# IOWA STATE UNIVERSITY
## Center for Multiphase Flow Research and Education

## December 2020 CoMFRE Newsletter

## Message from the Director

Well, 2020 is (finally) over. When the year started, no one had any idea that multiphase flows (i.e., COVID-19 transmission) would be so prominent in everyday life. Although many of us did not think of multiphase flows when someone sneezes, coughs, or even speaks, we now understand the importance of multiphase flow physics in staying healthy.

As we start 2021, the pandemic is still with us but we will continue to use our multiphase flow expertise to make life better. One way to do this is to expand CoMFRE's impact. We have recently added three new ISU faculty affiliates (see below), and we will continue to reach out to potential member companies. As the year progresses, future impacts will be highlighted in this newsletter.

Have a Happy and Healthy New Year!

Ted

Theodore (Ted) J. Heindel
Director, Center for Multiphase Flow Research and Education
Bergles Professor of Thermal Sciences

## Fall Membership Meeting Held Tuesday, October 27, 2020

Due to COVID-19 concerns, we held a virtual Industrial Advisory Board (IAB) meeting this year, with the purpose of providing our member companies an

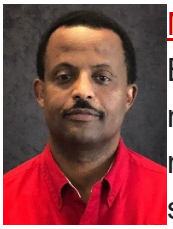
update on CoMFRE and the CoMFRE-supported projects. Only member companies and affiliated faculty/students were invited this year; we look forward to a more inclusive annual meeting in addition to the members-only IAB meeting in 2021.

## CoMFRE Expands by Adding Three New Faculty Affiliates

This quarter we welcomed three new CoMFRE Faculty Affiliates:

Todd Kingston is a new Assistant Professor in Mechanical Engineering. His primary research interests involve energy transport and conversion, specifically, multiphase thermal-fluid transport, thermal management, boiling heat transfer, and thermo-electrochemical coupling phenomena.

Ping He is a new Assistant Professor in Aerospace Engineering. His interests focus on Multidisciplinary Design Optimization (MDO), including modular high-fidelity MDO framework development, effective adjoint algorithm development, and aero-thermal-structural optimization for aircraft and turbomachinery. Additionally, his work in Computational Fluid Dynamics (CFD) includes exploring efficient unsteady flow simulation algorithms, DNS and LES of small-scale turbulence, and massively parallel computing for CFD.



Mehari Tekeste is an Assistant Professor in Agricultural and Biosystems Engineering. His research areas include simulation of machine performance at the machine-soil-crop interface for off-road machinery, and precision agriculture technology development (soil sensors and data analytics) for tillage and soil compaction management.

A full list of CoMFRE faculty affiliates can be found here: https://comfre.iastate.edu/faculty-2-2/page/1/

## CoMFRE and CoMFRE Affiliates in the News

**Using Computer Simulations to Improve Clean Energy Generation**

As the damaging effects of climate change become more apparent, researchers are studying ways to generate energy with minimal impact on the environment. Computer simulations could be the key to making this process more efficient. Iowa State University mechanical engineering professor and CoMFRE member **Shankar Subramaniam** is the principal investigator on this project.

https://news.engineering.iastate.edu/2020/10/02/using-computer-simulations-to-improve-clean-energy-generation/

**The Impacts of Converting Biomass into Renewable Fuel**

In a College of Engineering video, ME associate professor **Mark Mba-Wright** discusses his research involving biofuel production, specifically examining the economic and environmental impacts of converting biomass into renewable fuel: ME Research Focus: Mark Mba-Wright - YouTube

## Recent Degrees Granted to Students Working on Multiphase Flow Projects

- Julie K. Bothell, PhD, Mechanical Engineering, Thesis Title: “Experimental studies of the near-nozzle region of a coaxial spray,” Advisor: **Ted Heindel**

- Manjil Ray, PhD, Mechanical Engineering, Thesis Title: “Eulerian models and kinetic theory closures for triboelectric charging in dense granular and gas-particle flows,” Advisor: **Alberto Passalacqua**

## Recently Funded Research Awards

Feel free to contact the PI directly if you have any questions on the projects below.

- “Predictor for Aircraft Structural Loads Due to Buffet”; **Ming-Chen Hsu**; Funding Agency: DoD (Phase II SBIR); New Funding Amount: $354,760.
- “Testing of Durable Elastomeric and Metal Based Icephobic Coatings for Turbomachinery Ice Protections Applications”; **Hui Hu**; Funding Agency: DoD (Phase II SBIR); New Funding Amount: $208,000.

## Recent Journal Publications

Note that CoMFRE affiliates are identified by **bold** names.

