1st IHPC, Stuttgart

INTERNATIONAL HEAT PIPE CONFERENCE 1973

October 15-17, 1973
Stuttgart, Federal Republic of Germany

PREPRINTS

PROGRAM COMMITTEE:

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P.D.Dunn, UK
M.Groll, FRG
G.M.Grover, USA
A.Luikov, USSR

CONFERENCE CHAIRMAN:

M.Groll, IKE Stuttgart

Institut für Kernenergetik (IKE)
Universität Stuttgart
7 Stuttgart 80, Pfaffenwaldring 31

Verein Deutscher Ingenieure (VDI)
Fachgruppe Energietechnik
4 Düsseldorf 1, Postfach 1139

10th INTERNATIONAL HEAT PIPE CONFERENCE

September 21 - 25, 1997 • Stuttgart, Germany

PROGRAMME

Organised by

Institute for Nuclear Technology and Energy Systems (IKE)
University of Stuttgart

Research Institute for Nuclear Technology and
Energy Conversion e.V. (KE), Stuttgart

CONTENTS

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Research Institute for Nuclear Technology and Energy Conversion e.V. (KE), Stuttgart

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CONFERENCE COMMITTEES

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Local Conference Organizing Committee

(IKE, University of Stuttgart; KE e.V. Stuttgart)

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Mr. O. Brost	Mr. M. Schneider
Mr. R. Mertz	Mrs. S. Schumm
Mr. P. Pohlmann	Mr. M. Wierse

10th IHPC

The 10th Anniversary International Heat Pipe Conference is held again in Stuttgart, Germany, where this conference series started in 1973. The other previous conferences were held in Bologna, Italy (1976), Palo Alto, USA (1978), London, Great Britain (1981), Tsukuba, Japan (1984), Grenoble, France (1987), Minsk, Belarus (1990), Beijing, China (1992) and Albuquerque, USA (1995). The 11th IHPC will be held in Japan (1999 or 2000).

The 10th IHPC shall provide a forum for exchange of information and experience between scientists and engineers working in the field of heat and mass transfer and thermal engineering as related to heat pipes. This international meeting will provide an opportunity to review the state-of-the-art of heat pipe and closed two-phase heat transfer system technology.

The conference topics comprehensively comprise the world-wide state-of-the-art of heat pipe research, development, technology and commercial applications. They include:

- Fundamental research and basic thermofluiddynamic processes in heat pipes and two-phase thermosyphons, CPL's, loop heat pipes, oscillating heat pipes.
- Theoretical and experimental studies of heat pipes and closed two-phase thermosyphons, CPL's, loop heat pipes, oscillating heat pipes.
- Mathematical/numerical modelling of heat pipes.
- Electronics cooling and thermal control applications. Micro heat pipes, vapour chambers, high power electronics cooling.
- Heat recovery in HVAC and industrial applications. Solar and deicing applications.
- Aerospace applications. Space experiments, spacecraft thermal control, space power systems.
- Material problems in heat pipes. New developments in fluid, wick and envelope technology. Corrosion. Lifetests.

The 10th IHPC is organized under the auspices of the International Heat Pipe Conference Committee by the Institute for Nuclear Energy and Energy Systems (IKE), University Stuttgart and the Research Institute for Nuclear Technology and Energy Conversion e.V. (KE), Stuttgart.

An **exhibition** is provided where companies and other heat pipe manufacturers present their activities in heat pipe technology and production.

GENERAL INFORMATION

Welcome to Stuttgart

Stuttgart, the capital of Baden-Württemberg is situated in the southwest of Germany in the Neckar river valley. On the one hand the city, with approximately 560.000 residents, is well known as industrial metropolis and home of Daimler-Benz, Bosch and Porsche, but on the other hand it is also the cultural center of Baden-Württemberg. Two big theaters, the "Großes Haus" and the "Kleines Haus", a big music hall and a lot of other cultural locations show excellent performances, especially the "Stuttgarter Ballet" is known around the world. Several galleries with international reputations, e.g. the "Neue Staatsgalerie" and museums are waiting for your visit.

Guided or individual sight seeing tours will lead you to various historical buildings and monuments, e.g. the old castle or the new palace. A lot of the most interesting sights are quite near together in the city and can be reached by a pleasant foot walk.

Furthermore, on Saturday, September 27, at the end of the conference week, the second biggest fair in Germany, the "Volksfest", nearly as big and old as the Munich "Oktoberfest", starts in Stuttgart. For participants who want to stay longer in Stuttgart this will be an interesting attraction.

Shopping in Stuttgart is also very pleasant, various department stores and shops are located in the main shopping areas around the "Königstrasse". Most of the shops in these areas are open on weekdays from 09.30 to 20.00 h, on Saturday from 09.30 to 16.00 h. The business hours may change from shop to shop.

But besides all these industrial and cultural highlights Stuttgart is also an important location for science and technology with the two universities of Stuttgart and Hohenheim and a remarkable number of r&d institutions.

In general, the weather end of September can be very nice with sunny days (Indian Summer), however, a fast change to rain is possible, so a coat and an umbrella are recommended.

A cordial welcome and a pleasant stay in Stuttgart !

The Local Conference Organizing Committee

Conference Site

The conference site is at the **Training Center of Deutsche Telekom AG**, at the border of the University Campus in Stuttgart - Vaihingen very close to the S - Bahn station (see enclosed map). There is convenient transport from/to Stuttgart airport (18 min), Stuttgart railway station (10 min) and downtown Stuttgart (8 min).

The address is:

Deutsche Telekom AG
Bildungszentrum Südwest
Universitätsstrasse 34
D-70569 Stuttgart
Germany
Tel (+49) 711 - 6863 - 5082
Fax: (+49) 711 - 6863 - 5089

Arrivals and Registration

It is recommended that conference participants arrive and register on Sunday, September 21. The Conference Office will be open for registration and information at the Conference site on Sunday, September 21 from 16.00 - 19.00 h, on Monday, September 22 and Wednesday, September 24 from 08.00 - 17.00 h, on Tuesday, September 23 from 08.00 - 12.00 h and on Thursday , September 25 from 08.00 - 10.00 h.

