluid. The heat pipes produced were tested to determine their heat transfer performance.

Electronic components need cooling systems to operate reliably and to perform within their prescribed operating parameters.[1,2] The internal resistance of electronic components causes heat to be generated when current passes through the components during operation.[3] Many material properties are temperature dependent. When excessive heat changes the electrical conductivity of semiconductor materials, a component's electronic functions may be impaired. Heat also causes mechanical

AIAA Journal of Thermophysics and Heat Transfer used for style stresses in components. The various materials that make up a particular component all have different coefficients of thermal expansion. Temperature changes cause components produced from different materials to expand or contract nonuniformly. These expansions and contractions cause mechanical stresses that influence the physical integrity of the component over time.[3]

Conventional cooling techniques utilize conduction and convection to transfer heat. Heat always flows from an area of high temperature to one with a lower temperature. Metal heat sinks attached to electronic components allow heat to be transferred away from its source. Heat transfers through the heat sink material by conduction. In conduction, heat is transferred at the molecular level through a medium. Heat is also transferred to the ambient air surrounding the component by convection. Convection occurs when heat is transferred between a fluid (air in this case) and a solid surface when a temperature difference is present. In electronic applications, fans are commonly used to enhance convection heat transfer.[2,3]

HEAT PIPE OPERATION AND CONSTRUCTION

Heat pipes are two-phase heat transfer devices. The basic heat transfer operations in heat pipes are accomplished by liquid-vapor phase changes of the working fluid. Basic heat pipe construction consists of an outer shell, a wicking structure, and a working fluid. A simple cylindrical heat pipe configuration and its fundamental operational processes is illustrated in Fig. 1. There are three basic operational regions in a heat pipe: the evaporator, the condenser, and an adiabatic region.[4,5] Heat applied in the evaporator region causes the working fluid in that area to evaporate. The heat required to evaporate the working fluid is known as the latent heat of vaporization. The same amount of heat that was absorbed during the vaporization of the working fluid is rejected as the working fluid condenses in the cooler condenser region. The higher temperature and pressure in the evaporator region force vapor produced to travel to the condenser region. The region between the evaporator and condenser is adiabatic (no heat is transferred).

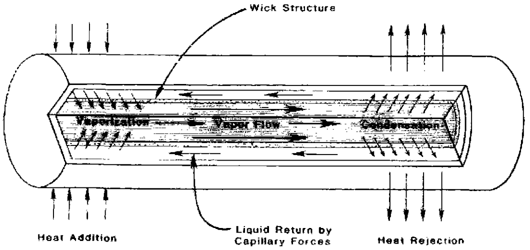

Fig. 1 Typical Heat Pipe Construction and Operation[5]

The physical components of heat pipes influence their operating characteristics.[5] The outer case of the heat pipe seals in the working fluid. The outer case may take on various sizes and geometry as dictated by the given application. The selection of the working fluid is based on the expected operating temperature of the device. The working fluid must properly wet the surface of the case and the wicking structure so that heat transfers to the fluid from the case and wick. The wicking structure of the heat pipe is critical to its operation. The wicking structure acts like a sponge; it draws the condensed liquid back to the evaporator using capillary pressure so that the evaporation-condensation process may continue.

The benefits that heat pipes provide are important for the thermal control of electronic components. Because excessive heat deteriorates the performance and life expectancy of electronic components, maintaining operational temperatures within their prescribed limits is crucial. Heat pipes provide four distinct advantages over conventional conduction and convection cooling techniques.[5]

1. Greater Effective Thermal Conductivity: Heat pipes require smaller temperature gradients to transfer thermal loads.

2. Ability to Handle Increased Heat Fluxes without Significant Temperature Increases: The evaporation-condensation rate within the heat pipe increases to handle larger heat inputs.

3. Rapid Thermal Response: Once enough energy is applied to evaporate the liquid, the vapor may travel from one end to the other transferring heat.

4. Design Flexibility: The independent operation of the evaporator and condenser in heat pipes allows these two regions to have different size and shapes

The heat pipes tested in this study may be classified as micro-heat pipes. A dimensionless expression that relates the capillary radius (r_c) to the reciprocal of the hydraulic radius (r_h) is used to distinguish micro-heat pipes from conventional heat pipes.[5] For micro-heat pipes:

$$\frac{r_c}{r_h} \geq 1$$

Micro-heat pipes typically utilize the sharp, angled corners in noncircular channels as liquid arteries. Differences in meniscus thickness in these corners along channels in the micro-heat pipe create a capillary pressure difference that returns liquid to the evaporator. Other operating principles in micro-heat pipe are similar to those in larger heat pipes.

METAL WIRE HEAT PIPE

The basic metal wire heat pipe design consists of metal wires bonded between two sheets of metal foil. The spaces between adjacent wires form channels for the working fluid. The simplicity of this design makes it appealing because of its potential for low manufacturing costs. The metal wire heat pipes are manufactured by 3M using a propriety process.

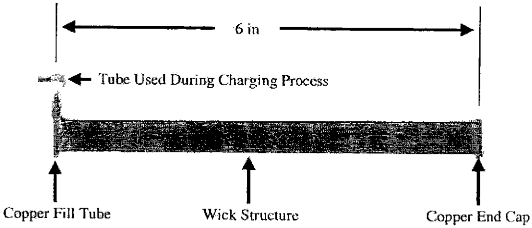

Fig. 2 Metal Wire Heat Pipe

Capillary Pumping Process

In the metal wire heat pipe design, the working fluid resides in the open regions between adjacent wires (Fig. 3). The angular corners formed where the wires and foil bond serve as the wicking structure in the heat pipe. Liquid that collects in these channels may be pumped axially within the heat pipe by capillary forces. Differences in meniscus thickness between the evaporator and the condenser create the capillary pumping forces. Fig. 3 also illustrates how the meniscus thickness varies between the evaporator and the condenser. Vapor travels through the middle of the channels. Wire diameter and the spacing between adjacent wires are two geometric parameters that influence the capillary pumping action in the wire heat pipe design.

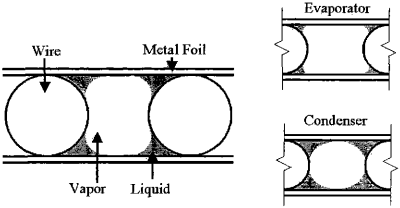

Fig. 3 Cross Section of Metal Wire Heat Pipe

Wick Construction

The various components of the metal wire and foil heat pipe are shown in Fig. 4. 3M produced the wire and foil wicking structure. The titanium wires (0.011in diameter) are bonded between two sheets of copper foil (0.005in thick). The samples tested contain 18 wires with an average spacing of 0.025in between the centers of adjacent wires. This wire and foil wick structure is provided as long bands that may be cut to length. The wire and foil wick structure also offers limited flexibility and low weight.

To determine whether or not the wick structure will wet when in contact with working fluid, the metal foil was removed from one side of the wick structure so that the wires were exposed. Drops of working fluid were then placed on the exposed wires.

The fluid quickly traveled down the channels to wet the wick. Incompatible working fluids would not wet the wick structure; the drops of incompatible fluid would bead on the surface and not flow into the grooves. This behavior was observed in samples that were heated for extended periods of time at high temperatures (400°F) when soldering operations were considered for fabrication. Water was selected as the best working fluid for the metal wire heat pipe because it has a large latent heat of vaporization allowing more heat to be transferred and greater surface tension that permits higher capillary pumping pressures.[4]

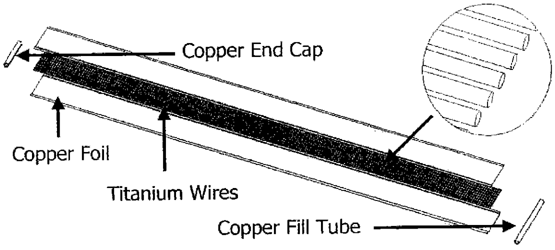

Fig. 4 Exploded View of Metal Wire Heat Pipe

Fabrication

In the fabrication process fill tubes are attached to the heat pipe so that there is a means for the working fluid to reach the wick structure during the charging process. The heat pipe is also sealed to eliminate leaks. A copper fill tube and end cap were added to enclose the exposed liquid/vapor channels. To form the fill tube, a notch was filed in one side of a copper tube. The wick structure slides into this notch. The fill tube was chemically cleaned in an acid solution so that it would have the proper cuprous oxide (Cu_2O) surface condition. This surface oxide condition is preferred because it permits water to wet the copper surface. In the cleaning process components are dipped in various acidic solutions and rinsed with water.[6] The fill tube was carefully bonded to the wick structure using epoxy. The end cap was fabricated in a similar manner. Finally, the edges of the wick structure were sealed with vacuum sealant.

LOOP HEAT PIPE (LHP) PLATE

The loop heat pipe (LHP) plate has a wick pattern formed in a copper plate. The wick pattern is designed to have the liquid and vapor phases travel in different channels. These distinct vapor and liquid channels guide the working fluid through a loop around the wick during operation. These LHP plates were manufactured and designed by MER Corp.

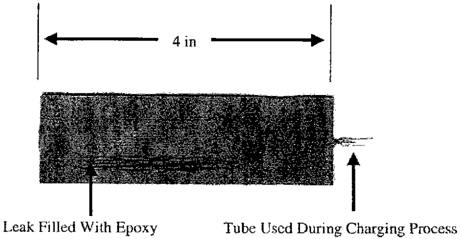

Fig. 5 LHP Plate

Capillary Pumping Process

The LHP plate is designed so that it may operate as a capillary-pumped loop where liquid and vapor phases of the working fluid travel in separate channels. This differs from the metal wire heat pipe in which liquid and vapor phases travel through the same channel, but in opposite directions. Hence, the frictional losses associated with the counter flow of the liquid and vapor phases within the same channel are eliminated. Fig.

6 illustrates the various components of the LHP plate's wick structure. A simplified model is presented in Fig. 7. Vapor travels through the wider channels along the outside of the LHP plate; liquid flows through the narrower inner channels. The liquid channels narrow as they approach the evaporator. This helps increase the capillary pumping pressure and encourages flow towards the evaporator by reducing the capillary radius. Liquid evaporates off the wick structure in the evaporator, while the wick structure at the condenser causes the vapor to condense.

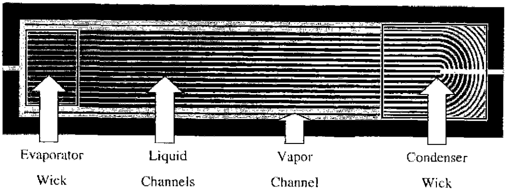

Fig. 6 LHP Plate Wick Features

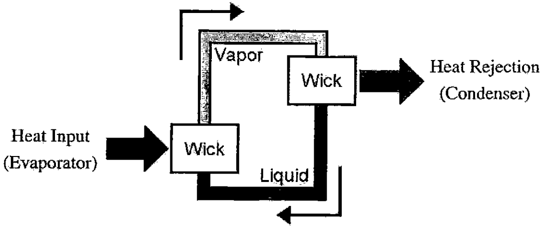

Fig. 7 Simplified Representation of LHP Wick

Wick Construction

The wick pattern of the LHP plate is formed on the surface of a copper plate. Fig. 8 shows the LHP plate and its components. A channel extending from each end of the wick structure to the edge of the plate permit the LHP plates to be filled. The depth of the features in the wick pattern is 0.004 in. Another metal plate is bonded to the top of the copper plate containing the wick structure so that the liquid/vapor channels are enclosed. Differences in the coefficient of thermal expansion among the materials used in the wick and its cover plate may cause the plates to warp or separate at elevated temperatures. These two plates were manufactured and bonded by MER Corp.