- Bothell, J.K., T.B. Morgan, A.L. Kastengren, and **T.J. Heindel,** “Determining spray axial velocity from focused X-ray radiography” *Atomization and Sprays*, 30(6): 389-400, 2020. https://doi.org/10.1615/AtomizSpr.2020034840
- Bryngelson, S.H., T. Colonius, and **R.O. Fox**, “QBMMlib: A library of quadrature-based moment methods” *SoftwareX,* **12**:100615, 2020. https://doi.org/10.1016/j.softx.2020.100615
- **Fox, R.O.**, “Effect of the conditional scalar dissipation rate in the conditional moment closure” *Physics of Fluids,* **32**:115118, 2020. https://doi.org/10.1063/5.0030092
- **Fox, R.O.**, F. Laurent, and A. Vié, “A hyperbolic two-fluid model for compressible flows with arbitrary material-density ratios” *Journal of Fluid Mechanics,* 903, A5, 2020). https://doi.org/10.1017/jfm.2020.615
- Lattanzi, A.M., V. Tavanashad, **S. Subramaniam**, and J. Capecelatro, “Stochastic models for capturing dispersion in particle-laden flows” *Journal of Fluid Mechanics,* 903, 2020. https://doi.org/10.1017/jfm.2020.625

- Minglani, D., A. Sharma, H. Pandey, R. Dayal, J. Joshi, B. Jyeshtharaj, and **S. Subramaniam**, “A review of granular flow in screw feeders and conveyors” *Powder Technology,* 366:369-381, 2020. https://doi.org/10.1016/j.powtec.2020.02.066
- **Subramaniam, S.**, “Multiphase flows: Rich physics, challenging theory, and big simulations” *Physical Review Fluids,* 5(11):110520, 2020. http://dx.doi.org/10.13140/RG.2.2.28950.16960
- Tavanashad, V., **A. Passalacqua**, and **S. Subramaniam**, “Particle-resolved simulation of freely evolving particle suspensions: Flow physics and modeling” *International Journal of Multiphase Flow*, 135:103533, 2020. https://doi.org/10.1016/j.ijmultiphaseflow.2020.103533.
- Tavanashad, V., and **S. Subramaniam**, “Fully resolved simulation of dense suspensions of freely evolving buoyant particles using an improved immersed boundary method” *International Journal of Multiphase Flow,* 132: 103396, 2020. https://doi.org/10.1016/j.ijmultiphaseflow.2020.103396
- Yeh, H.-L., and **J. Juárez**, “Ultrasound-enhanced diffusion and streaming of colloids in porous media” *Experimental Thermal and Fluid Science*, Available online 2020. https://doi.org/10.1016/j.expthermflusci.2020.110282

## Recent Conference Publications and Presentations

- Belekar, V.V., N.K. Nere, K. Sinha, **T.J. Heindel**, **S. Subramaniam**, “Continuum simulations of heat and mass transfer in wet granular mixtures” *2020 AIChE Annual Meeting*, San Francisco, CA, November 15-20, 2020.
- Belekar, V.V., **A. Passalacqua**, **T.J. Heindel**, K. Sinha, **S. Subramaniam**, “Continuum simulations of dense granular flow near the maximum packing limit” *2020 AIChE Annual Meeting*, San Francisco, CA, November 15-20, 2020.
- Lattanzi, A., V. Tavanashad, **S. Subramaniam**, J. Capecelatro, “Stochastic methods for capturing dispersion in particle-laden flows” *Bulletin of the American Physical Society*, November 22-24, 2020.

- Murphy, E., K. Sinha, M. Mummudi, R. Bharadwaj, V.V. Belekar, **S. Subramaniam**, N.K. Nere, “Computational approaches to scale-up and tech-transfer in agitated filter bed drying” *2020 AIChE Annual Meeting*, San Francisco, CA, November 15-20, 2020.
- Nadeem, H., **S. Subramaniam**, K. Sinha, **T.J. Heindel**, “Particle mixing measures in a vertical bladed mixture using X-ray computed tomography (CT)” *2020 AIChE Annual Meeting*, San Francisco, CA, November 15-20, 2020.
- Ni, M., M. Mehrabadi, J. Capecelatro, **S. Subramaniam**, “Residual terms in the spatially filtered fluid momentum equation for a particle--laden suspension” *Bulletin of the American Physical Society*, November 22-24, 2020.
- **Subramaniam, S.**, “Representing number fluctuations in disperse multiphase flow using the filtered Klimontovich density” *Bulletin of the American Physical Society*, November 22-24, 2020.
- **Subramaniam, S.**, B. Nagawkar, **A. Passalacqua**, “An index to characterize particle mixing at different scales” *2020 AIChE Annual Meeting*, San Francisco, CA, November 15-20, 2020.