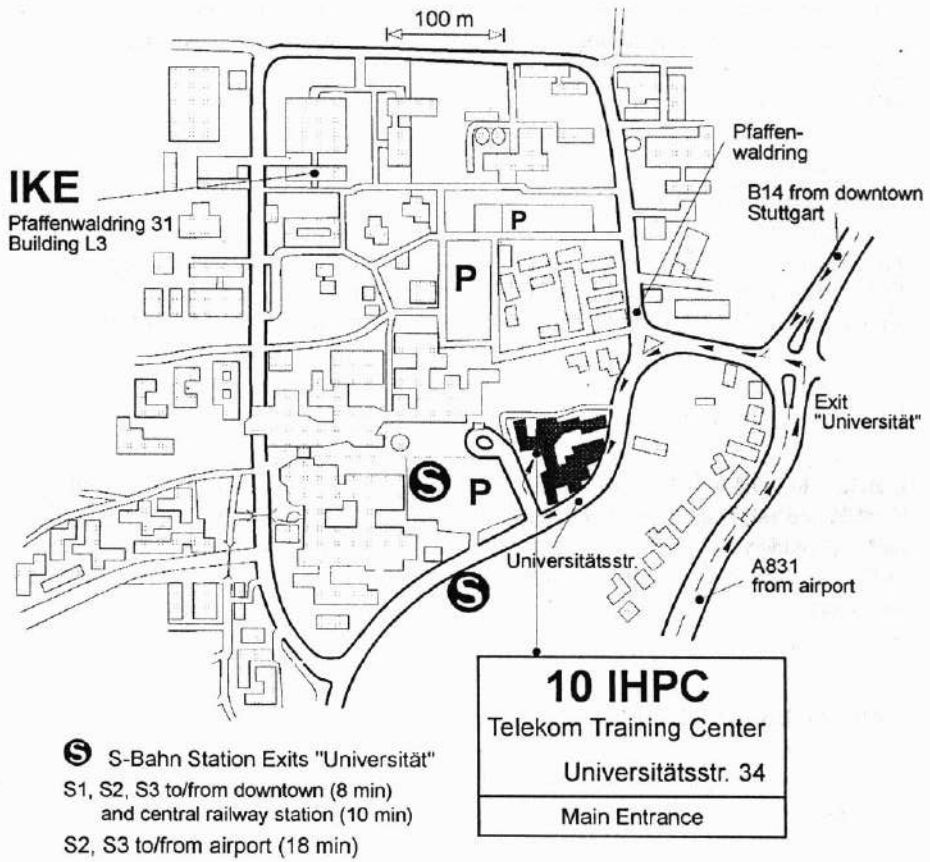
You can reach the Conference site by

- airplane directly to Stuttgart airport or via Frankfurt am Main airport.
  From Stuttgart airport with S-Bahn (suburban train) S2 direction "Schorndorf" or S3 direction "Backnang" from station "Flughafen" to station "Universität".

- train to Stuttgart Central Railway Station.
  From the main station with S-Bahn S1 direction "Herrenberg", S2 direction "Flughafen" or S3 direction "Flughafen" from station "Hauptbahnhof" to station "Universität"

From the S-Bahn station "Universität" the Conference site can be reached in a very few minutes by foot.

Map of University Campus and Conference Site



Accommodation

The Conference site (**Telekom Training Center**) is provided with a modern hotel. A number of single rooms (DM 92) and double rooms (DM 120) have been reserved for participants. The double rooms are provided with Queen size beds and are non-smoker only.
The rates are per day and room. Breakfast, service and tax included.

Conference Opening

The Conference will be inaugurated by the **Welcome Party** on Sunday, September 21, 1997, 19.00 h at the restaurant of the Conference site.
You are invited by the Organising Committee to welcome drinks and a buffet dinner.

Lunches / Dinners

Lunches and Dinners for participants and accompanying persons will be available at the Conference site restaurant. Price per lunch or dinner is DM 20 (incl. beverages). If you have not made your order on the registration form please buy the tickets at the Conference Office at least one day in advance. Special requests, e.g. vegetarian meals, can be considered.

Conference Language

The conference working language is English. No simultaneous translation will be provided.

Conference Fees

Regular participant,	registered before July 31, 1997	750 DM
	registered after July, 31, 1997	850 DM
Accompanying person*,	registered before July 31, 1997	125 DM
	registered after July 31, 1997	150 DM
Student (no proceedings, with proof of identity by ISIC)		150 DM
Extra copy of proceedings (incl. mailing)		130 DM
Exhibition element (for the whole conference duration)		
Poster board	(size 1.18 m x 1.44 m)	400 DM
Table	(size 1m x 2 m)	400 DM

The registration fee covers attendance of conference including exhibition, one copy of preprints (provided at registration), one copy of proceedings (to be mailed after the conference), coffee break and other refreshments during conference, welcome party and half day tour with dinner banquet.