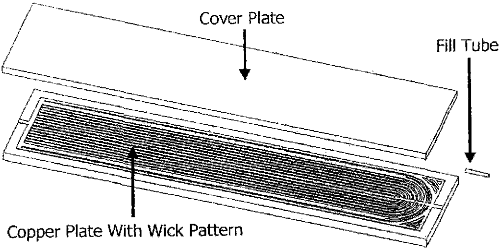

Fig. 8 Exploded View of LHP Plate

Initial working fluid compatibility tests were performed on a sample wicking structure that was not bonded to its metal cover plate. Drops of working fluid were placed on the exposed wick structure. The fluid quickly traveled down the channels to wet the wick when compatible materials were used. The drops of working fluid would bead on the surface and not flow into the grooves with incompatible fluids. To confirm that working fluid wets the wick structure in an assembled LHP plate, one end of the LHP plate was submerged in working fluid. If the wick structure wet properly, working fluid was drawn into the wick by capillary action. Compressed air was then used to remove the fluid from the LHP plate. Acetone was used as a working fluid for the LHP plates because of its compatibility with the stainless steel fill tube.[4]

Fabrication

In the fabrication process for the LHP plates, a fill tube was connected to one of the two channels extending from the wick structure. One of the two 0.004in deep channels was broadened to accept the fill tube. This channel was first enlarged to 0.0135in and then counter drilled to 0.0355in in diameter to fit the fill tube. A stainless steel hypodermic tube was needed to fit the thin profile of the LHP plate. The second channel was covered with epoxy. Leak tests performed on the LHP plates revealed several holes through the plate containing the wick pattern and along the joint between the wick and cover plate. These holes were sealed using epoxy.

CHARGING PROCESS

The heat pipe is filled with a working fluid in the charging process. To operate properly, a heat pipe must be filled with the proper amount of working fluid. The heat pipe designs being tested require a small amount of working fluid (70-100μL) and have wick structures with small channels. These characteristics make the charging process difficult.

To ensure that the heat pipe is properly sealed before charging, the heat pipe is pressurized to test for leaks. To perform the leak test, a heat pipe is connected to a compressed air source and submerged under water. Bubbles forming on the surface of the heat pipe indicate that a leak is present. The maximum anticipated operating temperature of the heat pipe determines the maximum leak test pressure. The heat pipe must be able to withstand the saturation pressure of the working fluid at the maximum operating temperature (Ex: P_{sat} for acetone at 80 °C ≈ 31 psi).[5]

In the charging process, a syringe with 1μL gradations meters the amount of working fluid that enters the heat pipe. Measuring the weight of the heat pipe during the charging process was an alternative method that was considered to control the amount of working fluid in the heat pipe. Generally, the heat pipes are filled with slightly more working fluid than theoretically calculated. Some extra fluid is preferred because the heat pipe will not operate as intended if there is not enough liquid to return to the evaporator. The extra fluid fills part of the condenser during operation, thus reducing the effective length of the heat pipe.

A schematic of the charging process is illustrated in Fig. 9. Flexible, plastic tubing is used to connect the heat pipe to a vacuum pump. The vacuum pump is used to remove all matter from the inside of the heat pipe. Any material remaining within the heat pipe will hinder the evaporation-condensation within the heat pipe during operation.

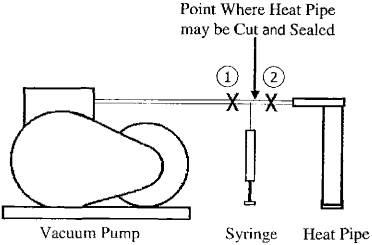

Fig. 9 Charging Schematic

After the heat pipe is evacuated, the tube connecting the heat pipe to the vacuum pump is closed at Point 1. The tubing is then pierced with the syringe and the proper amount of working fluid is injected into the heat pipe. Vacuum grease was applied to the tip of the syringe to maintain the seal when the tubing is pierced. The vacuum within the heat pipe helps draw the working fluid into the wick structure.

Before the syringe is removed, the tube attached to the heat pipe is then temporarily closed using forceps after the puncture at Point 2. The tube may then be cut and sealed. To permanently close the heat pipe, the metal fill tube may be crimped and sealed. This technique was not used because it allows the heat pipe to only be charged once. By keeping the plastic tubing at the end of the fill tube, the heat pipe may be recharged by simply removing the plastic tubing.

TEST APPARATUS

A test apparatus was created to measure the temperature distribution along the surface of a heat pipe during operation. The test apparatus was designed to test the response of the heat pipe to various heat inputs. The test facility used is represented in Fig. 10.

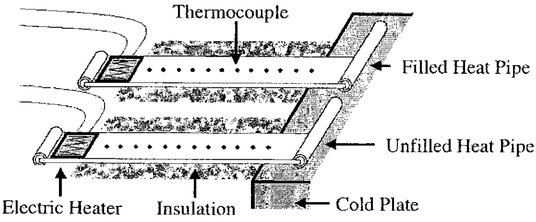

Fig. 10 Test Apparatus

To test the heat pipes, an electric heater was attached at one end to provide the heat input at the evaporator. Thin, foil-type resistance heaters were attached to the heat pipe using high-temperature silicone. The square heaters used have an approximate resistance of 23.4Ω and an effective area of $0.09in^2$. A single heater was attached to the metal wire heat pipes for testing. Two heaters were attached to the LHP plates for testing because of their greater evaporator width. The two heaters were wired in series. Current flowing through the heaters was controlled by a DC power supply. At the opposite end, the heat pipe was mounted to an aluminum heat sink. The heat sink keeps the condenser of the heat pipe at a predetermined temperature. Fluid running through the aluminum heat sink from a constant temperature bath maintains its temperature. The heat pipe was surrounded by insulation to prevent heat losses to the surroundings.

Ten thermocouples were used to measure the temperature distribution along the surface of each heat pipe during testing. The thermocouples were more closely spaced at the evaporator and condenser of the heat pipe to monitor the temperature in those regions. The T-type thermocouples used provide accuracy of approximately $\pm 0.5°C$. HP-VEE software was used to record experimental data.

TEST PROCEDURE

To evaluate the performance of the heat pipes tested, the temperature distribution was measured axially along filled and unfilled test articles. Ideally the evaporation and condensation of the working fluid in the filled heat pipe will enhance its heat transport ability and result in lower temperatures along the surface of the filled heat pipe.

Both a filled and an unfilled heat pipe were initially tested at the same time. The heat sink temperature was set at a predetermined value and allowed to reach steady state. The heaters on both test articles were then given the same input power and steady-state temperature distributions were measured. The amount of power supplied to the heaters was incrementally increased and new steady-state temperatures were recorded. By incrementally increasing the power, it may be possible to identify when dry-out occurs in the evaporator of the heat pipe. In dry-out, the working fluid evaporates at a faster rate than the wick can return working fluid to the evaporator. This stops the two-phase heat transfer action within the heat pipe. Dry-out would be identified by a more rapid increase in evaporator temperatures at the point of heat input.

TEST RESULTS

The thermal performance of the metal wire heat pipes and LHP plates is presented in Fig.11-Fig.14. The plots in Fig.11-Fig.14 illustrate the temperature distribution axially along both filled and unfilled versions of both heat pipe designs tested. On all charts, the three closely spaced data points on the left represent the thermocouples placed at the evaporator where the heat source is located. The last four data points on the right side of the plot monitor the condenser end of the heat pipe where heat is rejected to the heat sink. The temperature distributions for various power inputs are plotted. Points on each plot represent the average, steady state temperature for a given axial position and power input. Complete experimental data is located in the Appendix.

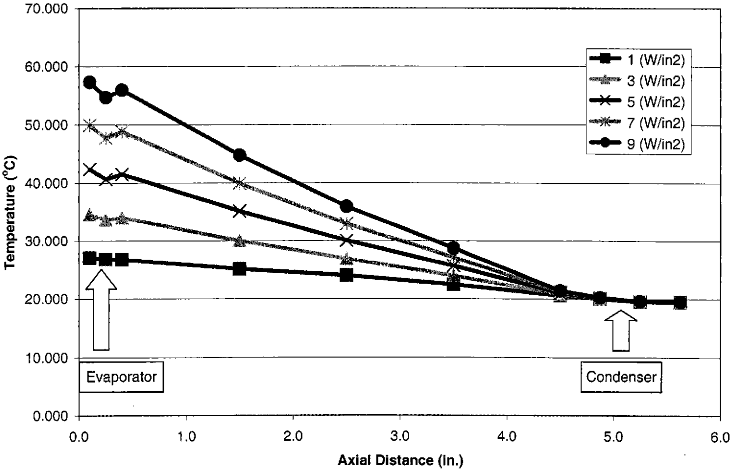

Fig. 11 Axial Temperature Distribution in a Unfilled Metal Wire Heat Pipe for Various Heat Inputs

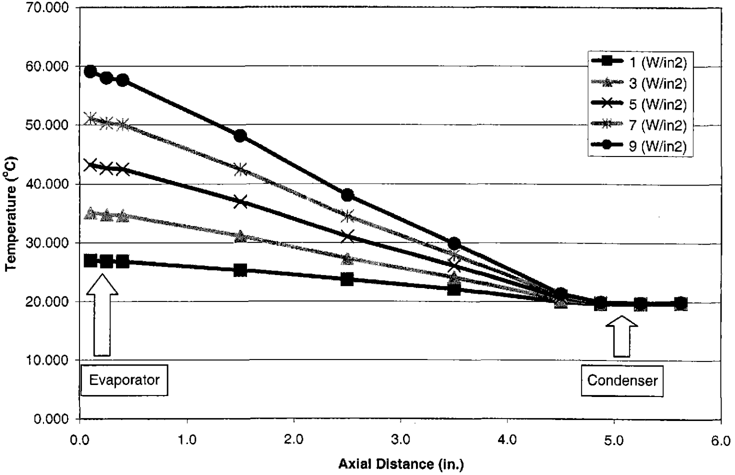

Fig. 12 Axial Temperature Distribution in a Filled Metal Wire Heat Pipe for Various Heat Inputs

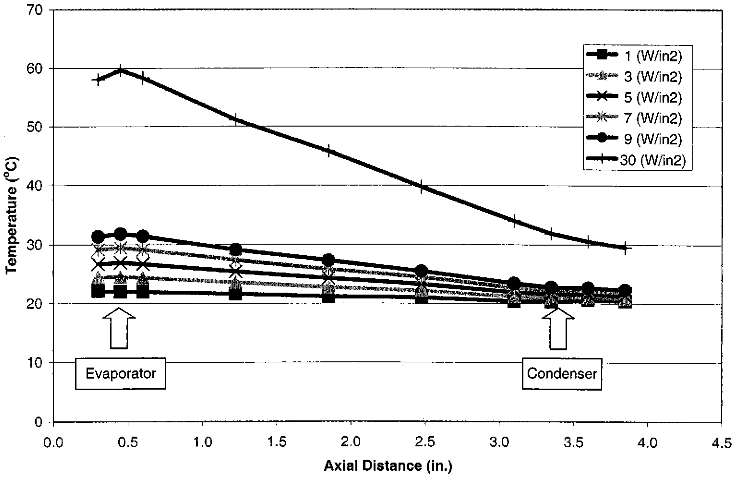

Fig. 13 Axial Temperature Distribution in a Unfilled LHP Plate for Various Heat Inputs

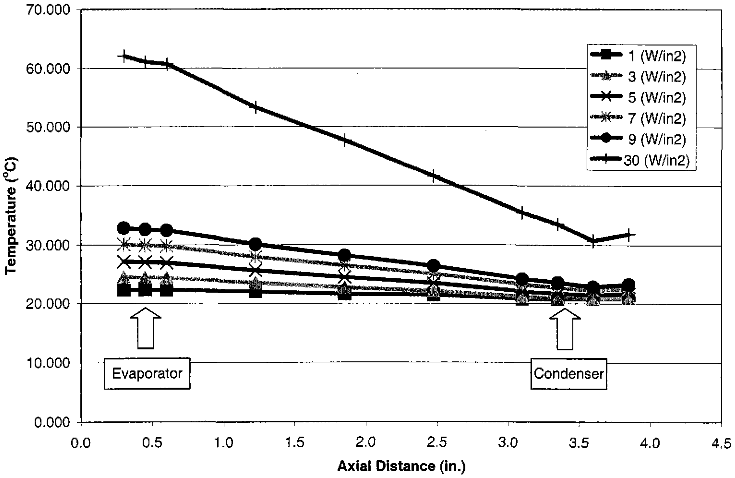

Fig. 14 Axial Temperature Distribution in a Filled LHP Plate for Various Heat Inputs

DISCUSSION

The nearly identical temperature distributions among the filled and unfilled heat pipes indicate that the desired evaporation and condensation processes are not occurring in the filled test articles. Without the liquid-vapor phase changes, the heat pipes do not enhance heat transfer performance. Lower temperatures in the evaporator of a filled test article at the point of heat addition would indicate that the heat pipe is operating as intended. The near linear temperature distribution between the evaporator and condenser indicate that heat is being transferred by conduction.

