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2009 Max Jakob Memorial Award

Presented to: **Ivan Catton, Ph.D.**

Lecture title: **Conjugate Heat Transfer within a Heterogeneous Hierarchical Structure**

August 9, 2010
10:00 a.m. – 11:00 a.m.

14th International Heat Transfer Conference (IHTC)

August 7-13, 2010
Omni Shoreham Hotel
Washington D.C.

http://www.asmeconferences.org/IHTC14/

Ivan Catton

IVAN CATTON was born in Vancouver, British Columbia, immigrating to the United States in 1943. He received his B.Sc. degree in engineering in 1959 and his Ph.D. degree in 1966 from UCLA. Under the guidance of Professor Donald K. Edwards at UCLA, he wrote his thesis on natural convection in confined regions for application to solar energy collectors. While obtaining his Ph.D. at UCLA, Professor Catton worked at Douglas Aircraft on the second stage of the Saturn, one of the earliest large hydrogen fueled rocket systems.

After completing his Ph.D., Professor Catton worked as a supervisor at Douglas Aircraft. In 1967, he returned to UCLA as an assistant professor. At the outset, he chose to be involved in environmental research and teaching. This led to courses in atmospheric dispersion and research into the use of solar energy. This line of research changed dramatically when the oil boycott occurred in 1973. Fortunately David Okrent (an eminent nuclear safety researcher) appeared on the scene and Catton shifted his interests to the application of transport phenomena (heat, mass, and momentum) to nuclear power plant safety and design issues.

Research in support of safety of nuclear power installations lasted until the mid-eighties and resulted in a number of interesting applications of his expertise. He was part of the Nuclear Regulatory Commission (NRC) Code Development Review Committee that led to fluid modeling being the basis for the large NRC computer codes now in use. He and his students were the first to obtain predictions of fluid elastic instability in nuclear power plant steam generators without resorting to empirical correlations. Early predictions of dryout of a damaged nuclear reactor core were made by Professors Catton and Vijay Dhir.

He was appointed to the top advisory committee in the field, the Advisory Committee on Reactor Safety (ACRS). The ACRS is the only congressionally mandated safety oversite committee of its type. This led to his moving away from the basic heat transfer discipline as he became involved in more system type problems and the role of phenomenological processes in risk evaluation. As a member of the ACRS he was chair of the Thermal Hydraulics Subcommittee and the Fire Safety Subcommittee. As the research opportunities in the nuclear field wound down, he again became involved with aerospace issues. He began a research effort into leading edge cooling problems such as were faced by the National Aerospace Plane (NASP). There were studies of the use of a large jet to steer the NASP and even some star wars research on how to deal with the impact of laser weapons on cooling systems for space power systems. For a brief time Professor Catton was involved in the development of non-intrusive flight instrumentation. He then ventured into the area of information processing using neural nets.

In 1985, he began his work on Volume Averaging Theory (VAT) as a basis for dealing with transport in heterogeneous hierarchical media. This work has continued and now forms the basis for optimization of heat sinks and heat exchangers.

During Professor Catton's forty year career at the University of California (1967-2010), he graduated close to 40 Ph.D. students, eight of whom are teaching. Along the way, he became a fellow of both ASME and ANS, received an ASME Best Paper Award, served as an associate editor of the *Journal of Heat Transfer* and received the Heat Transfer Memorial Award. He also published 176 papers in archival journals and 235 full papers were published in proceedings.

Citation

The Max Jakob Memorial Award is presented to Ivan Catton for extensive, sustained and pioneering contributions to a wide variety of basic and applied problems in thermal science and engineering, ranging from natural convection, flow instability, solar energy and porous media transport to nuclear reactor safety, and for outstanding service to the heat transfer community.