* social programme only

Social Programme

Welcome Party

Conference Opening Ceremony at the Conference site restaurant. Welcome drinks and buffet dinner.
Sunday, September 21 19.00 - 22.00 h

Half-Day Tour with Conference Dinner

Bus tour to Castle Guttenberg, visit of the German Raptor Research Centre and flight demonstration with Eagles and Vultures - Visit of Bad Wimpfen, an old historic town. Conference dinner at Castle Guttenberg
Tuesday, September 23 13.00 - 23.00 h
(Departure/Arrival at Telekom Training Center; **Start is at 13:00 h on time**)
(Please have your invitation card / badge with you)

Accompanying Persons Programme

Tour 1 - Stuttgart Sightseeing Tour (minimum of 8 participants)

Guided tour through historical and modern Stuttgart - incl. small snack
Monday, September 22 14.00 - 18.00 h Price **DM 50.-**
(Departure/Arrival at Telekom Training Center)

Tour 2 - Ludwigsburg Sightseeing Tour (minimum of 8 participants)

Tour to Ludwigsburg, the former residence of the dukes and kings of Württemberg - Guided tour of the Baroque Palace, called "Swabian Versailles", incl. the porcelain factory. Visit of the famous garden "Blühendes Barock", incl. lunch.
Wednesday, September 24 10.00 - 18.00 h Price **DM 110.-**
(Departure/Arrival at Telekom Training Center)

CONFERENCE TIME SCHEDULE

Date	Hours	Scientific Programme	Exhibition	Social and Ladies Programme
Sept. 21 (Sunday)	16.00 - 19.00	Registration		
	19.00 - 22.00			Welcome Party
Sept. 22 (Monday)	08.00 - 17.00	Registration		
	08.30 - 09.00	Welcome Addresses		
	09.00 - 10.30	Invited Lectures		
	10.30 - 11.00	Coffee break		
	11.00 - 13.00	Invited Lectures		
	13.00 - 14.15	Lunch		
	14.15 - 14.55	Invited Lecture		Stuttgart Sightseeing Tour 14.00 - 18.00 h
	14.55 - 15.35	Rapp. Overviews		
	15.35 - 18.00	Poster Sessions A1, A2		
Sept. 23 (Tuesday)	08.00 - 12.00	Registration		
	08.30 - 09.10	Invited Lecture		
	09.10 - 10.10	Rapp. Overviews		
	10.10 - 12.30	Poster Sessions B, C, D		
	13.00 - 23.00			Tour to Castle Guttenberg & Bad Wimpfen; Conference Dinner

Date	Hours	Scientific Programme	Exhibition	Social and Ladies Programme
Sept. 24 (Wednesday)	08.00 - 17.00	Registration		
	08.30 - 09.10	Invited Lecture		
	09.10 - 09.50	Rapp. Overviews		
	09.50 - 13.00	Poster Sessions E, F		
	13.00 - 14.15	Lunch		
	14.15 - 14.55	Invited Lecture		Ludwigsburg Sightseeing Tour 10.00 - 18.00 h
	14.55 - 15.35	Rapp. Overviews		
	15.35 - 18.00	Poster Sessions G, H1, H2		
Sept. 25 (Thursday)	08.00 - 10.00	Registration		
	08.30 - 09.10	Invited Lecture		
	09.10 - 09.50	Rapp. Overviews		
	09.50 - 12.30	Poster Sessions H3, I, J		
	12.30 - 13.00	Final Session		
	13.00 - 14.00	Lunch		

PROGRAMME

SUNDAY, SEPTEMBER 21, 1997

19.00 - 22.00 **WELCOME PARTY (Conference Site Restaurant)**

MONDAY, SEPTEMBER 22, 1997

08.30 - 13.00 **OPENING SESSION** (Lecture Room)
Chairmen: C.A. Busse, M. Groll

08.30 - 09.00 **WELCOME ADDRESSES:**
M. Groll, Chairman, 10th IHPC & IHPC Committee
E.W. Messerschmid, Vice President, University of Stuttgart
G. Lohnert, Director, Institute for Nuclear Technology and Energy Systems (IKE)
A. Schatz, Chairman, Research Institute for Nuclear Technology and Energy Conversion e.V. (KE)

09.00 - 10.00 **INVITED LECTURES:**

09.00 - 09.20 (1) **34 Years of Modern Heat Pipe Technology, 24 Years of International Heat Pipe Conferences** - M. Groll, Institute for Nuclear Technology and Energy Systems, University of Stuttgart, Germany

09.20 - 09.50 (2) **Heat Pipes for Space Power Systems: How Modern Heat Pipe Technology Started** - P.D. Dunn, Department of Engineering, University of Reading, United Kingdom

09.50 - 10.30 (3) **Methods of Heat Transfer Enhancement** - D. Reay, David Reay & Associates, Whitley Bay, United Kingdom

10.30 - 11.00 **COFFEE BREAK**

11.00 - 13.00 **INVITED LECTURES:**

11.00 - 11.40 (4) **Thermal Control of Electronic Components by Heat Pipes and Thermosyphons. A Historical Review** - F. Polášek* and M. Zelko#, * Energy Services, Prague, Czech Republic, # MAYR Slovakia, Nové Mesto n/V., Slovakia

11.40 - 12.20 (5) **Heat Pipe Cooling Technology in Computers and Telecommunication Industries** - Y. Kojima, Fujitsu Co., Kawasaki, Japan

12.20 - 13.00 (6) **Advances in Phase Change Microscale Heat Spreders for Electronic Applications** - G. P. Peterson, Department of Mechanical Engineering, Texas A&M University, College Station, USA

13.00 - 14.15 **LUNCH**

14.15 - 18.00 **POSTER SESSIONS A1 and A2**
Chairmen/Rapporteurs: A.A.M. Delil (A1), W. Supper (A2)

14.15 - 14.55 **INVITED LECTURE:** (Lecture Room)

(7) **Theoretical Basis and Classification of Loop Heat Pipes and Capillary Pumped Loops** - Yu. F. Maidanik and Yu.G. Fershtater, Institute of Thermophysics, Ural Division of Russian Academy of Sciences, Ekaterinburg, Russia

14.55 - 15.35 **RAPPORTEURS' OVERVIEWS** (Lecture Room)

15.35 - 18.00 **POSTER SESSION A1** (Lecture Room)
Capillary Pumped Loops & Loop Heat Pipes

A1-1 **Intensification of Heat Exchange in Two-Phase Loop Condensers for Space Applications** - H.F. Smirnov*, V.N. Buz* and K.A. Goncharov#, * Odessa State Academy of Refrigeration, Odessa, Ukraine, # Lavochkin Association, Khimky, Russia