After the initial tests were performed, various methods were employed in an attempt to improve thermal performance. The heat pipes were filled with different amounts of working fluid. Because the proper amount of working fluid is essential for proper operation, this variable was the first to be studied as being the probable cause for failure. Methanol was also used as the working fluid in the metal wire heat pipe in place of water. This was done to determine if there was any unknown compatibility problems between the materials used to make the heat pipe and the working fluid.

The highest heat inputs ($30W/in^2$) applied to the LHP plates were done to determine if noncondensible gases from the charging process hindered performance. By applying this high heat input, the evaporator temperature was kept above the saturation temperature of the working fluid (56.1°C for acetone) at atmospheric pressure. The high temperature would force some of the working fluid to evaporate and promote two-phase heat transfer within the heat pipe. The higher operating temperatures did not result in enhanced heat transfer performance for the filled LHP plates; thermal performance was similar to the unfilled test article.

During the testing procedures, various experimental errors were found. The accuracy of some thermocouples were observed to vary, but no corrections were made because no data indicated that these thermocouples significantly influenced the test results. The thermocouples may be calibrated or remanufactured to obtain more accurate readings. Variances were also found among the electric heaters used. Improper mounting of the heaters or damage from high power inputs could influence the amount of heat applied to the test article. To eliminate these heater variances, only one heat pipe will be tested both before and after the charging process with the same heater.

CONCLUSIONS

The results of this study indicate that none of the heat pipes produced were able to provide enhanced heat transfer performance when filled with working fluid. This indicates that the desired two-phase heat transfer operations are not occurring in the metal wire heat pipes and LHP plates. To evaluate the performance of the wire heat pipe and LHP plate designs, test articles were fabricated and a charging process was developed to fill the heat pipes with working fluid. Testing facilities were also created to evaluate the performance of the heat pipes produced. The lack of improved heat transfer performance in the test articles may be attributed to error in the charging process and/or non-optimal wick structures. Modifications to the charging process that eliminate the need to puncture the vacuum line would eliminate some the uncertainty associated with that process. Presently there is not means of detecting leaks that may occur when the vacuum line is pierced. The metal wire and LHP plate heat pipe designs tested may be modeled to determine the optimal wick configuration or size. Reducing the potential for contamination of the wick structure during fabrication would also increase the chance for success.

REFERENCES

[1]*ASM Metals Handbook,* Vol. 2, *Heat Treating, Cleaning, and Finishing*, 8th Ed., ASM, 1964, pp. 635-647

[2]Bar-Cohen, Avram and Kraus, Allan D, Editors, *Advances in Thermal Modeling of Electronic Components and Systems*, Vol. 3, ASME Press, New York, 1993, pp. 61-152

[3]Faghri, Amir, *Heat Pipe Science and Technology*, Taylor & Francis, Washington DC, 1995, pp. 1-60, 803-833

[4]Fuqua, Norman B, *Reliability Engineering for Electronic Design*, Marcel Dekker, New York, 1987, pp. 39-53, 229-253

[5]Peterson, G.P., *An Introduction to Heat Pipes: Modeling, Testing and Applications*, John Wiley & Sons, New York, 1994, pp. 1-16, 175-209, 271-284

[6]Steinberg, Dave S, *Cooling Techniques for Electronic Equipment*, 2nd Ed., John Wiley & Sons, New York, 1991, pp. 1-13, 363-371

Table 1 Unfilled Metal Wire Heat Pipe - 1 W/in^2

Power Input 1 W/in^2
Working Fluid N/A

Axial Position (in)	0.1	0.25	0.4	1.5	2.5	3.5	4.5	4.875	5.25	5.625
	Temperature (°C)									
	27.034	26.756	26.729	25.080	24.014	22.477	20.592	20.055	19.512	19.487
	27.029	26.763	26.722	25.075	24.009	22.475	20.593	20.059	19.507	19.485
	27.022	26.779	26.724	25.077	23.996	22.479	20.592	20.058	19.526	19.487
	27.047	26.760	26.725	25.081	24.006	22.483	20.584	20.059	19.516	19.477
	27.018	26.771	26.728	25.084	24.003	22.472	20.590	20.056	19.504	19.497
	27.026	26.748	26.733	25.084	24.018	22.478	20.575	20.064	19.533	19.485
	27.035	26.754	26.733	25.072	24.015	22.480	20.584	20.070	19.516	19.471
	27.008	26.762	26.729	25.083	23.990	22.479	20.592	20.066	19.515	19.476
	27.035	26.766	26.716	25.084	24.003	22.472	20.584	20.070	19.513	19.477
	27.038	26.766	26.719	25.081	24.003	22.486	20.593	20.047	19.513	19.482
	27.032	26.760	26.730	25.075	24.006	22.492	20.590	20.064	19.513	19.488
	27.053	26.760	26.719	25.072	24.023	22.456	20.590	20.059	19.510	19.479
	27.020	26.762	26.741	25.080	23.993	22.479	20.580	20.066	19.503	19.461
	27.029	26.757	26.725	25.084	24.015	22.489	20.590	20.062	19.521	19.488
	27.052	26.753	26.713	25.089	24.005	22.474	20.571	20.066	19.523	19.479
	27.012	26.751	26.730	25.081	24.012	22.469	20.599	20.059	19.507	19.479
	27.038	26.769	26.728	25.081	23.994	22.475	20.572	20.059	19.519	19.479
	27.055	26.759	26.735	25.068	24.008	22.471	20.586	20.058	19.512	19.476
	27.037	26.768	26.727	25.089	24.008	22.477	20.589	20.061	19.500	19.481
	27.008	26.765	26.729	25.089	23.981	22.465	20.592	20.072	19.497	19.479
	27.043	26.756	26.738	25.080	23.999	22.479	20.577	20.066	19.521	19.464
	27.037	26.747	26.735	25.098	23.993	22.477	20.589	20.052	19.500	19.481
	27.026	26.760	26.736	25.072	24.003	22.483	20.590	20.056	19.516	19.488
	27.052	26.750	26.732	25.098	23.993	22.462	20.586	20.066	19.515	19.484
	26.999	26.762	26.735	25.083	24.011	22.471	20.592	20.058	19.523	19.484
	27.049	26.765	26.732	25.089	24.005	22.458	20.586	20.061	19.509	19.479
	27.017	26.768	26.729	25.080	24.002	22.485	20.592	20.061	19.515	19.476
	27.037	26.753	26.729	25.074	24.005	22.471	20.589	20.058	19.512	19.473
	27.025	26.756	26.721	25.089	23.999	22.465	20.598	20.058	19.521	19.479
	27.166	26.891	26.867	25.197	24.050	22.480	20.554	20.031	19.527	19.438
	27.151	26.888	26.870	25.197	24.050	22.498	20.560	20.028	19.500	19.459
Average	27.040	26.768	26.737	25.089	24.007	22.476	20.585	20.059	19.513	19.478
Std. Dev.	0.035	0.033	0.036	0.030	0.014	0.009	0.010	0.010	0.009	0.011

Table 2 Unfilled Metal Wire Heat Pipe - 3 W/in^2

Power Input 3 W/in^2
Working Fluid N/A

Axial Position (in)	0.1	0.25	0.4	1.5	2.5	3.5	4.5	4.875	5.25	5.625
	Temperature (°C)									
	34.593	33.656	34.027	30.007	26.896	24.023	20.797	20.111	19.622	19.580
	34.584	33.643	34.036	30.013	26.893	24.000	20.794	20.111	19.607	19.557
	34.573	33.656	34.021	30.010	26.896	24.015	20.794	20.091	19.628	19.560
	34.590	33.656	34.036	30.001	26.893	23.996	20.797	20.091	19.631	19.554
	34.599	33.650	34.019	30.007	26.893	23.996	20.791	20.097	19.625	19.557
	34.575	33.656	34.027	30.007	26.890	24.009	20.797	20.124	19.616	19.568
	34.590	33.656	34.027	30.001	26.907	24.015	20.782	20.108	19.625	19.565
	34.584	33.668	34.030	29.995	26.898	24.015	20.776	20.111	19.631	19.560
	34.584	33.677	34.021	30.019	26.881	24.003	20.785	20.120	19.625	19.545
	34.573	33.674	34.036	29.998	26.896	24.009	20.779	20.097	19.625	19.563
	34.590	33.662	34.021	30.013	26.907	23.996	20.791	20.105	19.613	19.568
	34.570	33.671	34.030	30.019	26.893	24.012	20.788	20.094	19.625	19.557
	34.596	33.662	34.019	30.004	26.893	24.009	20.782	20.097	19.625	19.563
	34.575	33.659	34.017	30.013	26.896	24.003	20.779	20.117	19.628	19.554
	34.567	33.646	34.030	30.019	26.893	24.009	20.785	20.103	19.622	19.568
	34.575	33.659	34.017	30.013	26.890	24.015	20.794	20.108	19.622	19.545
	34.581	33.647	34.042	30.010	26.893	24.000	20.794	20.111	19.628	19.548
	34.570	33.640	34.027	30.004	26.887	24.009	20.797	20.100	19.619	19.557
	34.574	33.658	34.029	30.014	26.896	23.992	20.795	20.104	19.617	19.561
	34.578	33.640	34.030	30.004	26.878	24.003	20.797	20.105	19.613	19.554
	34.588	33.629	34.018	29.999	26.908	24.016	20.780	20.112	19.623	19.563
	34.571	33.660	34.021	30.008	26.896	24.013	20.771	20.104	19.629	19.566
	34.594	33.655	34.015	30.008	26.914	24.013	20.792	20.112	19.623	19.555
Average	34.582	33.656	34.026	30.008	26.895	24.007	20.789	20.106	19.623	19.559
Std. Dev.	0.009	0.011	0.007	0.007	0.008	0.008	0.008	0.009	0.006	0.008

Table 3 Unfilled Metal Wire Heat Pipe - 5 W/in^2

Power Input 5 W/in^2
Working Fluid N/A

Axial Position (in)	0.1	0.25	0.4	1.5	2.5	3.5	4.5	4.875	5.25	5.625
	Temperature (°C)									
	42.407	40.672	41.520	35.143	30.034	25.700	21.055	20.167	19.615	19.526
	42.400	40.682	41.536	35.136	30.054	25.690	21.057	20.169	19.604	19.537
	42.409	40.671	41.513	35.133	30.036	25.696	21.035	20.189	19.607	19.540
	42.402	40.642	41.510	35.129	30.047	25.701	21.043	20.171	19.598	19.542
	42.405	40.658	41.518	35.126	30.056	25.689	21.028	20.180	19.595	19.536
	42.419	40.652	41.517	35.143	30.040	25.688	21.046	20.176	19.588	19.541
	42.379	40.666	41.500	35.143	30.043	25.703	21.039	20.188	19.612	19.541
	42.391	40.663	41.520	35.114	30.043	25.709	21.039	20.170	19.597	19.550
	42.410	40.663	41.522	35.137	30.043	25.694	21.033	20.182	19.594	19.550
	42.382	40.663	41.522	35.131	30.043	25.688	21.042	20.179	19.615	19.522
	42.399	40.663	41.517	35.137	30.037	25.697	21.052	20.185	19.597	19.538
	42.384	40.671	41.530	35.147	30.045	25.688	21.041	20.163	19.599	19.530
	42.384	40.680	41.533	35.147	30.048	25.705	21.047	20.172	19.599	19.533
	42.367	40.682	41.541	35.142	30.054	25.690	21.041	20.175	19.604	19.533
	42.400	40.690	41.533	35.142	30.039	25.696	21.057	20.175	19.599	19.537
	42.390	40.674	41.533	35.130	30.048	25.693	21.029	20.181	19.596	19.524
	42.382	40.666	41.522	35.134	30.043	25.680	21.046	20.179	19.597	19.517
	42.381	40.680	41.521	35.124	30.042	25.682	21.057	20.163	19.617	19.521
	42.415	40.674	41.527	35.142	30.045	25.688	21.057	20.181	19.599	19.543
	42.400	40.659	41.519	35.130	30.042	25.699	21.041	20.178	19.596	19.521
	42.409	40.651	41.519	35.139	30.051	25.693	21.044	20.175	19.593	19.533
	42.400	40.671	41.516	35.136	30.048	25.693	21.047	20.175	19.602	19.530
	42.396	40.662	41.516	35.133	30.042	25.708	21.047	20.172	19.587	19.543
	42.440	40.665	41.519	35.145	30.042	25.688	21.044	20.163	19.611	19.530
	42.409	40.656	41.521	35.127	30.060	25.702	21.032	20.184	19.617	19.530
	42.414	40.636	41.513	35.129	30.053	25.689	21.046	20.165	19.610	19.536
	42.428	40.650	41.495	35.132	30.044	25.681	21.046	20.186	19.598	19.526
	42.389	40.653	41.513	35.132	30.053	25.684	21.049	20.183	19.589	19.533
Average	42.400	40.665	41.520	35.135	30.045	25.693	21.044	20.176	19.601	19.534
Std. Dev.	0.016	0.013	0.010	0.008	0.006	0.008	0.008	0.008	0.009	0.008

