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USING X-RAYS TO VISUALIZE MULTIPHASE FLOWS

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Abstract:

Multiphase flows are defined as one or more dispersed phases in a continuous fluid phase. They are commonly found in many industries (e.g., chemical and fuel processing, pharmaceutical manufacturing, food and beverage production) as well as throughout the environment (e.g., waves, rain, avalanches). Although multiphase flows are commonly observed, their operation and control are very complex. Experimental observations of multiphase flows are crucial to improve our understanding of the fundamental hydrodynamic and transport processes, as well as to develop and validate computational models. This seminar will provide an overview of the multiphase flow research performed in the Experimental Multiphase Flow Laboratory at Iowa State University. A key feature of this research is the use of a unique X-ray flow visualization facility that can perform X-ray radiography, X-ray stereography, and X-ray computed tomography imaging. Several examples of each of these imaging methods will be discussed relative to various multiphase flows, including gas-liquid, gas-solid, and particle-particle flows. How X-rays are used to characterize and quantify these flows will be emphasized. The seminar will conclude with examples from high-speed X-ray flow visualization (up to 100 kHz) using X-rays produced at the Advanced Photon Source (APS) at Argonne National Laboratory. Using the high X-ray beam flux from APS, distinct fluid flow physics will be identified that can only be observed with high-speed X-ray imaging.

Speaker:

Ted Heindel is an ISU University Professor, the Bergles Professor of Thermal Science in the Department of Mechanical Engineering, and the Director of the Center for Multiphase Flow Research and Education (CoMFRE); he also holds a courtesy professor appointment in the Department of Chemical and Biological Engineering. He directs the Experimental Multiphase Flow Laboratory, which houses a one-of-a-kind instrument for performing X-ray visualization studies of complex fluid flows. His research currently focuses on multiphase flow hydrodynamics (e.g., mixing in gas-liquid, gas-solid, and particle-particle flows) and multiphase flow visualization and characterization using X-ray imaging technology. His research program has been funded by over 60 projects supported through the NSF, ONR, USDA, DOE, the State of Iowa, and industrial partners. He has co-authored one book and published over 105 peer-reviewed journal papers and over 300 conference papers, abstracts, and technical reports. Ted has been recognized at ISU with a College of Engineering D.R. Boylan Eminent Faculty Award for Research in 2022, Regents Award for Faculty Excellence in 2018, the Exemplary Faculty Mentor Award in 2014, the College of Engineering's Superior Engineering Teacher of the Year Award in 2006, and was twice selected by graduating seniors as mechanical engineering's Professor of the Year. He is an ASME Fellow, a past associate editor for the *ASME Journal of Fluids Engineering*, and a past chair of the Fluids Measurement and Instrumentation Technical Committee of ASME. He is currently an associate editor of the *International Journal of Multiphase Flow*. He received his B.S. from the University of Wisconsin – Madison and his M.S. and Ph.D. from Purdue University, all in mechanical engineering with an emphasis in the thermal sciences.

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