A1-2 **Spacecraft Capillary Pumped Loop Technology - Towards a Qualified Thermal Control Tool** - N. Dunbar* and W. Supper#, * MMS Space Systems Ltd., Stevenage, United Kingdom, # European Space Agency, ESA/ESTEC, The Netherlands

A1-3 **Heat Transfer Enhancement in a Loop Heat Pipe Evaporator** - Yu. F. Maidanik, Yu.G. Fershtater and S.V. Vershinin, Institute of Thermophysics, Ural Division of Russian Academy of Sciences, Ekaterinburg, Russia

A1-5 **Improved High Heat Flux Loop Heat Pipes Using Bidisperse Evaporator Wicks** - J.H. Rosenfeld, M.T. North and W.G. Anderson, DTX Inc., Lancaster, USA

A1-6 **Experimental Study on Fluctuation Phenomenon of Fluid Circulation in Two-phase Capillary Pumped Loops** - Wang Jinliang, Ma Tongze and Zhang Zhengfang, Institute of Engineering Thermophysics, Chinese Academy of Sciences, Beijing, China

A1-7 **Test Study on Unsteady Operation of Capillary Pumped Loop** - Hou Zengqi, Sun Chenhui, Zhang Jiaxun and M. Min, Institute of Spacecraft System Engineering, Chinese Academy of Space Technology, Beijing, China

A1-8 **Capillary Pumped Loop Testing at USAF Phillips Laboratory** - C. Gerhart*, D.F.Gluck#, B.J. Tomlinson# and M. Stoyanof#, *Nichols Research Corp., Albuquerque, USA, #Phillips Laboratory, Albuquerque, USA

A1-9 **A Study of Loop Heat Pipe Thermal Resistance** - V.M. Kiseev, A.A. Belyaev and N.P. Pogorelov, Ural State University, Ekaterinburg, Russia

15.35 - 18.00 **POSTER SESSION A2** (Foyer)

Capillary Pumped Loops & Loop Heat Pipes

A2-1 **Small Scale Two-Phase Loop Thermosyphons for Cooling Telecommunication MCM** - I. Pioro*, University of Ottowa, Ottawa, Canada

A2-2 **ESA Two-Phase Heat Transport System Flight Experiments: TPX I & TPX II** - A.A.M. Delil*, M. Dubois# and W. Supper+, * NLR National Aerospace Lab., Emmeloord, The Netherlands, # SABCA-ADT/RDS, Brussels, Belgium,+ European Space Agency, ESA/ESTEC, Noordwijk, The Netherlands

A2-3 **Heat Transfer Performance of Flexible Loop Heat Pipe** - T. Ogushi*, M. Murakami*, A. Yao#, H. Masumoto#, T. Okamoto# and H. Yamakage+, Mitsubishi Electric Corp., * Amayasaki, # Kamakura, + Kobe, Japan

A2-4 **Modeling of Heat Pipe Startup Transients: Frozen and Supercritical** - J. Ochterbeck and Y.H. Yan, Clemson University, Clemson, USA

A2-5 **Study on Unsteady Characteristics of Vapor - Liquid Two Phase Flow in CPL Evaporator** - Qu Wei and Liu Jifu, Harbin Institute of Technology, Harbin, China

A2-6 **Numerical Analysis of Vapor-Liquid Two-Phase Flow in CPL Evaporator** - Mou Qizheng*, Tu Chuanjing*, Mou Kai# and Hou Zhengqi+, * Zhejiang University, Hangzhou , China, # Nanjing University of Chemical Technology, Nanjing, China, + No. 501 Institute of China Aeronautics and Astronautics Corporation, China

A2-7 **Modeling of Temperature Distribution of Solar Absorbers for Space Applications** - M.B.H. Mantelli and E. Bazzo, Federal University of Santa Catarina, Florianopolis, Brazil

A2-8 **Experimental Evaluation of a Novel Microscopic Model of a Capillary Pumped Evaporator** - C. Figus*, N. Dunbar* and W. Supper#, * MMS Space Systems Ltd., Stevenage, United Kingdom, # European Space Agency,. ESA/ESTEC, Noordwijk, The Netherlands

A2-9 **Investigation of the Vapor Ejector Autonomous Refrigerator Characteristics** - K. A. Goncharov*, I.P. Chikaev*, T.N. Kachteeva*, M.A. Bukraba#, V.N. Buz# and H.F. Smirnov#, * TAIS Ltd., Khimky, Russia, # Odessa State Academy of Refrigeration, Odessa, Ukraine

A2-10 **Experimental Study of Loop Heat Pipe Behavior in the Presence of Noncondensible Gases** - W.B. Bienert*, D.A. Wolf*, M.N. Nikitkin* and K.A. Goncharov#, * Dynatherm Corp., Cockeysville, USA, # TAIS Ltd., Khimky, Russia

TUESDAY, SEPTEMBER 23, 1997

08.30 - 12.30 **POSTER SESSIONS B, C, D**

Chairmen/Rapporteurs: W.B. Bienert (B), D.A. Reay (C), T.Z. Ma (D)

08.30 - 09.10 **INVITED LECTURE:** (Lecture Room)

Evolution of Heat Pipe Technology for Satellite Application - R. Schlitt, OHB-System GmbH, Bremen, Germany

09.10 - 10.10 **RAPPORTEURS' OVERVIEWS** (Lecture Room)

10.10 - 12.30 **POSTER SESSION B** (Lecture Room)

B: Space Applications

B-1 **Space Qualification of High Capacity Grooved Heat Pipes** - M. Dubois*, B. Mullender* and W. Supper#, * SABCA-ADT/RDS, Brussels, Belgium, # European Space Agency, ESA/ESTEC, Noordwijk, The Netherlands

B-2 **High-Effective Aluminium Heat Pipes in Heat Control Systems of Honeycomb Panel Platform of the Ukrainian Space Vehicle** - B.M. Rassamakin, S.J. Badayev, S.M. Khairnasov, G.V. Tarasov, M.G. Semena and A.B. Rassamakin, Kiev Polytechnic Institute, Kiev, Ukraine