Table 4 Unfilled Metal Wire Heat Pipe - 7 W/in²

Power Input 7 W/in²
Working Fluid N/A

Axial Position (in)	0.1	0.25	0.4	1.5	2.5	3.5	4.5	4.875	5.25	5.625
	Temperature (°C)									
	49.923	47.725	48.813	39.938	32.929	27.179	21.221	20.200	19.612	19.500
	49.920	47.728	48.825	39.940	32.929	27.177	21.212	20.200	19.574	19.523
	49.906	47.744	48.833	39.938	32.920	27.179	21.209	20.194	19.609	19.503
	49.902	47.735	48.841	39.950	32.921	27.169	21.231	20.187	19.591	19.511
	49.919	47.740	48.843	39.944	32.921	27.178	21.220	20.190	19.600	19.511
	49.938	47.732	48.832	39.941	32.918	27.164	21.214	20.193	19.603	19.517
	49.907	47.726	48.843	39.952	32.912	27.180	21.225	20.189	19.574	19.507
	49.940	47.731	48.834	39.933	32.921	27.163	21.219	20.183	19.578	19.504
	49.932	47.731	48.826	39.933	32.921	27.166	21.228	20.201	19.578	19.497
	49.923	47.733	48.819	39.938	32.929	27.145	21.229	20.194	19.589	19.512
	49.917	47.717	48.825	39.945	32.934	27.177	21.218	20.191	19.592	19.512
	49.920	47.708	48.830	39.943	32.908	27.168	21.224	20.183	19.580	19.523
	49.928	47.692	48.821	39.919	32.916	27.178	21.217	20.184	19.585	19.508
	49.928	47.713	48.810	39.939	32.910	27.166	21.211	20.199	19.566	19.504
	49.930	47.713	48.815	39.939	32.921	27.169	21.231	20.202	19.588	19.504
	49.907	47.723	48.812	39.949	32.932	27.169	21.228	20.192	19.587	19.500
	49.927	47.723	48.810	39.941	32.923	27.169	21.216	20.204	19.581	19.504
	49.917	47.725	48.816	39.932	32.926	27.177	21.212	20.186	19.574	19.493
	49.906	47.714	48.822	39.935	32.934	27.165	21.209	20.183	19.595	19.493
	49.912	47.714	48.822	39.926	32.905	27.193	21.215	20.188	19.589	19.497
	49.925	47.715	48.826	39.937	32.907	27.166	21.217	20.181	19.581	19.495
	49.933	47.713	48.835	39.931	32.918	27.175	21.223	20.184	19.591	19.495
	49.925	47.698	48.818	39.941	32.918	27.166	21.229	20.184	19.597	19.498
	49.924	47.712	48.828	39.938	32.921	27.174	21.201	20.192	19.590	19.500
	49.915	47.717	48.828	39.927	32.915	27.174	21.204	20.177	19.581	19.510
	49.921	47.729	48.826	39.933	32.918	27.174	21.222	20.192	19.578	19.491
	49.921	47.723	48.817	39.938	32.921	27.160	21.225	20.183	19.590	19.491
	49.906	47.730	48.827	39.940	32.911	27.171	21.206	20.191	19.583	19.500
	49.909	47.736	48.830	39.935	32.911	27.171	21.218	20.194	19.570	19.521
	49.923	47.742	48.833	39.945	32.934	27.162	21.206	20.191	19.580	19.500
	49.908	47.718	48.821	39.959	32.930	27.166	21.217	20.193	19.581	19.504
Average	49.920	47.723	48.825	39.939	32.920	27.171	21.218	20.191	19.586	19.504
Std. Dev.	0.010	0.012	0.009	0.008	0.008	0.008	0.008	0.007	0.011	0.009

Table 5 Unfilled Metal Wire Heat Pipe - 9 W/in^2

Power Input 9 W/in^2
Working Fluid N/A

Axial Position (in)	0.1	0.25	0.4	1.5	2.5	3.5	4.5	4.875	5.25	5.625
	Temperature (°C)									
	57.282	54.639	55.924	44.771	35.926	28.733	21.426	20.241	19.595	19.503
	57.279	54.636	55.924	44.760	35.908	28.742	21.426	20.247	19.595	19.512
	57.281	54.651	55.901	44.775	35.896	28.744	21.434	20.259	19.579	19.502
	57.254	54.646	55.918	44.772	35.910	28.735	21.434	20.265	19.594	19.502
	57.265	54.648	55.948	44.765	35.916	28.715	21.428	20.234	19.594	19.514
	57.281	54.662	55.945	44.775	35.910	28.732	21.437	20.229	19.582	19.511
	57.273	54.651	55.932	44.781	35.904	28.735	21.434	20.259	19.597	19.508
	57.251	54.662	55.940	44.772	35.919	28.732	21.434	20.249	19.591	19.514
	57.287	54.665	55.932	44.790	35.916	28.727	21.445	20.253	19.582	19.511
	57.234	54.671	55.932	44.784	35.919	28.729	21.428	20.243	19.597	19.511
	57.281	54.657	55.935	44.778	35.919	28.741	21.445	20.246	19.585	19.520
	57.262	54.674	55.945	44.778	35.925	28.729	21.442	20.243	19.588	19.502
	57.262	54.654	55.938	44.790	35.913	28.729	21.442	20.243	19.597	19.520
	57.264	54.670	55.937	44.780	35.909	28.723	21.433	20.239	19.584	19.516
	57.267	54.667	55.926	44.783	35.924	28.734	21.436	20.245	19.590	19.501
	57.270	54.670	55.950	44.800	35.918	28.734	21.433	20.233	19.587	19.507
	57.275	54.689	55.956	44.789	35.924	28.737	21.424	20.239	19.596	19.498
	57.267	54.681	55.947	44.786	35.918	28.729	21.436	20.252	19.584	19.498
	57.284	54.646	55.940	44.775	35.916	28.721	21.442	20.240	19.585	19.522
	57.275	54.662	55.935	44.790	35.907	28.715	21.422	20.246	19.582	19.502
	57.251	54.671	55.951	44.765	35.934	28.744	21.416	20.240	19.591	19.511
	57.275	54.662	55.942	44.772	35.916	28.721	21.437	20.246	19.585	19.505
	57.248	54.659	55.945	44.778	35.913	28.735	21.425	20.249	19.603	19.511
	57.280	54.647	55.928	44.770	35.930	28.726	21.427	20.239	19.572	19.510
	57.277	54.658	55.934	44.777	35.915	28.723	21.412	20.245	19.587	19.495
	57.250	54.642	55.906	44.780	35.907	28.729	21.430	20.239	19.590	19.510
	57.316	54.642	55.917	44.783	35.904	28.720	21.430	20.249	19.581	19.504
	57.270	54.645	55.926	44.795	35.907	28.726	21.418	20.245	19.581	19.495
	57.260	54.663	55.930	44.776	35.905	28.730	21.420	20.244	19.586	19.512
Average	57.270	54.658	55.934	44.779	35.915	28.730	21.431	20.245	19.588	19.508
Std. Dev.	0.016	0.013	0.013	0.009	0.008	0.008	0.009	0.008	0.007	0.007

Table 6 Filled Metal Wire Heat Pipe - 1 W/in^2

Power Input 1 W/in^2
Working Fluid Water

Axial Position (in)	0.1	0.25	0.4	1.5	2.5	3.5	4.5	4.875	5.25	5.625
	Temperature (°C)									
	26.915	26.803	26.762	25.271	23.667	22.086	19.938	19.608	19.579	19.736
	26.916	26.783	26.766	25.272	23.670	22.086	19.936	19.618	19.591	19.733
	26.909	26.788	26.756	25.266	23.670	22.089	19.924	19.618	19.573	19.728
	26.916	26.786	26.754	25.272	23.661	22.100	19.923	19.607	19.575	19.724
	26.916	26.780	26.754	25.264	23.672	22.082	19.938	19.614	19.581	19.732
	26.919	26.783	26.751	25.281	23.665	22.083	19.936	19.605	19.579	19.719
	26.907	26.792	26.754	25.272	23.669	22.079	19.923	19.614	19.593	19.721
	26.921	26.785	26.753	25.269	23.665	22.083	19.930	19.621	19.585	19.733
	26.910	26.777	26.757	25.270	23.659	22.086	19.930	19.603	19.600	19.728
	26.916	26.783	26.763	25.270	23.652	22.091	19.932	19.617	19.566	19.724
	26.910	26.792	26.763	25.278	23.667	22.107	19.911	19.618	19.582	19.730
	26.913	26.798	26.748	25.278	23.665	22.095	19.938	19.618	19.591	19.722
	26.912	26.800	26.762	25.266	23.647	22.083	19.924	19.618	19.582	19.733
	26.904	26.792	26.754	25.270	23.665	22.089	19.933	19.624	19.573	19.733
	26.924	26.785	26.756	25.266	23.650	22.089	19.936	19.633	19.576	19.733
	26.919	26.795	26.748	25.270	23.659	22.104	19.933	19.611	19.582	19.722
	26.913	26.780	26.757	25.275	23.667	22.083	19.941	19.614	19.579	19.730
	26.915	26.791	26.756	25.277	23.647	22.100	19.930	19.611	19.582	19.728
	26.921	26.791	26.759	25.274	23.667	22.080	19.936	19.611	19.591	19.725
	26.915	26.797	26.759	25.271	23.650	22.092	19.924	19.597	19.585	19.722
	26.924	26.782	26.747	25.274	23.656	22.095	19.921	19.594	19.585	19.725
	26.906	26.776	26.756	25.277	23.656	22.100	19.930	19.624	19.588	19.728
	26.934	26.783	26.751	25.278	23.682	22.089	19.933	19.603	19.573	19.733
	26.900	26.782	26.756	25.283	23.662	22.095	19.941	19.618	19.570	19.739
	26.915	26.779	26.759	25.269	23.673	22.077	19.930	19.605	19.579	19.733
	26.915	26.785	26.744	25.260	23.676	22.092	19.917	19.627	19.585	19.745
	26.912	26.791	26.765	25.280	23.656	22.092	19.924	19.621	19.582	19.730
	26.912	26.773	26.756	25.269	23.665	22.080	19.938	19.614	19.585	19.745
	26.924	26.776	26.747	25.274	23.667	22.100	19.950	19.603	19.582	19.722
	27.076	26.931	26.891	25.392	23.765	22.166	19.938	19.597	19.653	19.802
	27.064	26.934	26.885	25.380	23.771	22.145	19.947	19.603	19.645	19.787
Average	26.925	26.796	26.764	25.280	23.670	22.094	19.932	19.613	19.586	19.734
Std. Dev.	0.039	0.037	0.033	0.029	0.028	0.018	0.009	0.009	0.018	0.018

