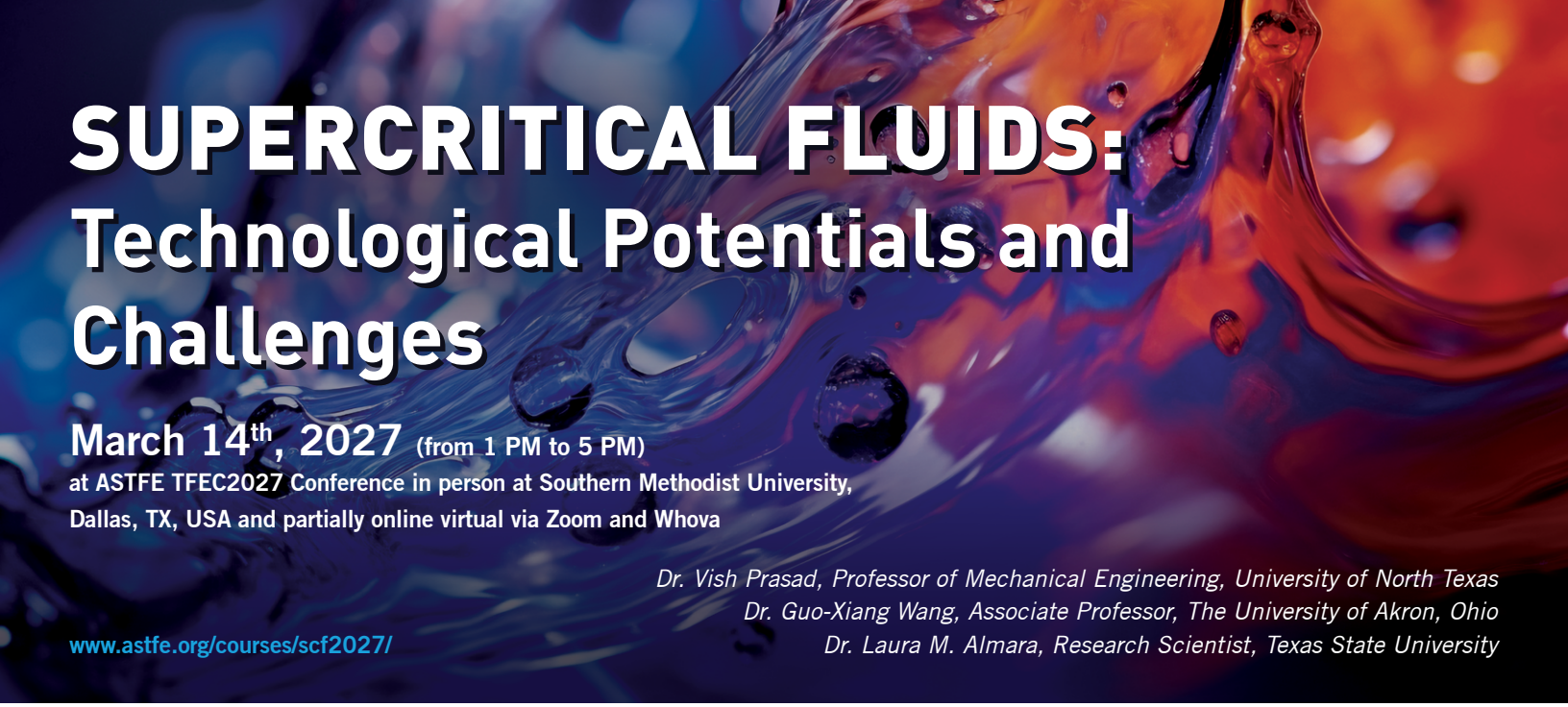


SUPERCRITICAL FLUIDS: Technological Potentials and Challenges

March 14th, 2027 (from 1 PM to 5 PM)
at ASTFE TFEC2027 Conference in person at Southern Methodist University, Dallas, TX, USA and partially online virtual via Zoom and Whova

Dr. Vish Prasad, Professor of Mechanical Engineering, University of North Texas
Dr. Guo-Xiang Wang, Associate Professor, The University of Akron, Ohio
Dr. Laura M. Almara, Research Scientist, Texas State University

www.astfe.org/courses/scf2027/

COURSE OVERVIEW AND FUTURE TECHNOLOGICAL APPLICATIONS

Supercritical fluids have already enabled major advances in extraction, separation, and deposition technologies across the chemical, pharmaceutical, food, and materials industries, largely owing to their exceptional solubility properties. However, despite their enormous potential for developing high-capacity, energy-efficient, and environmentally sustainable transport, energy-conversion, and thermal-management systems, their broader technological applications remain relatively limited. Looking ahead, significant opportunities exist across many technological sectors, including