B-3 **Development and Testing of Heat Pipes Embedded in Thermal Stabilized Honeycomb Panels** - V.L. Barantzevich, Research Institute of Electromechanics, Istra, Moscow, Russia

B-4 **Design Considerations for Lightweight Space Radiators Based on Fabrication and Test Experience with a Carbon-Carbon Composite Prototype Heat Pipe** - A. Juhasz, NASA Lewis Research Center, Cleveland, USA

B-5 **Heat Pipe Collector Design for a Planar Thermionic Converter for the ISUS (Intergrated Solar Upper Stage) Space Power and Propulsion Concept** - G. Miskolczy* and L. Begg#, * Coleman Research Corporation, Waltham, USA, # General Atomics, San Diego, USA

B-6 **The Thermostabilization System for the MART-LIME Telescope** - M.D. Parfentiev, Research Institute of Electromechanics, Istra, Moscow, Russia

B-7 **Design, Manufacturing and Testing of a Flexible Heat Pipe** - A Hauser* and W. Supper#, * Dornier Satellitensysteme GmbH, Friedrichshafen, Germany, # European Space Agency, ESA/ESTEC, Noordwijk, The Netherlands

B-8 **Heat Pipes for Cryogenic Applications on Satellites** - E. Voyer*, B. Moschetti*, R. Briet#, I. Alet# and R. Evan#, * SNIAS - Aérospatiale, Cannes, France, # CNES, France

B-9 **Development and Space Flight Verification of Cryogenic Flexible Diode Heat Pipes** - D. Glaister*, P. Thomas*, M. Stoyanof#, P. Brennan+ and L. Thienel~, * The Aerospace Corporation, Albuquerque, # Air Force Phillips Laboratory, Albuquerque, + Swales & Assoc., Inc., Greenbelt, ~ Jackson & Tull, Albuquerque, USA

10.10 - 12.30 **POSTER SESSIONS C and D** (Foyer)

C: Heat Pipe Heat Exchangers

D: Heating & Cooling Applications

C-2 **Operation and Modification of a Large-Scale Heat Tube Air Preheater** - Wang Min-Yue, Tongting Nitrogenous Fertilizer Plant, Yueyuang, China

C-3 **Heat Exchanger by Using Closed Two Phase Thermosyphons with Two Cooling Fluids** - M.G. Gamal, M.S. Adel, Yuan Hai, Hu Yacai and Tu Chuanjing, Zhejiang University, Hangzhou, China

C-6 **Effect of Temperature and Velocity of Both Hot and Cold Side Fluids on the Characteristics of a Thermosyphon Economizer for Package Boilers** - P. Terdtoon*, S. Chaitep*, N. Soponpis# and M. Groll+, * Chiang Mai University, Chiang Mai, Thailand, # Ministry of Science, Technology and Environment, Bangkok, Thailand, + Institute for Nuclear Technology and Energy Systems, University of Stuttgart, Germany

C-7 **Some Applications of Heat Exchanger with Vacuum Phase Change** - Xu Zhijian*, Chen Tingkuan# and Chen Xhuanzheng#, * No.2 Refinery of Fushun Petrochemical Corp., Fushun, China, # Xian Jiaotong University, Xian, China

C-8 **Heat Pipe Radiator Analysis, Design and Manufacturing** - Z.J. Zuo*, J.E. Fale*, N.J. Gernert* and M.L. Goryca#, * Thermacore Inc., Lancaster, USA, # U.S. Army Tank Automotive Command, Warren, USA

D-1 **Variable Conductance Heat Pipe (VCHP) for Cooling Sodium-Sulfur (NaS) Batteries** - K. Kawabata, J. Niekawa and K.Watanabe, The Furukawa Electric Co., Ltd., Yokohama, Japan

D-2 **Frozen Drainage Canal Clearing System on the Basis of Solar Collector and Heat Pipes** - I. Shekriladze*, E.S. Machavariani*, D.E. Machavariani*, K.A. Goncharov# and G.B. Gogishvili#, * Georgian Technical University, Tbilisi, Georgia, # TAIS Ltd., Khimky, Russia

D-3 **Heat and Aerodynamics Reliability of Heat Pipe Heat Exchangers** - O.G. Burdo, Y.A. Kozak, S. Guyda, A.I. Knuish and S.G. Terziev, Odessa State Academy of Food Technologies, Odessa, Ukraine

D-4 **The Application of Heat Pipe Technology on Sulfric Acid Industry** - Zhuang Jun, Zhang Hong and Dong Renhe, Nanjing University of Chemical Technology, Nanjing, China

D-5 **Heat Pipe Application for Welding of Polymeric Pipelines** - V. Novikov*, V. Baturkin#, S. Zouk# and N. Mostovoy#, * Institute of Electrowelding, Kiev, Ukraine, # Kiev Polytechnic Institute, Kiev, Ukraine

D-6 **Heat Pipe Snow Melting & Deicing System By Natural Heat** - M. Mochizuki, S. Sugihara, M. Saito, T. Chiba, S. Ishi, T. Yamada, M. Takahashi and N. Adachi, Energy System Laboratory, Fujikura Ltd., Tokyo, Japan

D-7 **The Use of Two-Phase Thermosyphons in the Energy Saving Technologies** - Bayasan, A.D. Lobanov and M.D. Parfentiev, Res. Inst. of Electromechanics, Istra, Moscow Region, Russia

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13.00 - 23.00 **EXCURSION TO CASTLE GUTTENBERG AND BAD WIMPFEN CONFERENCE DINNER**
(incl. Best Poster Awards for Sessions A1, A2, B, C, D)

WEDNESDAY, SEPTEMBER 24, 1997

08.30 - 13.00 **POSTER SESSIONS E and F**
Chairmen/Rapporteurs: A. Alexandre (E), L.L. Vasiliev/R. Ponnappan (F)

08.30 - 09.10 **INVITED LECTURE:** (Lecture Room)