Table 7 Filled Metal Wire Heat Pipe - 3 W/in^2

Power Input 3 W/in^2
Working Fluid Water

Axial Position (in)	0.1	0.25	0.4	1.5	2.5	3.5	4.5	4.875	5.25	5.625
	Temperature (°C)									
	35.115	34.775	34.637	31.117	27.304	24.102	20.329	19.712	19.768	19.901
	35.115	34.753	34.640	31.114	27.304	24.093	20.335	19.706	19.750	19.910
	35.098	34.759	34.634	31.117	27.286	24.096	20.320	19.712	19.762	19.910
	35.106	34.756	34.646	31.111	27.313	24.087	20.333	19.728	19.745	19.899
	35.112	34.764	34.646	31.117	27.293	24.097	20.324	19.716	19.769	19.888
	35.095	34.767	34.631	31.117	27.293	24.094	20.327	19.716	19.769	19.917
	35.106	34.759	34.640	31.132	27.296	24.103	20.321	19.722	19.771	19.896
	35.127	34.764	34.646	31.129	27.305	24.087	20.333	19.728	19.754	19.905
	35.109	34.764	34.646	31.123	27.305	24.090	20.315	19.728	19.760	19.891
	35.121	34.759	34.634	31.120	27.305	24.081	20.327	19.710	19.760	19.902
	35.112	34.753	34.643	31.111	27.293	24.090	20.327	19.719	19.763	19.905
	35.115	34.764	34.637	31.120	27.296	24.075	20.321	19.722	19.763	19.899
	35.109	34.770	34.634	31.135	27.290	24.087	20.324	19.730	19.771	19.899
	35.130	34.772	34.643	31.129	27.293	24.103	20.324	19.719	19.757	19.896
	35.115	34.772	34.640	31.123	27.299	24.105	20.324	19.728	19.757	19.899
	35.115	34.767	34.646	31.123	27.297	24.091	20.322	19.723	19.767	19.909
	35.106	34.764	34.631	31.114	27.294	24.094	20.319	19.714	19.752	19.915
	35.106	34.764	34.648	31.111	27.297	24.106	20.334	19.726	19.749	19.903
	35.110	34.766	34.649	31.112	27.291	24.073	20.322	19.737	19.755	19.906
	35.115	34.778	34.634	31.111	27.294	24.091	20.322	19.734	19.758	19.915
	35.116	34.757	34.649	31.121	27.305	24.085	20.322	19.723	19.758	19.895
	35.110	34.763	34.644	31.115	27.300	24.098	20.319	19.717	19.770	19.909
	35.125	34.757	34.652	31.115	27.294	24.085	20.331	19.723	19.764	19.900
Average	35.113	34.764	34.641	31.119	27.297	24.092	20.325	19.721	19.760	19.903
Std. Dev.	0.008	0.007	0.006	0.007	0.006	0.009	0.005	0.008	0.007	0.008

Table 8 Filled Metal Wire Heat Pipe - 5 W/in^2

Power Input 5 W/in^2
Working Fluid Water

Axial Position (in)	0.1	0.25	0.4	1.5	2.5	3.5	4.5	4.875	5.25	5.625
	Temperature (°C)									
	43.219	42.647	42.480	36.988	30.994	26.084	20.670	19.788	19.720	19.862
	43.218	42.655	42.472	36.990	31.000	26.079	20.682	19.773	19.723	19.839
	43.215	42.649	42.497	36.977	30.997	26.093	20.670	19.785	19.717	19.871
	43.233	42.646	42.484	36.979	30.986	26.108	20.670	19.794	19.720	19.854
	43.226	42.654	42.490	36.981	30.988	26.096	20.679	19.785	19.732	19.862
	43.222	42.656	42.489	36.988	31.000	26.099	20.676	19.782	19.732	19.859
	43.225	42.659	42.492	36.980	30.994	26.111	20.685	19.785	19.729	19.865
	43.225	42.662	42.479	36.980	31.005	26.090	20.679	19.782	19.732	19.856
	43.241	42.659	42.486	36.988	30.983	26.090	20.688	19.776	19.729	19.856
	43.225	42.665	42.480	36.991	30.983	26.108	20.673	19.782	19.726	19.865
	43.235	42.650	42.479	36.983	30.994	26.105	20.670	19.768	19.732	19.859
	43.221	42.652	42.479	36.984	30.994	26.102	20.682	19.776	19.735	19.859
	43.231	42.664	42.500	36.993	30.991	26.096	20.673	19.791	19.714	19.865
	43.231	42.666	42.479	36.977	31.007	26.094	20.686	19.795	19.733	19.863
	43.246	42.661	42.491	36.979	30.997	26.099	20.670	19.776	19.726	19.865
	43.231	42.661	42.491	36.971	30.995	26.097	20.688	19.789	19.718	19.857
	43.247	42.659	42.483	36.985	30.981	26.103	20.686	19.760	19.745	19.863
	43.234	42.652	42.491	36.984	30.992	26.097	20.686	19.786	19.722	19.876
	43.234	42.664	42.482	36.984	30.998	26.094	20.680	19.795	19.722	19.866
	43.227	42.658	42.477	36.979	30.995	26.100	20.671	19.774	19.733	19.866
	43.221	42.658	42.485	36.974	31.008	26.087	20.678	19.781	19.743	19.864
	43.218	42.649	42.485	36.993	31.005	26.098	20.681	19.775	19.737	19.864
	43.229	42.661	42.488	36.977	31.005	26.095	20.675	19.787	19.731	19.861
	43.243	42.669	42.482	36.987	30.995	26.109	20.683	19.783	19.736	19.873
	43.224	42.664	42.488	36.990	30.982	26.098	20.689	19.784	19.734	19.867
	43.230	42.663	42.505	36.984	30.995	26.089	20.688	19.795	19.733	19.863
	43.236	42.663	42.496	36.986	31.008	26.101	20.678	19.793	19.743	19.883
	43.217	42.668	42.484	36.979	31.008	26.101	20.678	19.796	19.731	19.870
Average	43.229	42.659	42.486	36.983	30.996	26.097	20.679	19.784	19.730	19.864
Std. Dev.	0.009	0.006	0.008	0.006	0.008	0.007	0.006	0.009	0.008	0.008

Table 9 Filled Metal Wire Heat Pipe - 7 W/in^2

Power Input 7 W/in^2
Working Fluid Water

Axial Position (in)	0.1	0.25	0.4	1.5	2.5	3.5	4.5	4.875	5.25	5.625
	Temperature (°C)									
	51.148	50.296	50.042	42.428	34.436	27.921	21.012	19.830	19.738	19.872
	51.143	50.291	50.022	42.456	34.445	27.924	21.006	19.845	19.744	19.875
	51.132	50.302	50.014	42.438	34.439	27.924	21.000	19.848	19.753	19.875
	51.145	50.292	50.013	42.435	34.456	27.915	21.006	19.854	19.741	19.869
	51.149	50.284	50.019	42.440	34.448	27.933	21.000	19.851	19.750	19.863
	51.155	50.290	50.005	42.460	34.430	27.921	21.012	19.842	19.735	19.869
	51.130	50.294	50.015	42.439	34.451	27.910	21.009	19.845	19.741	19.881
	51.141	50.300	50.026	42.432	34.448	27.924	21.009	19.845	19.741	19.872
	51.141	50.286	50.015	42.429	34.442	27.930	21.000	19.857	19.738	19.881
	51.134	50.288	50.022	42.444	34.430	27.924	21.003	19.842	19.747	19.875
	51.150	50.291	50.030	42.444	34.445	27.933	21.003	19.857	19.744	19.881
	51.143	50.296	50.017	42.437	34.436	27.921	21.000	19.857	19.735	19.866
	51.139	50.292	50.021	42.452	34.460	27.911	21.007	19.870	19.745	19.870
	51.145	50.290	50.024	42.430	34.454	27.931	21.004	19.852	19.745	19.861
	51.142	50.287	50.021	42.458	34.449	27.922	21.004	19.846	19.745	19.867
	51.148	50.297	50.023	42.454	34.449	27.922	21.013	19.846	19.739	19.867
	51.148	50.292	50.012	42.432	34.449	27.928	21.007	19.849	19.745	19.870
	51.137	50.293	50.020	42.437	34.440	27.937	21.004	19.858	19.730	19.873
	51.148	50.302	50.017	42.450	34.454	27.916	20.998	19.840	19.751	19.870
	51.140	50.285	50.022	42.438	34.443	27.925	21.004	19.852	19.730	19.873
	51.139	50.281	50.021	42.435	34.443	27.931	21.010	19.840	19.736	19.873
	51.145	50.298	50.008	42.438	34.446	27.925	21.007	19.864	19.748	19.876
	51.146	50.295	50.013	42.435	34.452	27.922	20.998	19.846	19.745	19.861
	51.138	50.289	50.028	42.448	34.437	27.931	20.994	19.852	19.739	19.864
	51.148	50.297	50.021	42.448	34.440	27.919	21.013	19.861	19.745	19.864
	51.135	50.292	50.018	42.435	34.452	27.928	21.007	19.852	19.748	19.861
	51.146	50.297	50.031	42.451	34.449	27.922	21.004	19.849	19.736	19.867
	51.140	50.293	50.030	42.425	34.446	27.908	21.010	19.846	19.751	19.876
	51.146	50.296	50.020	42.441	34.449	27.934	21.027	19.834	19.757	19.867
	51.140	50.313	50.017	42.456	34.446	27.931	20.985	19.849	19.739	19.867
	51.131	50.301	50.027	42.440	34.431	27.913	21.004	19.846	19.742	19.870
Average	51.142	50.294	50.020	42.441	34.445	27.924	21.005	19.849	19.743	19.870
Std. Dev.	0.006	0.006	0.008	0.010	0.008	0.007	0.007	0.008	0.006	0.006

Table 10 Filled Metal Wire Heat Pipe - 9 W/in^2

Power Input 9 W/in^2
Working Fluid Water

Axial Position (in)	0.1	0.25	0.4	1.5	2.5	3.5	4.5	4.875	5.25	5.625
	Temperature (°C)									
	59.110	57.990	57.637	48.158	37.994	29.842	21.348	19.914	19.784	19.905
	59.104	57.993	57.642	48.142	37.991	29.848	21.336	19.905	19.793	19.891
	59.093	58.000	57.630	48.146	38.002	29.854	21.336	19.905	19.787	19.902
	59.093	58.000	57.638	48.138	37.993	29.838	21.341	19.910	19.795	19.898
	59.099	58.003	57.638	48.138	38.001	29.833	21.338	19.904	19.777	19.896
	59.096	58.000	57.636	48.133	38.009	29.853	21.341	19.928	19.792	19.896
	59.112	58.017	57.633	48.144	38.012	29.844	21.341	19.907	19.792	19.907
	59.102	58.012	57.644	48.138	38.001	29.833	21.350	19.919	19.789	19.901
	59.104	57.986	57.624	48.130	38.021	29.847	21.338	19.907	19.783	19.896
	59.099	57.989	57.633	48.144	37.999	29.844	21.347	19.919	19.789	19.896
	59.102	58.020	57.636	48.149	37.999	29.838	21.344	19.910	19.783	19.910
	59.104	57.998	57.644	48.152	38.012	29.841	21.347	19.907	19.783	19.896
	59.104	58.009	57.633	48.154	38.001	29.841	21.347	19.916	19.792	19.907
	59.108	58.011	57.635	48.156	37.993	29.838	21.341	19.904	19.789	19.898
	59.101	58.005	57.626	48.143	38.004	29.838	21.361	19.904	19.801	19.898
	59.092	58.002	57.635	48.146	38.009	29.847	21.350	19.916	19.792	19.893
	59.108	57.994	57.643	48.146	38.001	29.844	21.350	19.919	19.792	19.904
	59.084	57.988	57.629	48.140	37.993	29.838	21.364	19.910	19.798	19.901
	59.104	58.000	57.630	48.141	38.004	29.841	21.353	19.922	19.786	19.901
	59.102	57.992	57.638	48.138	37.990	29.835	21.347	19.904	19.792	19.890
	59.104	58.006	57.636	48.133	38.004	29.838	21.353	19.916	19.792	19.890
	59.093	58.006	57.619	48.141	38.012	29.844	21.341	19.910	19.780	19.904
	59.090	58.003	57.624	48.138	38.007	29.838	21.347	19.907	19.783	19.901
	59.098	57.991	57.638	48.148	38.012	29.833	21.361	19.922	19.795	19.901
	59.104	58.002	57.632	48.151	37.999	29.853	21.347	19.916	19.798	19.913
	59.092	58.002	57.635	48.146	37.996	29.833	21.341	19.913	19.798	19.901
	59.095	58.008	57.635	48.148	38.015	29.853	21.350	19.913	19.786	19.910
	59.098	57.988	57.648	48.138	38.004	29.844	21.353	19.922	19.789	19.896
	59.085	58.004	57.637	48.136	38.007	29.825	21.350	19.932	19.792	19.910
Average	59.099	58.001	57.635	48.143	38.003	29.841	21.347	19.913	19.790	19.900
Std. Dev.	0.007	0.009	0.006	0.007	0.008	0.007	0.007	0.007	0.006	0.006