- **Fluid Transport and Carbon Management**: Pipeline transport of natural gas and carbon dioxide, particularly for carbon capture and storage (CCS), enhanced oil and gas recovery, and other high-pressure transport systems.
- **Power Generation and Energy Conversion**: Advanced fossil-fuel and nuclear power plants, SC CO2 power cycles, concentrated solar power, geothermal energy, and emerging energy-conversion technologies.
- **Heat Exchangers and Industrial Thermal Systems**: Large-scale, compact, and micro heat exchangers; high-capacity heating and cooling systems; chemically stable, corrosion-resistant, long-life thermal systems; and environmentally sustainable industrial cooling.
- **Refrigeration and Advanced Thermal Management**: Refrigeration and cryogenic technologies; cooling of electronic, avionic, and medical devices; and thermal management of data centers, high-performance computing systems, and high-power batteries.
- **Advanced Energy Technologies**: Thermal management of superconducting transmission cables, fusion-energy systems, and other advanced scientific and industrial installations.
- **Aerospace and Space Exploration**: Thermal-control and energy-management systems for spacecraft, satellites, space stations, lunar installations, and future extraterrestrial missions.

Realizing these opportunities requires overcoming major scientific and engineering challenges, including extreme thermophysical-property variations, critical-region anomalies, complex fluid-flow and heat-transfer behavior, heat-transfer enhancement and deterioration, flow instabilities, high operating pressures, and materials compatibility. Understanding the physical origins of these phenomena, identifying favorable operating regimes, and developing strategies to avoid or mitigate adverse effects are essential for designing efficient, reliable, and commercially viable systems.

This course will integrate fundamental science, emerging technological opportunities, and practical engineering considerations. Special emphasis will be placed on critical-region fluid anomalies, new thermodynamic approaches and extended phase diagrams, fluid-flow and heat-transfer challenges, and innovative approaches for expanding the use of SC fluids in next-generation technologies.

COURSE LEARNING OBJECTIVES

The primary objective of this course is to develop a comprehensive understanding of supercritical-fluid behavior, including critical-region anomalies, their physical origins, and strategies for avoiding or mitigating their adverse effects. The course will also introduce emerging thermodynamic frameworks, particularly the proposed Gibbs–Prasad phase diagrams, which extend the thermodynamic description of fluids to very high pressures and temperatures. It will connect thermodynamics, fluid mechanics, and heat transfer with engineering challenges and future technological applications.

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UPON COMPLETION, PARTICIPANTS WILL BE ABLE TO:

1. **Understand Fundamental Science**: Explain supercritical-fluid thermodynamic and transport properties, critical and pseudo-critical phenomena, liquid-like to gas-like crossovers, the evolution toward more regular property behavior at high pressures and temperatures, and their engineering implications.
2. **Interpret Fluid Anomalies and Advanced Phase Diagrams**: Examine conventional and proposed Gibbs–Prasad phase diagrams, identify anomalous regions and thermodynamic crossover lines, and evaluate their significance in understanding fluid behavior, selecting operating conditions, and mitigating adverse effects.
3. **Analyze Fluid Flow and Heat Transfer**: Evaluate the effects of property variations, turbulence, buoyancy, and flow acceleration on heat-transfer enhancement, deterioration, and flow instabilities, and identify operating strategies for improving performance and reliability.
4. **Evaluate Modeling and Experimental Challenges**: Assess the capabilities and limitations of experimental techniques, thermophysical-property databases, heat-transfer correlations, and computational models, particularly under critical and pseudo-critical conditions.
5. **Explore Emerging Technological Applications**: Assess the potential and challenges of supercritical-fluid technologies in pipeline transport, carbon management, enhanced oil and natural gas recovery, advanced power generation, renewable energy, compact heat exchangers, high-performance cooling, fusion energy, and aerospace systems.
6. **Define Future Research Priorities**: Identify critical knowledge gaps, promising research directions, and scientific and technological advances required for developing high-capacity, efficient, sustainable, and reliable supercritical-fluid technologies.

EXPECTED LEARNING OUTCOMES

By the end of the course, participants will be equipped to interpret complex supercritical-fluid behavior, recognize and mitigate critical-region anomalies, understand conventional and emerging phase-diagram frameworks, evaluate fluid-flow and heat-transfer challenges, and critically assess emerging technological opportunities. They will gain the scientific perspective and engineering insight needed to initiate new research, improve existing systems, and contribute to the development of next-generation supercritical-fluid technologies.

WHO SHOULD ATTEND?

This course is designed for researchers, scientists, engineers, graduate students, and technical professionals, including both newcomers to supercritical-fluid technologies and experienced practitioners. It will be particularly valuable to those seeking to initiate research in SC fluids' thermodynamics, fluid flow, and heat transfer, or to innovate, design, evaluate, and operate high-pressure fluid-transport, thermal-management, and energy-conversion systems.

WORKSHOP INSTRUCTORS



DR. VISH PRASAD
Professor of Mechanical Engineering,
University of North Texas



DR. GUO-XIANG WANG
Associate Professor,
The University of Akron, Ohio



DR. LAURA M. ALMARA
Research Scientist,
Texas State University

REGISTRATION

- **Fee: $100**
- **Registration will be limited to 50 participants**
- **Each participant will receive a certificate of the course completion**

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