Cooling Requirements for Future High Performance Electronic Components - D. Agonafer, IBM Corp., Poughkeepsie, USA

09.10 - 09.50 **RAPPORTEURS' OVERVIEWS** (Lecture Room)

09.50 - 13.00 **POSTER SESSION E** (Lecture Room)

E: Electronics Cooling

E-1 **Thermal Control of IGBT Modules in Traction Drives by Pulsating Heat Pipes** - H. Akachi* and F. Polášek#, * Actronics Co., Ltd., Tokyo, Japan, # Energy Services, Praha, Czech Republic

E-2 **Transient Modelling of Heat Pipe Heat Sink for IGBT Cooling** - A. Bricard*, F. Davrieux#, S. Langlois+ and F. Ternay+, * Commissariat à l'Energie Atomique, DTP/STI/GREThi, Grenoble, France, # GEC Alsthom Transport, France, + CISI, Région Rhône-Alpes, France

E-3 **Experimental Study on the Cooling Characteristics of Heat Pipe for High Power Electronic Components** - K.S. Kim*, W.T. Kim* and K.B. Lee#, * Electronics and Telecommunications Research Institute (ETRI), Taejon, Korea, # Pusan National University, Pusan, Korea

E-4 **Investigation on Thermosyphon Cooling Equipment of High-power Thyristors in Explosion - proof Shell** - Li Chuantong and Song Zhengchang, China University of Mining & Technology, Xuzhou, China

E-6 **The Application for Personal Computer Using Heat Pipe Technology** - M. Mochizuki, K. Mashiko, K. Goto, Y. Saito, T. Nguyen, K. Eguchi, Y. Nagaki and A. Takamiya, Energy System Laboratory, Fujikura Ltd., Tokyo, Japan

E-7 **Cooling Method for Notebook PC with Heat Pipes** - Y. Kojima*, N. Yamazaki*, M. Mogi*, S. Maezawa# and K. Gi#, * Fujitsu Limited, Kawasaki-shi, Japan, # Seikei University, Tokyo, Japan

E-8 **High Performance, Spiraled Supermicro Flexible Heat Pipe for Cooling Electronic Systems** - A. Itoh and S. Itoh, Itoh R&D Laboratory Co., Ltd., Ashiya, Hyogo, Japan

E-9 **Theoretical and Experimental Investigation of Flat Plate Heat Pipe for Electronic Cooling** - Mou Kai* and Mou Qizheng#, * Nanjing University of Chemical Technology, Nanjing, China, # Zhejiang University, Hangzhou, China

E-10 **Heat Pipe Cooled Integrated Printed Circuit Boards** - C. Sarno et al., Sextant Avionique, Valence, France

09.50 - 13.00 **POSTER SESSION F** (Foyer)

F: Special Heat Pipes

F-1 **Using of Heat Pipe for Combustible Gases Calorimetry** - L.L. Vasiliev,Yu.I. Alexandrov, A.S. Zhuravlyov, F.F. Molodkin, M.A. Prohorov, V.P. Varganov and E.N. Levengagen, Luikov Heat & Mass Transfer Institute, Minsk, Republic Belarus

F-2 **Stereo-Type Heat Lane Heat Sink** - H. Akachi* and Y. Miyazaki#, * Actronics Co., Ltd., Tokyo, Japan, # Fukui University of Technology, Fukui, Japan

F-3 **Experimental Chaos in Oscillating Capillary Tube Heat Pipes** - S. Maezawa*, R. Nakajima*, K. Gi* and H. Akachi#, Seikei University, Tokyo, Japan, # Actronics Co.. Ltd., Tokyo, Japan

F-4 **Vapordynamic Thermosyphons and Spaghetti Heat Pipes for Refrigerators** - L.L. Vasiliev, A.A. Antuh, D.A. Mishkinis and L.L. Vasiliev Jr., Luikov Heat & Mass Transfer Institute, Minsk, Republic Belarus

F-5 **Two - Dimensional Analysis of the Evaporator of a Constrained Vapor Bubble** - J. Huang, M. Karthikeyan, J. Plawsky and P.C. Wayner Jr., Rensselaer Polytechnic Institute, Troy, USA

F-6 **Heat Transfer Characteristics of Micro/Miniature Inverted Sintered Evaporator** - Zhu Ning*, Zhang Zhengfang*, Wu Shanhong*, Ma Tongze* and Hou Zengqi#, * Institute of Engineering Thermophysics, Chinese Academy of Sciences, Beijing, China, # Institute of Spacecraft Engineering, Chinese Academy of Space Technology, Beijing, China

F-7 **Development of Mesh Type Micro Heat Pipe and its Thermal Evaluation** - K. Namba and H. Hashimoto, The Furukawa Electric Co. Ltd., Yokohama, Japan

F-8 **Performance Limitation of a Micro Closed Two-Phase Thermosyphon** - Chen Huanzhuo*, Ma Tongze* and M. Groll#, * Institute of Engineering Thermophysics, Chinese Academy of Sciences, Beijing, China, # Institute for Nuclear Technology and Energy Systems, University of Stuttgart, Germany

F-9 **Theoretical Investigation of Micro Heat Pipe Performance** - M.C. Zaghdoudi, V. Sartre and M. Lallemand, Institute National des Sciences Appliquées, Villeurbanne, France

F-10 **The Experimental Research of an Anti-Gravity Thermosyphon for a Heating System** - V.N. Fedorov, E.M. Bolotin, A.A. Borodkin and V.J. Sasin, Moscow Power Engineering Institute, Moscow, Russia

F-11 **Development of Downward Heat Pipe Using Principle of Heat Driven Pump** - Y. Takamura*, T. Yamamoto#, S. Matsumoto# and M. Katsuta+, * Tokyo Denki University, Tokyo, Japan, # National Institute for Resources and Environment, Tsukuba, Ibaraki, Japan, + Waseda University, Tokyo, Japan