Table 11 Unfilled LHP Plate - 1W/in^2

Power Input 1 W/in^2
Working Fluid N/A

Axial Position (in)	0.3	0.45	0.6	1.225	1.85	2.475	3.1	3.35	3.6	3.85
	Temperature (°C)									
	22.116	22.036	21.978	21.639	21.164	21.024	20.408	20.298	20.586	20.408
	22.123	22.045	21.989	21.647	21.179	21.015	20.385	20.289	20.583	20.426
	22.149	22:033	21.972	21.647	21.188	21.015	20.369	20.301	20.586	20.420
	22.124	22.034	21.976	21.637	21.182	20.991	20.391	20.298	20.577	20.399
	22.121	22.038	21.970	21.651	21.176	21.021	20.396	20.295	20.560	20.417
	22.133	22.044	21.981	21.640	21.179	21.012	20.394	20.289	20.565	20.420
	22.118	22.034	21.967	21.651	21.176	21.009	20.385	20.298	20.568	20.423
	22.121	22.022	21.973	21.646	21.171	21.010	20.395	20.299	20.563	20.424
	22.133	22.028	21.981	21.643	21.185	21.012	20.385	20.286	20.580	20.402
	22.133	22.034	21.979	21.646	21.180	21.019	20.379	20.278	20.578	20.412
	22.137	22.029	21.977	21.649	21.180	21.004	20.389	20.275	20.566	20.403
	22.119	22.038	21.979	21.644	21.177	21.013	20.373	20.284	20.575	20.409
	22.128	22.038	21.974	21.635	21.177	21.019	20.395	20.290	20.578	20.400
	22.140	22.029	21.979	21.644	21.168	21.001	20.389	20.287	20.575	20.424
	22.102	22.036	21.980	21.645	21.174	21.004	20.395	20.290	20.569	20.397
	22.129	22.030	21.980	21.642	21.168	21.019	20.386	20.278	20.575	20.406
	22.132	22.036	21.983	21.647	21.194	21.005	20.404	20.285	20.582	20.410
	22.127	22.038	21.973	21.648	21.175	21.014	20.387	20.279	20.573	20.413
	22.145	22.028	21.984	21.651	21.172	21.005	20.374	20.294	20.573	20.422
	22.103	22.025	21.984	21.651	21.191	21.011	20.393	20.288	20.582	20.407
	22.133	22.022	21.976	21.637	21.181	21.005	20.398	20.297	20.573	20.416
	22.130	22.047	21.976	21.664	21.175	21.017	20.384	20.288	20.567	20.401
	22.127	22.047	21.981	21.651	21.188	21.003	20.382	20.298	20.586	20.429
	22.128	22.051	21.977	21.649	21.176	21.003	20.396	20.283	20.577	20.414
	22.122	22.041	21.974	21.649	21.173	21.003	20.378	20.283	20.574	20.414
	22.134	22.045	21.977	21.646	21.179	21.009	20.396	20.283	20.577	20.420
	22.109	22.041	21.982	21.655	21.182	21.003	20.396	20.286	20.580	20.420
	22.135	22.033	21.980	21.647	21.173	21.012	20.382	20.292	20.574	20.402
	22.119	22.021	21.986	21.656	21.167	21.021	20.382	20.311	20.565	20.426
	22.127	22.038	21.967	21.651	21.191	21.009	20.382	20.274	20.571	20.435
	22.136	22.038	21.979	21.643	21.182	21.012	20.399	20.298	20.574	20.411
Average	22.127	22.036	21.978	21.647	21.178	21.010	20.389	20.290	20.575	20.414
Std. Dev.	0.011	0.008	0.005	0.006	0.007	0.007	0.009	0.008	0.007	0.010

Table 12 Unfilled LHP Plate - 3W/in^2

Power Input 3 W/in^2
Working Fluid N/A

Axial Position (in)	0.3	0.45	0.6	1.225	1.85	2.475	3.1	3.35	3.6	3.85
	Temperature (°C)									
	24.426	24.490	24.360	23.556	22.761	22.205	21.193	20.965	21.054	20.843
	24.440	24.500	24.366	23.564	22.791	22.193	21.208	20.965	21.048	20.834
	24.452	24.503	24.375	23.562	22.772	22.198	21.201	20.964	21.062	20.821
	24.432	24.503	24.354	23.567	22.766	22.201	21.181	20.955	21.056	20.830
	24.433	24.513	24.358	23.557	22.766	22.189	21.192	20.967	21.038	20.833
	24.424	24.510	24.355	23.554	22.769	22.189	21.198	20.973	21.059	20.833
	24.433	24.498	24.373	23.551	22.766	22.182	21.201	20.970	21.044	20.824
	24.438	24.498	24.367	23.557	22.771	22.188	21.188	20.975	21.049	20.812
	24.437	24.502	24.359	23.555	22.768	22.200	21.197	20.975	21.031	20.835
	24.422	24.499	24.362	23.566	22.765	22.188	21.186	20.963	21.052	20.829
	24.434	24.511	24.354	23.563	22.751	22.197	21.212	20.960	21.046	20.826
	24.429	24.503	24.369	23.556	22.768	22.206	21.194	20.963	21.046	20.848
	24.449	24.512	24.378	23.564	22.758	22.193	21.190	20.965	21.054	20.831
	24.438	24.513	24.370	23.551	22.788	22.196	21.193	20.968	21.051	20.843
	24.433	24.504	24.367	23.575	22.767	22.205	21.193	20.979	21.057	20.828
	24.445	24.490	24.368	23.566	22.779	22.199	21.199	20.962	21.060	20.834
	24.448	24.511	24.365	23.561	22.767	22.181	21.188	20.985	21.051	20.837
	24.434	24.508	24.359	23.569	22.758	22.199	21.199	20.968	21.054	20.828
	24.445	24.502	24.374	23.572	22.763	22.189	21.198	20.973	21.056	20.833
	24.452	24.497	24.375	23.547	22.775	22.216	21.192	20.964	21.056	20.833
	24.438	24.509	24.366	23.559	22.757	22.207	21.204	20.961	21.053	20.830
Average	24.437	24.504	24.366	23.561	22.768	22.196	21.196	20.967	21.051	20.832
Std. Dev.	0.009	0.007	0.007	0.008	0.009	0.009	0.007	0.007	0.007	0.008

Table 13 Unfilled LHP Plate - 5W/in^2

Power Input 5 W/in^2
Working Fluid N/A

Axial Position (in)	0.3	0.45	0.6	1.225	1.85	2.475	3.1	3.35	3.6	3.85
	Temperature (°C)									
	26.721	26.924	26.697	25.422	24.295	23.298	21.936	21.577	21.574	21.292
	26.712	26.921	26.697	25.410	24.289	23.310	21.941	21.556	21.559	21.292
	26.719	26.922	26.695	25.420	24.307	23.293	21.930	21.568	21.562	21.286
	26.716	26.928	26.689	25.432	24.294	23.294	21.941	21.573	21.573	21.297
	26.730	26.922	26.689	25.414	24.276	23.300	21.941	21.570	21.562	21.288
	26.704	26.913	26.692	25.429	24.285	23.292	21.938	21.567	21.559	21.279
	26.713	26.910	26.695	25.402	24.285	23.297	21.932	21.555	21.564	21.297
	26.725	26.922	26.704	25.423	24.291	23.303	21.917	21.576	21.546	21.288
	26.714	26.932	26.685	25.421	24.280	23.296	21.942	21.548	21.569	21.305
	26.714	26.920	26.690	25.415	24.287	23.296	21.934	21.554	21.565	21.293
	26.720	26.911	26.696	25.424	24.284	23.287	21.939	21.569	21.551	21.299
	26.717	26.929	26.696	25.421	24.280	23.302	21.928	21.575	21.557	21.296
	26.724	26.912	26.700	25.413	24.284	23.299	21.939	21.563	21.572	21.278
	26.727	26.912	26.697	25.422	24.280	23.299	21.937	21.560	21.563	21.290
	26.718	26.924	26.695	25.425	24.277	23.286	21.938	21.559	21.559	21.298
	26.730	26.913	26.707	25.426	24.281	23.293	21.938	21.566	21.575	21.302
	26.725	26.931	26.704	25.435	24.280	23.293	21.927	21.547	21.568	21.298
	26.730	26.934	26.695	25.423	24.289	23.298	21.927	21.568	21.577	21.295
	26.733	26.925	26.710	25.414	24.292	23.298	21.933	21.571	21.565	21.292
	26.736	26.925	26.707	25.443	24.277	23.307	21.938	21.571	21.559	21.289
	26.736	26.922	26.701	25.423	24.295	23.293	21.924	21.580	21.568	21.307
	26.714	26.929	26.711	25.427	24.277	23.301	21.966	21.562	21.550	21.289
	26.714	26.938	26.699	25.436	24.298	23.293	21.933	21.577	21.562	21.286
	26.729	26.920	26.714	25.433	24.283	23.307	21.948	21.571	21.568	21.292
	26.723	26.917	26.717	25.430	24.276	23.297	21.929	21.564	21.573	21.297
	26.731	26.932	26.696	25.438	24.279	23.309	21.935	21.559	21.567	21.300
	26.720	26.914	26.699	25.447	24.297	23.286	21.929	21.570	21.582	21.291
Average	26.722	26.922	26.699	25.425	24.286	23.297	21.936	21.566	21.565	21.293
Std. Dev.	0.008	0.008	0.008	0.010	0.008	0.007	0.009	0.009	0.009	0.007

Table 14 Unfilled LHP Plate - 7W/in²

Power Input 7 W/in²
Working Fluid N/A

Axial Position (in)	0.3	0.45	0.6	1.225	1.85	2.475	3.1	3.35	3.6	3.85
	Temperature (°C)									
	29.126	29.462	29.129	27.366	25.857	24.474	22.726	22.221	22.111	21.781
	29.120	29.456	29.120	27.360	25.848	24.465	22.723	22.212	22.117	21.787
	29.120	29.441	29.129	27.349	25.863	24.474	22.707	22.218	22.120	21.784
	29.135	29.441	29.138	27.360	25.855	24.482	22.728	22.208	22.128	21.774
	29.123	29.456	29.149	27.363	25.841	24.464	22.728	22.217	22.112	21.789
	29.117	29.456	29.135	27.366	25.844	24.476	22.728	22.208	22.119	21.792
	29.111	29.444	29.144	27.372	25.841	24.473	22.728	22.205	22.115	21.777
	29.117	29.444	29.138	27.363	25.841	24.476	22.718	22.205	22.122	21.774
	29.129	29.447	29.129	27.369	25.847	24.467	22.718	22.211	22.109	21.792
	29.100	29.450	29.129	27.354	25.847	24.482	22.728	22.217	22.119	21.780
	29.110	29.436	29.119	27.380	25.837	24.466	22.711	22.216	22.108	21.791
	29.128	29.427	29.113	27.359	25.843	24.481	22.727	22.216	22.127	21.788
	29.119	29.449	29.134	27.354	25.849	24.472	22.727	22.216	22.127	21.773
	29.126	29.450	29.129	27.357	25.837	24.484	22.717	22.210	22.108	21.773
	29.116	29.446	29.140	27.365	25.832	24.487	22.708	22.207	22.103	21.788
	29.119	29.449	29.128	27.374	25.851	24.474	22.717	22.218	22.120	21.781
	29.132	29.436	29.126	27.369	25.836	24.468	22.704	22.206	22.135	21.778
Average	29.121	29.447	29.131	27.364	25.845	24.474	22.720	22.212	22.118	21.783
Std. Dev.	0.009	0.009	0.009	0.008	0.008	0.007	0.008	0.005	0.008	0.007