Yogesh Jaluria, Dept. of Mechanical and Aerospace Engineering, Rutgers University

Abstract

Optimization of heat exchangers (HE), compact heat exchangers (CHE) and micro- heat exchangers by design of their basic structure is the focus of this work. Consistent models are developed to describe transport phenomena in a porous medium that take into account the scales and other characteristics of the medium morphology. Equation sets allowing for turbulence and two-temperature or two-concentration diffusion are obtained for non-isotropic porous media with interface exchange. The equations differ from known equations and were developed using a rigorous averaging technique, hierarchical modeling methodology, and fully turbulent models with Reynolds stresses and fluxes in the space of every pore. The transport equations are shown to have additional integral and differential terms. The description of the structural morphology determines the importance of these terms and the range of application of the closure schemes. A natural way to transfer from transport equations in a porous media with integral terms to differential equations with coefficients that could be experimentally or numerically evaluated and determined is described. The relationship between CFD, experiment and closure needed for the volume averaged equations is discussed. Mathematical models for modeling momentum and heat transport based on well established averaging theorems are developed. Use of a 'porous media' length scale is shown to be very beneficial in collapsing complex data onto a single curve yielding simple heat transfer and friction factor correlations.

The general transport equations developed for a single phase fluid in a heat exchange medium have many more integral and differential terms than the homogenized or classical continuum mechanics equations. Once these terms are dealt with by closure, the resulting equation set is relatively simple and their solution is obtained using simple numerical methods quickly enough for multiple parameter optimization using Design of Experiment (DOE) or genetic algorithms. Current efforts to significantly improve the performance of a heat exchanger for electronic cooling, a two temperature problem, and of a finned tube heat exchanger, a three temperature problem, are described.

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Max Jakob, 1879 – 1955

Scientist, engineer, educator – Max Jakob belongs to that group of remarkable individuals whose talents and achievements earned German science a position of eminence in the latter part of the 19th century and the early part of the 20th century. Although his accomplishments in his native country had already given him worldwide recognition, they were followed by a second distinguished career in the United States.

Max Jakob Memorial Award

The Max Jakob Memorial Award is bestowed in recognition of eminent achievement and or distinguished service in the area of heat transfer. Made annually, without regard to society affiliation or nationality, the award consists of a bronze plaque, an honorarium, and an embossed certificate. The award was established in 1961 by the ASME Heat Transfer Division in honor of Max Jakob, a pioneer in the science of heat transmission, commemorating his outstanding contributions as a research worker, educator and author. In 1962, AICHE joined in the award, which is administered by a board of seven, three from each Society, and the past chair.

Max Jakob was born on July 20, 1879 in Ludwigshaven, Germany. After completing the gymnasium, he attended the Technische Hochschüle München where he received an Electrical Engineer degree in 1902, a Diplom-Ingenieur in Applied Physics degree in 1903, and the degree of Doktor Ingenieur in 1904. In 1910 he embarked on a 25 year career at the Physikalisch-Technische Reichsanstalt, during which he founded and directed applied thermodynamics, heat transfer, and fluid flow laboratories.

He wrote over 200 technical papers, and was a prolific source of critical reviews, articles, and discussions. When he left Germany in 1936 fleeing Nazi persecution, he had already gained great stature as a scientist-engineer.

After a one-year lecture tour sponsored by ASME, Dr. Jakob became research professor of Mechanical Engineering at Illinois Institute of Technology (IIT) and consultant in Heat Research at the Armour Research Foundation. In 1942, he founded and became the first director of IIT's Heat Transfer Laboratory.

He was active in research, teaching, consulting, and writing, and became one of America's educational and scientific leaders. His books, an elementary textbook and a two-volume treatise on heat transfer, have had a profound influence on education and research. His formal honors include an Honorary Degree of Doctor of Engineering from Purdue University in 1950, and the Worcester Reed Warner Medal of ASME in 1952.

His colleagues and his students loved and admired him for his warm personality, subtle wit, and rare humility of spirit. When he died on January 4, 1955, they had lost a great friend, and humankind had lost one of its truly outstanding members.

Max Jakob Memorial Award Board of Award (2009)

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