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13.00 - 14.15 **LUNCH**

14.15 - 18.00 **POSTER SESSIONS G, H1 and H2**

Chairmen/Rapporteurs: C.A. Busse / P. Stephan (G + H1), Y. Kobayashi / M. Hall (H2)

14.15 - 14.55 **INVITED LECTURE:** (Lecture Room)

10 **Heat Transfer in the Evaporator of Closed Two-Phase Thermosyphons** - M.S. El-Genk and H.H. Saber, The University of New Mexico, Albuquerque, USA

14.55 - 15.35 **RAPPORTEURS' OVERVIEWS** (Lecture Room)

15.35 - 18.00 **POSTER SESSION G and H1** (Lecture Room)

G: Thermodynamics
H1: Heat Pipe / Thermosyphon Performance

G-1 **Development of Thermal Powered Membrane Pump by Application of Heat Pipe Principle** - K. Gi, T. Motegi and S. Maezawa, Seikei University, Tokyo, Japan

G-2 **Advancement of the Heat Pipe Turbine for Production of Electrical Power from Renewable Sources** - A. Akbarzadeh and P. Johnson, Royal Melbourne Institute of Technology, Melbourne, Australia

H1-1 **Two-Phase Flow and Condensation in Horizontal Tubes with Three-Dimensional Microfins** - Xin Ming-dao and Du Yang, Chongqing University, Chongqing, China

H1-2 **A Mathematical Model for Predicting the Length and Heat Transfer Coefficient in an Uniformly Heated Vertical Tube of Two-Phase Thermosyphon Circulation Loop** - Zou Linjiang, Gu Jinrong, East China Institute of Metallurgy, Maanshan, China

H1-4 **Pool Boiling of Water on Oxidized Enhanced Thermosyphons** - A. Bricard*, and C. Godet#, * Commissariat à l'Energie Atomique, DTP/STI/GREThi, Grenoble, France, # ATHERM, Domene, France

H1-5 **Boiling Heat Transfer Characteristics of Thin Liquid Layers in a Horizontally Flat Two-Phase Closed Thermosyphon** - I. Pioro, University of Ottowa, Ottawa, Canada

H1-6 **Heat Transfer Characteristics of Evaporation and Condensation in a Two-Phase Closed Thermosyphon** - F. Kaminaga, C. Feroz, H. Hashimoto and K. Goto, Ibaraki University, Ibaraki-ken, Japan

H1-7 **Calculation of the Heat Transfer Coefficient in Heat Pipe Evaporation Zone with Regard to Partial Capillary Structure Drying** - V.V. Maziuk and V.K. Sheleg, Belorussian Powder Metallurgy Association, Minsk, Belarus

15.30 - 18.00 **POSTER SESSION H2** (Foyer)

Heat Pipe / Thermosyphon Performance

H2-1 **Al/NH3 Heat Pipe Model with Non Uniform Heat Flux** - C. Romestant and A. Alexandre, Laboratoire d' Etudes Thermiques, ENSMA, Futuroscope, France

H2-2 **Estimation of Heat Transfer Coefficient in Axially Grooved Heat Pipes** - H.P. Cardoso* and S. Colle#, * Institute of Space Research, S.J. Dos Campos, Brazil, # Federal University of Santa Catarina, Florianopolis, Brazil

H2-3 **Experimental Investigation of the Performance of a Loop Heat Pipe Having a Flat Evaporator** - J.H. Boo, Hankuk Aviation University, Seoul, Korea

H2-4 **Limit Heat Fluxes and Heat Exchange on the Surfaces of Evaporators with Capillary Structures** - H.F. Smirnov, Odessa State Academy of Refrigeration, Odessa, Ukraine

H2-5 **Influence of Filtration of Liquid on Heat Transfer During Condensation on Surface covered with Porous Structure and in Gravity Assist Heat Pipe** - V.M. Khaustov, L. L. Vasiliev and S.V. Konev, Luikov Heat & Mass Transfer Institute, Minsk, Republic Belarus

H2-6 **Pool Boiling Heat Transfer Coefficient Correlations inside Closed Two-Phase Thermosyphons** - M. Aburghaia, A. Mohmed, Fu Rai, Zhu Hua and Tu Chuanjing, Zhejiang University, Hangzhou, China

H2-7 **Experimental Investigation of Critical Heat Fluxes in Two- Phase Closed Thermosyphons** - H. Imura, M. Sakamoto and S. Ippohshi, Kumamoto University, Kumamoto, Japan

H2-8 **Thermal Performance of Low Density Heat Transfer in Two-Phase Closed Thermosyphon** - M.A. Sayegh*, J. Danielewicz#, W. Tomczak#, * Aleppo University, Aleppo, Syria, #Techn. Univ. of Wroclaw, Wroclaw, Poland

H2-9 **Performance Limits of an Inclined Gravity-Assisted Heat Pipe** - M. Shiraishi*, A. Nakano*, P. Terdtoon# and M. Murakami+,* Ministry of International Trade and Industry, Ibaraki, Japan # Chiang Mai University, Chiang Mai, Thailand, + University of Tsukuba, Ibaraki, Japan

H2-10 **Effect of Evaporator Surface on the Maximum Heat Transfer Rate of an Inclined Two-Phase Closed Thermosyphon** - R.T. Dobson and D.G. Kröger, University of Stellenbosch, Stellenbosch, South Africa

H2-11 **Performance Envelops for Gravity Assisted Two-Phase Thermosyphons** - M.S. El-Genk and H.H. Saber, The University of New Mexico, Albuquerque, USA

H2-12 **Study of Internal Enhancing Boiling Heat Transfer Mechanism of Concentric Perforated Tube in Thermosyphon** - Yu Bin, Zhuang Jun, Sun Shimei and Zhang Hong, Nanjing University of Chemical Technology, Nanjing, China

THURSDAY, SEPTEMBER 25, 1997

08.30 - 12.30 **POSTER SESSIONS H3, I and J**

Chairmen/Rapporteurs: A. Akbarzadeh / H. Imura (H3), M.A. Merrigan (I), O. Brost (J)