Table 15 Unfilled LHP Plate - 9W/in^2

Power Input 9 W/in^2
Working Fluid N/A

Axial Position (in)	0.3	0.45	0.6	1.225	1.85	2.475	3.1	3.35	3.6	3.85
	Temperature (°C)									
	31.326	31.825	31.388	29.132	27.283	25.484	23.424	22.757	22.649	22.306
	31.341	31.813	31.385	29.132	27.271	25.478	23.424	22.766	22.670	22.303
	31.332	31.813	31.405	29.126	27.277	25.493	23.430	22.760	22.658	22.309
	31.329	31.831	31.396	29.129	27.304	25.488	23.446	22.767	22.671	22.300
	31.329	31.816	31.396	29.123	27.290	25.494	23.428	22.767	22.674	22.300
	31.334	31.835	31.392	29.121	27.290	25.500	23.449	22.757	22.677	22.310
	31.334	31.826	31.409	29.121	27.281	25.485	23.422	22.761	22.659	22.300
	31.348	31.829	31.392	29.139	27.284	25.497	23.443	22.767	22.659	22.304
	31.336	31.826	31.397	29.139	27.288	25.495	23.432	22.773	22.669	22.307
	31.337	31.824	31.375	29.131	27.285	25.486	23.432	22.749	22.654	22.311
	31.340	31.801	31.401	29.137	27.285	25.477	23.438	22.773	22.672	22.301
	31.334	31.804	31.401	29.128	27.282	25.483	23.440	22.749	22.672	22.301
	31.341	31.816	31.396	29.144	27.296	25.495	23.432	22.749	22.663	22.292
	31.335	31.822	31.396	29.141	27.277	25.490	23.421	22.766	22.661	22.309
	31.341	31.828	31.388	29.129	27.286	25.481	23.433	22.763	22.670	22.296
	31.339	31.806	31.406	29.133	27.289	25.496	23.427	22.774	22.661	22.306
	31.336	31.809	31.389	29.130	27.289	25.484	23.427	22.738	22.661	22.303
	31.339	31.817	31.397	29.136	27.287	25.482	23.425	22.751	22.647	22.291
	31.328	31.827	31.401	29.128	27.293	25.497	23.425	22.761	22.653	22.297
	31.337	31.818	31.398	29.119	27.287	25.476	23.410	22.757	22.662	22.291
	31.329	31.816	31.396	29.132	27.299	25.488	23.431	22.761	22.645	22.291
	31.350	31.811	31.394	29.138	27.273	25.483	23.429	22.765	22.663	22.304
	31.338	31.825	31.391	29.129	27.282	25.489	23.426	22.768	22.657	22.289
	31.330	31.820	31.395	29.145	27.282	25.489	23.426	22.765	22.666	22.295
	31.345	31.817	31.400	29.130	27.288	25.477	23.438	22.755	22.660	22.311
	31.340	31.821	31.398	29.137	27.285	25.489	23.440	22.768	22.654	22.295
	31.331	31.818	31.393	29.119	27.274	25.493	23.430	22.760	22.661	22.300
	31.352	31.813	31.398	29.131	27.283	25.496	23.433	22.763	22.658	22.314
Average	31.337	31.819	31.396	29.131	27.285	25.488	23.431	22.761	22.662	22.301
Std. Dev.	0.006	0.008	0.007	0.007	0.007	0.007	0.008	0.008	0.008	0.007

Table 16 Unfilled LHP Plate - 30W/in²

Power Input 30 W/in²
Working Fluid N/A

Axial Position (in)	0.3	0.45	0.6	1.225	1.85	2.475	3.1	3.35	3.6	3.85
	Temperature (°C)									
	58.043	59.650	58.309	51.112	45.773	39.762	34.022	31.874	30.566	29.528
	58.032	59.640	58.339	51.123	45.767	39.757	34.020	31.868	30.563	29.520
	58.041	59.640	58.326	51.119	45.753	39.762	34.020	31.871	30.555	29.525
	58.041	59.643	58.326	51.121	45.756	39.755	34.031	31.865	30.552	29.511
	58.038	59.653	58.334	51.121	45.750	39.749	34.022	31.868	30.561	29.528
	58.051	59.651	58.332	51.111	45.756	39.762	34.017	31.868	30.575	29.531
	58.042	59.644	58.318	51.137	45.763	39.766	34.032	31.872	30.562	29.541
	58.048	59.644	58.327	51.117	45.765	39.758	34.029	31.872	30.547	29.521
	58.040	59.658	58.314	51.118	45.760	39.753	34.032	31.878	30.553	29.532
	58.054	59.655	58.322	51.118	45.749	39.741	34.032	31.875	30.564	29.519
	58.046	59.642	58.331	51.132	45.765	39.758	34.026	31.863	30.550	29.529
	58.050	59.659	58.334	51.124	45.774	39.756	34.032	31.863	30.570	29.513
	58.050	59.643	58.334	51.121	45.768	39.750	34.032	31.878	30.567	29.513
	58.053	59.659	58.340	51.121	45.763	39.766	34.029	31.866	30.567	29.519
	58.048	59.665	58.332	51.128	45.757	39.764	34.023	31.869	30.567	29.510
	58.051	59.646	58.321	51.137	45.752	39.761	34.026	31.872	30.559	29.526
	58.067	59.646	58.330	51.128	45.768	39.769	34.015	31.884	30.556	29.521
	58.051	59.649	58.327	51.131	45.765	39.758	34.023	31.869	30.567	29.523
	58.065	59.655	58.342	51.126	45.763	39.761	34.035	31.875	30.547	29.532
	58.037	59.661	58.325	51.135	45.775	39.751	34.039	31.873	30.565	29.521
	58.049	59.669	58.325	51.126	45.777	39.776	34.036	31.873	30.554	29.521
	58.058	59.670	58.334	51.124	45.769	39.767	34.024	31.873	30.568	29.521
	58.053	59.662	58.334	51.136	45.752	39.759	34.042	31.873	30.565	29.530
	58.058	59.664	58.332	51.127	45.772	39.754	34.021	31.870	30.568	29.524
	58.055	59.653	58.329	51.133	45.752	39.770	34.033	31.861	30.563	29.513
	58.069	59.662	58.335	51.120	45.780	39.764	34.024	31.870	30.577	29.516
	58.067	59.654	58.341	51.139	45.766	39.767	34.042	31.873	30.554	29.521
	58.059	59.662	58.330	51.137	45.758	39.764	34.027	31.867	30.563	29.536
Average	58.051	59.654	58.329	51.126	45.763	39.760	34.028	31.871	30.562	29.523
Std. Dev.	0.010	0.009	0.008	0.008	0.009	0.008	0.007	0.005	0.008	0.008

Table 17 Filled LHP Plate - 1W/in^2

Power Input 1 W/in^2
Working Fluid Acetone

Axial Position (in)	0.3	0.45	0.6	1.225	1.85	2.475	3.1	3.35	3.6	3.85
	Temperature (°C)									
	22.336	22.348	22.327	22.039	21.575	21.419	20.856	20.782	20.782	20.934
	22.332	22.361	22.320	22.038	21.586	21.413	20.862	20.795	20.773	20.925
	22.338	22.355	22.309	22.029	21.557	21.405	20.856	20.795	20.782	20.939
	22.339	22.359	22.324	22.027	21.579	21.414	20.857	20.790	20.777	20.953
	22.354	22.362	22.318	22.027	21.587	21.414	20.854	20.808	20.787	20.932
	22.359	22.362	22.327	22.042	21.587	21.417	20.864	20.796	20.766	20.947
	22.336	22.362	22.321	22.033	21.567	21.417	20.870	20.790	20.777	20.941
	22.348	22.356	22.327	22.030	21.570	21.403	20.864	20.793	20.774	20.950
	22.356	22.351	22.324	22.030	21.593	21.412	20.876	20.790	20.769	20.926
	22.345	22.362	22.313	22.033	21.590	21.414	20.849	20.780	20.780	20.941
	22.336	22.359	22.321	22.039	21.576	21.403	20.864	20.790	20.771	20.950
	22.348	22.368	22.336	22.030	21.585	21.412	20.864	20.796	20.774	20.947
	22.339	22.351	22.321	22.033	21.580	21.415	20.850	20.806	20.775	20.924
	22.324	22.362	22.324	22.039	21.580	21.412	20.858	20.800	20.775	20.945
	22.345	22.359	22.324	22.027	21.577	21.421	20.855	20.797	20.775	20.945
	22.333	22.348	22.321	22.039	21.580	21.404	20.868	20.800	20.787	20.942
	22.339	22.359	22.321	22.030	21.586	21.415	20.853	20.784	20.775	20.957
	22.348	22.365	22.324	22.019	21.591	21.421	20.865	20.797	20.778	20.933
	22.348	22.356	22.324	22.024	21.578	21.431	20.848	20.801	20.776	20.931
	22.339	22.384	22.324	22.033	21.581	21.411	20.854	20.801	20.771	20.942
Average	22.342	22.360	22.323	22.032	21.580	21.414	20.859	20.794	20.776	20.940
Std. Dev.	0.009	0.008	0.006	0.006	0.009	0.007	0.008	0.007	0.006	0.010

Table 18 Filled LHP Plate - 3W/in^2

Power Input 1 W/in^2
Working Fluid Acetone

Axial Position (in)	0.3	0.45	0.6	1.225	1.85	2.475	3.1	3.35	3.6	3.85
	Temperature (°C)									
	24.482	24.420	24.357	23.539	22.725	22.095	21.172	20.952	20.831	21.018
	24.485	24.429	24.361	23.536	22.728	22.089	21.160	20.949	20.831	21.021
	24.485	24.414	24.370	23.536	22.719	22.106	21.172	20.955	20.828	21.015
	24.482	24.423	24.357	23.527	22.728	22.109	21.163	20.965	20.825	21.032
	24.491	24.417	24.354	23.539	22.713	22.118	21.169	20.958	20.825	21.029
	24.485	24.408	24.364	23.542	22.737	22.089	21.181	20.952	20.822	21.015
	24.488	24.414	24.364	23.539	22.714	22.096	21.173	20.956	20.832	21.024
	24.482	24.417	24.354	23.557	22.723	22.110	21.179	20.947	20.826	21.033
	24.491	24.420	24.364	23.536	22.714	22.104	21.170	20.950	20.823	21.019
	24.477	24.417	24.364	23.545	22.729	22.090	21.167	20.956	20.829	21.019
	24.482	24.420	24.364	23.551	22.720	22.101	21.167	20.956	20.826	21.021
	24.488	24.417	24.364	23.542	22.714	22.093	21.170	20.956	20.835	21.007
	24.488	24.420	24.349	23.545	22.726	22.096	21.173	20.953	20.835	21.036
	24.476	24.413	24.342	23.529	22.726	22.104	21.179	20.953	20.820	21.013
	24.479	24.408	24.357	23.536	22.727	22.108	21.177	20.951	20.827	21.011
	24.491	24.420	24.357	23.536	22.730	22.091	21.180	20.948	20.813	21.014
	24.485	24.420	24.364	23.536	22.732	22.101	21.179	20.930	20.829	20.998
	24.479	24.414	24.367	23.536	22.720	22.093	21.179	20.953	20.820	21.030
	24.491	24.414	24.370	23.548	22.718	22.099	21.168	20.964	20.839	21.025
	24.485	24.414	24.364	23.533	22.724	22.099	21.165	20.961	20.836	21.041
	24.482	24.426	24.352	23.524	22.715	22.096	21.183	20.945	20.827	21.017
	24.488	24.420	24.361	23.542	22.739	22.096	21.174	20.951	20.824	21.028
	24.494	24.423	24.354	23.539	22.730	22.094	21.180	20.954	20.839	21.011
	24.497	24.417	24.361	23.545	22.724	22.108	21.162	20.967	20.842	21.020
	24.485	24.420	24.373	23.545	22.727	22.105	21.174	20.954	20.813	21.025
	24.471	24.423	24.361	23.542	22.727	22.111	21.168	20.957	20.836	21.020
	24.488	24.417	24.367	23.542	22.727	22.111	21.174	20.942	20.818	21.020
	24.485	24.414	24.357	23.539	22.718	22.114	21.177	20.954	20.824	21.031
Average	24.485	24.418	24.361	23.540	22.724	22.101	21.173	20.953	20.828	21.021
Std. Dev.	0.006	0.005	0.007	0.007	0.007	0.008	0.006	0.007	0.007	0.010

