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Dr. Yu has 24 years of diversified engineering and teaching experience in research, design, and development in the fields of fluid dynamics, heat transfer, mechanical system dynamics and control, condition monitoring and fault diagnosis, and manufacturing engineering. His recent research activities include phase-change heat transfer, two-phase flow in small channels, nanofluid characterization, supercritical fluids, and biomedical engineering.

Education

Ph.D.	1995,	Mechanical Engineering, Zhejiang University, Hangzhou, China.
M.S.	1984,	Mechanical Engineering, Zhejiang University, Hangzhou, China.
B.S.	1982,	Mechanical Engineering, Zhejiang University, Hangzhou, China.

Professional Experience

1998-Present: From September 1998 to August 2001, Dr. Yu worked as Visiting Scholar in the Energy Technology Division of Argonne National Laboratory. In September 2001, he was promoted to Assistant Mechanical Engineer in the Energy Technology Division to continue the research work that he had been doing. Dr. Yu's research interests at Argonne National Laboratory have been focused on phase-change heat transfer, two-phase flow in small channels, nanofluid characterization, and supercritical fluids. He has worked as a main researcher on several projects funded by the U.S. Department of Energy.

Multiport Cylinder Dryers. The multiport cylinder dryer concept developed by Argonne National Laboratory is aimed at increasing the rates of paper drying. In a multiport cylinder dryer, steam flows through "ports," or longitudinally oriented passages, close to the dryer surface. This design minimizes the "rim of condensate" and offers a larger surface area for drying, thereby increasing the drying rates. It also uses forced convection, which is more effective as a heat transfer mechanism than heat conduction in the conventional dryer design. Dr. Yu's studies on this project have resulted in the discovery of several new and important facts, which demonstrate the feasibility of this novel concept. In proof-of-concept tests, he has shown that (a) the condensing heat transfer coefficient of the multiport cylinder dryer is much higher than that of conventional dryers; (b) the two-phase pressure gradient of the multiport cylinder dryer is relatively low, and is less than the maximum acceptable value for cylinder dryers; (c) because of the small size of the condensing channel and the low mass flow range of operation of the multiport cylinder dryer, the condensing heat transfer coefficient of the dryer is approximately independent of flow rate, system pressure, and quality; (d) all of the above factors ensure good uniformity of dryer wall temperature, which has been confirmed by wall-temperature measurements; and (e) the newly designed multiport cylinder dryer can potentially increase the paper drying or production rate by as much as 50% when compared with conventional dryers. These results translate into huge energy savings and waste reduction, which are of substantial

benefit, both to the pulp and paper industries and to environmental preservation. This technology is so promising for the pulp and paper industries that it won R&D 100 award in 2006.

Nucleate-Boiling Engine Cooling Systems. The nucleate-boiling cooling systems can achieve order-of-magnitude higher heat transfer rates compared with conventional, single-phase, forced-convective cooling systems, and therefore are of high potential to meet the challenges of the greater heat loads in vehicle engine cooling because of higher power engines, more air conditioning, more stringent emission requirements, and additional auxiliary equipment. They also provide the possibility of reducing the size of cooling systems to obtain a better aerodynamic profile. Through this project, Dr. Yu has discovered some important facts about water and ethylene glycol/water mixture boiling in small channels. Firstly, the critical heat flux for water boiling in small channels has a higher quality compared with large channels. This finding means that very high heat loads can be removed before the occurrence of critical heat flux and is a key advantage for engine cooling applications. Secondly, the critical-heat-flux quality in small channels decreases with decreased mass flux. This relationship is opposite to larger channel trends and is very important for engine cooling system design. Thirdly, the boiling heat transfer of ethylene glycol/water mixtures is mainly limited by flow instability rather than critical heat fluxes that are usually the limits for water boiling heat transfer. Tests show that stable long-term two-phase boiling flow is possible for ethylene glycol/water mixtures as long as the mass quality is less than a certain critical value (approximately <0.2). The heat transfer rate at this mass quality is significantly higher than that of conventional, single-phase, forced-convective heat transfer. Fourthly, based on boiling data of water, ethylene glycol/water mixtures (concentrations 40/60, 50/50, and 60/40), and refrigerants, a general correlation has been developed. This correlation predicts the experimental data quite well, and most of the predicted values are within ±30% of the experimental data. These results are well recognized by researchers in the area, which can be seen through the fact that the research paper, "Two-Phase Pressure Drop, Boiling Heat Transfer, and Critical Heat Flux to Water in a Small-Diameter Horizontal Tube," published in the International Journal of Multiphase Flow, June 2002, has received 21 citations July 2002 through December 2005.