08.30 - 09.10 **INVITED LECTURE:** (Lecture Room)

11 **Evaporation and Condensation on Capillary Surfaces: Achievements and Unsolved Problems** - I. Shekriladze, Georgian Technical University, Tbilisi, Republic Georgia

09.10 - 09.50 **RAPPORTEURS' OVERVIEWS** (Lecture Room)

09.50 - 12.30 **POSTER SESSION H3** (Lecture Room)

Heat Pipe / Thermosyphon Performance

H3-1 **Analysis of Heat Transfer in the Condenser Section of Naphthalene Thermosyphon at Small Inclination** - Zhang Jiancheng, Tongming Xu and Jun Yang, Nanjing University of Chemical Technology, Nanjing, China

H3-3 **A Mathematical Model Study on Heat-Exchanging Process of Separate-type Heat Pipe** - Xu Yonggui*, Qian Hongwei*, Xu Shishang*, Yin Yonding# and Chen Delong#, * East China Institute of Metallurgy, Maanshan, China, # Jiandu Energy Reutilization Equipment Plant, China

H3-5 **Heat Transfer Limits of the Separate Type Heat Pipe** - Li Juxiang, Xu Tongmin, Zhang Jiancheng, Nanjing University of Chemical Technology, Nanjing, China

H3-7 **Mathematical Modelling of Gas Controlled Heat Pipe for Communications Satellites** - A.G. Kozlov, V.I. Halimanovich, V.P. Ganzhenko, V.V. Dvirny, K.G. Smirnov-Vasiliev, A.V. Lekanov, S.P. Ermilov, G.I. Ovechkin and G.I. Panov, Institute of Applied Mechanics, Krasnoyarsk, Russia

H3-9 **Performances of Heat Pipes under High Acceleration Field** - C. Romestant and A. Alexandre, Laboratoire d' Etudes Thermiques, ENSMA, Futuroscope, France

H3-10 **High Speed Rotating Heat Pipe: Analysis and Test Results** - R. Ponnappan*, Qun He*, J. Baker#, J.G. Myers# and J.E. Leland+, * UES Inc., Dayton, USA, # University of Alabama, Birmingham, USA, + Aero Propulsion and Power Directorate, WPAFB, Dayton, USA

H3-12 **An Analytical Study of Performance Characteristics of Rotating Heat Pipes** - J. H. Jang, University of Ulsan, Ulsan, Kyungnam, South Korea

09.50 - 12.30 **POSTER SESSION I and J** (Foyer)

I: Liquid Metal Heat Pipes
J: Materials Problems / Technology

I-3 **Heat Transfer Enhancement by Bubble Removable Wick and Partial Evaporator Surface Temperature Control in a Sodium Heat Pipe** - T. Yamamoto*, M. Katsuta# and S. Matsumoto*, * National Institute for Resources and Enivronment, Tsukuba, Ibaraki, Japan, # Waseda University, Tokyo, Japan

I-4 **Heat Transfer Characteristic Change and Mass Transfer under Long-Term Operation in SUS316L / Sodium Heat Pipe** - S. Matsumoto*, T. Yamamoto* and M. Katsuta#, * National Institute for Resources and Enivronment, Tsukuba, Ibaraki, Japan, # Waseda University, Tokyo, Japan

I-5 **Hybrid Sodium Heat Pipe Receiver for Dish/Stirling Systems** - D. Laing*, M. Reusch* and O. Brost#, * Deutsche Forschungsanstalt für Luft- und Raumfahrt e.V., Stuttgart, Germany, # Forschungsinstitut für Kerntechnik und Energiewandlung e.V., Stuttgart, Germany

I-6 **Solar Heat Pipe Transient Operations for Solar Stirling Power NALSEM 500** - T. Fujihara*, T.Hoshino*, S. Ogiwara*, K. Eguchi* and Y. Nakamura#, * National Aerospace Lab., Tokyo, Japan, # Hosei University, Tokyo, Japan

I-7 **Microgravity Experiment of Three Liquid Metal Heat Pipes** - T.J. Dickinson*, Jerry Bowman*, K. Woloshun# and M. Stoyanof+, * Air Force Institute of Technology, WPAFB, Dayton, USA, # Los Alamos National Laboratory, Los Alamos, USA, + Phillips Laboratory, Kirtland AFB, Albuquerque, USA

J-1 **Choice of the Effective Corrosion Inhibitors and the Results of the Resources Tests of Steel and Aluminium Thermosyphon with Water** - B.M. Rassamakin, N.D. Gomelya and T.M. Mazina, Kiev Polytechnic Institute, Kiev, Ukraine

J-2 **Results of Life Tests on Heat Pipes used in Communications Satellites** - A.G. Kozlov, V.I. Halimanovich, V.P. Ganzhenko, V.V. Dvirny, K.G. Smirnov-Vasiliev, V.A. Abroskin, S.A. Urakov, S.P. Ermilov, O.V. Zagar, S.F. Podshivalov and G.I.Ovechkin, Institute of Applied Mechanics, Krasnoyarsk, Russia

J-4 **Experimental Study of the Outgassing from Suspension Moulding Capillary Structures** - N.P. Pogorelov and V.M. Kiseev, Ural State University, Ekaterinburg, Russia

J-5 **Spinning Sealing of the End of Heat Pipes** - Wang Xuemei, China Great Wall Industry Co., Harbin Fenhua Machine Factory, Harbin, China

J-6 **Cryogenic Heat Pipe Ageing** - S. van Oost* and B. Aalders#, SABCA-ADT/RDS, Bruxelles, Belgium, # ESTEC, Noordwijk, The Netherlands

12.30 - 13.00 **FINAL SESSION** (Lecture Room)
(incl. Best Poster Awards for Sessions E, F, G + H1, H2, H3, I + J)

13.00 - 14.15 **LUNCH**