Table 19 Filled LHP Plate - 5W/in^2

Power Input 5 W/in^2
Working Fluid Acetone

Axial Position (in)	0.3	0.45	0.6	1.225	1.85	2.475	3.1	3.35	3.6	3.85
	Temperature (°C)									
	27.182	27.060	26.967	25.677	24.485	23.446	22.075	21.713	21.396	21.681
	27.173	27.063	26.955	25.647	24.479	23.455	22.078	21.722	21.410	21.687
	27.193	27.058	26.944	25.657	24.485	23.458	22.058	21.733	21.413	21.698
	27.190	27.058	26.974	25.660	24.461	23.452	22.084	21.719	21.410	21.684
	27.182	27.063	26.962	25.663	24.473	23.449	22.078	21.713	21.410	21.687
	27.185	27.066	26.971	25.663	24.471	23.444	22.076	21.708	21.414	21.688
	27.179	27.063	26.968	25.660	24.470	23.464	22.078	21.716	21.419	21.687
	27.191	27.056	26.957	25.670	24.480	23.435	22.076	21.708	21.411	21.676
	27.183	27.076	26.954	25.649	24.471	23.447	22.070	21.714	21.408	21.676
	27.180	27.056	26.951	25.644	24.471	23.438	22.067	21.717	21.420	21.682
	27.188	27.062	26.951	25.670	24.474	23.447	22.070	21.717	21.402	21.682
	27.180	27.062	26.957	25.655	24.465	23.441	22.076	21.705	21.420	21.685
	27.183	27.056	26.957	25.667	24.478	23.439	22.071	21.712	21.406	21.686
	27.188	27.062	26.957	25.667	24.465	23.447	22.079	21.705	21.414	21.682
	27.187	27.054	26.961	25.653	24.460	23.445	22.077	21.709	21.418	21.688
	27.179	27.063	26.955	25.662	24.481	23.448	22.071	21.712	21.439	21.677
	27.176	27.065	26.964	25.665	24.478	23.448	22.086	21.718	21.421	21.703
	27.184	27.068	26.961	25.665	24.475	23.448	22.080	21.715	21.418	21.686
	27.182	27.077	26.964	25.659	24.478	23.451	22.083	21.721	21.400	21.688
	27.187	27.057	26.955	25.665	24.466	23.448	22.077	21.718	21.403	21.680
	27.190	27.066	26.956	25.672	24.475	23.451	22.077	21.715	21.412	21.674
	27.185	27.069	26.968	25.666	24.460	23.451	22.071	21.721	21.412	21.688
	27.199	27.058	26.974	25.672	24.466	23.454	22.068	21.715	21.412	21.683
	27.199	27.063	26.956	25.669	24.479	23.449	22.078	21.728	21.416	21.681
	27.182	27.069	26.977	25.663	24.467	23.449	22.072	21.722	21.416	21.681
Average	27.185	27.063	26.961	25.662	24.472	23.448	22.075	21.716	21.413	21.684
Std. Dev.	0.007	0.006	0.008	0.008	0.007	0.006	0.006	0.007	0.008	0.007

Table 20 Filled LHP Plate - 7W/in²

Power Input 7 W/in²
Working Fluid Acetone

Axial Position (in)	0.3	0.45	0.6	1.225	1.85	2.475	3.1	3.35	3.6	3.85
	Temperature (°C)									
	30.103	29.932	29.796	28.024	26.458	25.040	23.248	22.791	22.209	22.568
	30.105	29.926	29.808	28.007	26.458	25.046	23.269	22.755	22.215	22.580
	30.111	29.926	29.811	28.001	26.463	25.048	23.269	22.771	22.209	22.586
	30.111	29.932	29.802	28.004	26.458	25.060	23.271	22.771	22.218	22.571
	30.117	29.923	29.802	28.004	26.452	25.068	23.266	22.768	22.215	22.560
	30.102	29.933	29.820	28.017	26.452	25.060	23.254	22.779	22.203	22.574
	30.114	29.932	29.802	28.004	26.463	25.054	23.266	22.768	22.221	22.560
	30.110	29.936	29.797	28.014	26.449	25.051	23.277	22.768	22.212	22.565
	30.115	29.936	29.809	28.020	26.455	25.054	23.274	22.771	22.197	22.568
	30.124	29.930	29.809	27.996	26.472	25.066	23.251	22.765	22.215	22.577
	30.121	29.938	29.806	28.011	26.472	25.057	23.257	22.788	22.206	22.563
	30.112	29.938	29.817	28.014	26.453	25.052	23.270	22.769	22.198	22.572
	30.124	29.936	29.809	28.008	26.465	25.046	23.275	22.769	22.210	22.575
	30.118	29.941	29.806	28.005	26.476	25.052	23.270	22.771	22.213	22.575
	30.130	29.919	29.806	28.011	26.476	25.058	23.270	22.780	22.201	22.569
	30.118	29.950	29.820	28.008	26.465	25.052	23.272	22.769	22.204	22.578
	30.121	29.927	29.809	28.022	26.456	25.049	23.264	22.763	22.204	22.569
	30.121	29.950	29.812	28.017	26.462	25.061	23.267	22.777	22.204	22.584
	30.127	29.930	29.803	28.011	26.456	25.052	23.267	22.769	22.210	22.555
	30.121	29.941	29.823	28.011	26.470	25.064	23.261	22.777	22.216	22.572
	30.115	29.941	29.809	28.020	26.462	25.055	23.258	22.763	22.195	22.572
	30.121	29.941	29.820	28.017	26.470	25.067	23.255	22.769	22.219	22.566
Average	30.117	29.934	29.809	28.011	26.462	25.055	23.265	22.771	22.209	22.571
Std. Dev.	0.007	0.008	0.008	0.007	0.008	0.007	0.008	0.008	0.007	0.008

Table 21 Filled LHP Plate - 9W/in^2

Power Input 9 W/in^2
Working Fluid Acetone

Axial Position (in)	0.3	0.45	0.6	1.225	1.85	2.475	3.1	3.35	3.6	3.85
	Temperature (°C)									
	32.821	32.572	32.424	30.131	28.186	26.387	24.215	23.576	22.844	23.262
	32.839	32.575	32.436	30.110	28.204	26.378	24.218	23.588	22.841	23.273
	32.845	32.572	32.418	30.122	28.210	26.384	24.221	23.604	22.844	23.273
	32.827	32.575	32.424	30.119	28.195	26.390	24.224	23.591	22.844	23.262
	32.821	32.590	32.427	30.134	28.210	26.378	24.212	23.594	22.853	23.268
	32.836	32.578	32.427	30.113	28.207	26.387	24.224	23.594	22.844	23.259
	32.833	32.578	32.409	30.116	28.198	26.390	24.215	23.598	22.834	23.262
	32.827	32.584	32.427	30.113	28.205	26.379	24.206	23.598	22.845	23.257
	32.833	32.590	32.421	30.099	28.208	26.388	24.228	23.583	22.835	23.251
	32.854	32.587	32.412	30.116	28.199	26.385	24.216	23.598	22.842	23.257
	32.818	32.572	32.430	30.110	28.219	26.385	24.222	23.589	22.829	23.266
	32.842	32.575	32.409	30.107	28.211	26.373	24.222	23.602	22.835	23.251
	32.836	32.581	32.427	30.137	28.199	26.385	24.213	23.589	22.845	23.269
	32.827	32.572	32.433	30.113	28.216	26.385	24.216	23.598	22.848	23.245
	32.827	32.572	32.427	30.110	28.205	26.385	24.230	23.589	22.835	23.251
	32.833	32.566	32.424	30.119	28.187	26.382	24.230	23.602	22.832	23.271
	32.818	32.587	32.421	30.125	28.199	26.382	24.219	23.592	22.845	23.269
	32.833	32.566	32.418	30.119	28.208	26.379	24.210	23.586	22.845	23.260
	32.842	32.558	32.436	30.116	28.197	26.395	24.220	23.596	22.839	23.255
	32.833	32.587	32.418	30.125	28.194	26.386	24.229	23.596	22.839	23.255
	32.827	32.578	32.433	30.113	28.212	26.386	24.231	23.596	22.830	23.255
	32.833	32.581	32.415	30.113	28.197	26.380	24.217	23.587	22.824	23.258
	32.827	32.575	32.424	30.110	28.197	26.389	24.201	23.584	22.852	23.249
	32.833	32.578	32.412	30.125	28.200	26.401	24.207	23.590	22.842	23.264
Average	32.832	32.577	32.423	30.117	28.202	26.385	24.218	23.592	22.840	23.260
Std. Dev.	0.008	0.008	0.008	0.009	0.008	0.006	0.008	0.007	0.007	0.008

Table 22 Filled LHP Plate - 30W/in²

Power Input 30 W/in²
Working Fluid Acetone

Axial Position (in)	0.3	0.45	0.6	1.225	1.85	2.475	3.1	3.35	3.6	3.85
	Temperature (°C)									
	61.997	61.028	60.652	53.175	47.582	41.486	35.394	33.429	30.654	31.741
	61.988	61.034	60.663	53.175	47.574	41.487	35.393	33.447	30.649	31.751
	61.999	61.021	60.660	53.194	47.583	41.495	35.400	33.438	30.669	31.754
	62.005	61.031	60.652	53.172	47.561	41.497	35.402	33.448	30.662	31.738
	62.005	61.025	60.652	53.169	47.583	41.484	35.398	33.447	30.661	31.742
	62.005	61.036	60.649	53.186	47.570	41.497	35.399	33.439	30.654	31.738
	62.013	61.034	60.645	53.166	47.564	41.491	35.391	33.445	30.662	31.756
	61.994	61.034	60.647	53.186	47.565	41.478	35.415	33.441	30.664	31.742
	62.002	61.034	60.658	53.178	47.590	41.475	35.400	33.444	30.652	31.754
	61.999	61.034	60.645	53.178	47.583	41.494	35.399	33.445	30.656	31.741
	62.005	61.025	60.658	53.178	47.574	41.484	35.400	33.452	30.652	31.748
	62.002	61.031	60.660	53.183	47.574	41.490	35.403	33.447	30.641	31.745
	62.010	61.022	60.669	53.186	47.593	41.481	35.409	33.438	30.655	31.754
	62.019	61.018	60.652	53.180	47.562	41.501	35.400	33.450	30.655	31.748
	62.002	61.031	60.645	53.183	47.577	41.481	35.409	33.441	30.669	31.736
	62.005	61.031	60.652	53.183	47.558	41.494	35.408	33.439	30.648	31.759
	62.016	61.034	60.655	53.188	47.582	41.500	35.411	33.445	30.651	31.747
	62.010	61.041	60.654	53.180	47.570	41.494	35.405	33.451	30.648	31.744
	61.999	61.028	60.649	53.191	47.590	41.493	35.412	33.436	30.646	31.757
	62.010	61.035	60.651	53.174	47.573	41.500	35.417	33.429	30.668	31.738
	62.007	61.038	60.648	53.185	47.574	41.490	35.400	33.450	30.667	31.742
	62.007	61.022	60.657	53.180	47.574	41.495	35.406	33.444	30.658	31.751
	62.015	61.030	60.662	53.182	47.583	41.509	35.406	33.438	30.649	31.748
	62.001	61.033	60.651	53.198	47.577	41.493	35.400	33.444	30.655	31.739
	62.007	61.041	60.657	53.190	47.571	41.481	35.400	33.450	30.664	31.760
	62.208	61.245	60.861	53.377	47.743	41.652	35.536	33.553	30.758	31.865
	62.211	61.243	60.861	53.386	47.734	41.644	35.519	33.562	30.761	31.860
	62.204	61.241	60.862	53.390	47.756	41.643	35.541	33.555	30.763	31.862
	62.207	61.244	60.852	53.381	47.751	41.652	35.527	33.553	30.770	31.854
	62.193	61.244	60.859	53.384	47.740	41.647	35.533	33.553	30.764	31.862
	62.212	61.241	60.854	53.387	47.762	41.647	35.542	33.556	30.758	31.857
Average	62.044	61.072	60.693	53.221	47.609	41.521	35.428	33.465	30.677	31.769
Std. Dev.	0.081	0.085	0.082	0.082	0.070	0.063	0.053	0.045	0.043	0.046

VITA

BRIAN CORBETT

3734 Quail Meadow Dr.
Missouri City, TX 77459

EDUCATION

Texas A&M University, College Station, TX
B. S. Mechanical Engineering

EPF, Sceaux, France
Engineering study abroad program (Summer '98)

EXPERIENCE

9/99 – 5/00 **Undergraduate Fellows Program** Texas A&M University
Student Researcher
- Research concerned with the application of micro-heat pipes for the thermal control of semiconductor devices
- Testing and modeling of a flat plate, two-phase heat transfer device to be used as a substrate for electronic components

Summer '99 **Undergraduate Summer Research Grant** Texas A&M University
Student Researcher
- Developed testing procedures intended to evaluate the tear resistant properties of polymer films using a fracture mechanics approach
- Helped create testing apparatus used to tensile test polymer films
- Experience with sponsor relationships and meeting customer needs
- Project planning and time management skills gained to complete work in 10 week research period

Summer '97 **Texas Department of Transportation** Houston, TX
Summer Intern – Engineering Technician
- Worked in laboratory to ensure the quality of locally produced materials
- Tested materials to ensure compliance with state regulations
- Monitored production operations in the field

AFFILIATIONS

American Society of Mechanical Engineers
Engineering Scholars Program
Tau Beta Pi engineering honors society