Nanofluid Characterization. Nanofluids are a new class of heat transfer fluids engineered by dispersing nanometer-sized solid particles in conventional heat transfer fluids. Because of their fine sizes, solid particles will suspend in nanofluids, and the drawback of settlement, which occurs in conventional mixtures of liquids and large-sized solid particles, is eliminated. Since joined Argonne, Dr. Yu has been performing theoretical and experimental studies of the thermal properties of nanofluids. The results of his studies on this subject include: (a) He developed a device for accurately measuring the thermal conductivity of nanofluids for temperature up to 100°C and has measured thermal conductivities of various mixtures including oxide, metal, and nanotube particle based nanofluids. (b) Nanofluids not only enhance the thermal conductivities of the base fluids but also have a temperature-related feature that the higher the temperature, the higher the enhancement. (c) He developed several particle interface and distribution related models to explain the anomalous enhancement of the thermal conductivities of nanofluids over the base fluids. Because of their numerous application potentials and technical challenges, the research on nanofluids is rapidly becoming an important direction of thermal engineering applications. Dr. Yu's recent research activities on this subject are focused on the key factors for cooling applications of nanofluid: production of stable nanofluids, characteristics of nanofluid thermal properties, models of nanofluid thermal conductivity and heat transfer.

Supercritical Heat Transfer. In-situ hydrocarbon fuel reforming is being studied as a strategy for emissions reduction in industrial gas turbine engines. The concept is to reform the fuel under supercritical conditions to obtain gaseous fuel with improved combustion

characteristics. Dr. Yu's research work on this subject was focused on the heat exchanger/reactor and, specifically, on supercritical heat transfer with an endothermic reaction (thermal cracking). To investigate the heat transfer characteristics of supercritical fuel reforming (including the interaction of sensible and endothermic heat transfer), Dr. Yu performed a series of experiments to measure supercritical heat transfer to a hydrocarbon fuel in a small-diameter tube. With these tests, he was able to demonstrate the independence of the sensible and supercritical endothermic heat transfer processes. Based on the experimental data, he has also developed a new correlation for the prediction of Nusselt numbers with very low predicted errors. The results provide a basis for supercritical fuel heat-exchanger/reactor design and its practical applications, in an area that has received relatively little attention in the engineering literature, viz., supercritical forced convection heat transfer with endothermic chemical reaction.

l984-1998: In November l984 Dr. Yu joined the faculty at Zhejiang University, Hangzhou, China as Assistant Professor. During 14 years working at Zhejiang University, Dr. Yu was a main investigator for two projects funded by the National Science Foundation of China and several other government-funded projects. From 1984 to 1998, he and his students performed studies in the area of fluid dynamics and heat transfer, numerical control machine tools, condition monitor and fault diagnosis technologies for large-scale rotating machinery, manufacturing quality control, and mechanical transmission system error and noise. He conducted systematic and in-depth studies on the modeling, recognition, and compensation of motion errors of NC machine tools on which he received his Ph.D. degree. The results of his studies on this subject include: (a) he established systematic mathematical models of geometrical and dynamic errors of numerical control machine tools; (b) he designed and implemented a novel test instrument for circular locus motion error; (c) he established mathematical models of time-domain correlation coefficients, frequency-domain spectral distributions, and artificial neural networks of error source identification; (d) he developed a computer code of error source identification with numerical control machine tools; (e) he developed and implemented two feed-forward compensation techniques of motion errors for numerical control machine tools, which were formulated with controlled auto-regression moving averages and artificial neural network models and resulted in an order-of-magnitude reduction in machining errors. On this subject alone, he has published 13 articles at international conferences or in peer-reviewed mechanical engineering journals. Six of these articles won the Zhejiang Provincial Natural Science Paper Award. Dr. Yu was also awarded two Chinese patents for the studies on the test instrument for circular locus motion errors of numerical control machine tools.

Teaching Activities

- Taught graduate courses *Manufacturing Process Control* and *Advanced Test Technique*.
- Taught undergraduate courses *Numerical Analysis* and *Test Technique*.
- Directed doctoral and master thesis research.
- Supervised postdoctoral research.
- Served as a member of the thesis defense examination committees for six Ph.D. students and ten MS students at Zhejiang University, and one MS student at the University of Illinois at Chicago since 1996.

Professional Societies

The American Society of Mechanical Engineers.
The Society of Automotive Engineers.
The Zhejiang Measurement & Testing Society.
The Zhejiang Vibration Engineering Society.

Honors, Awards, and Patents

- Who's Who in Science and Engineering 2005-2006, 8th Edition, Marquis, New Providence, New Jersey, 2004.
- Received the 2003 TAPPI Pulp Manufacturing Division Award for Best Department of Energy Project, Development of Multiport Dryer Technology for the Forest Products Industry, 2004.
- Received six of the Zhejiang Provincial Natural Science Paper Award, 1994-1998.
- Received the Excellent Teaching Award, Department of Mechanical Engineering, Zhejiang University, 1987-1988.
- Awarded one United States patents, 2006.
- Awarded five Chinese patents, 1991-1997.

Publications

Author or co-author of two scientific books and more than 40 scientific papers.