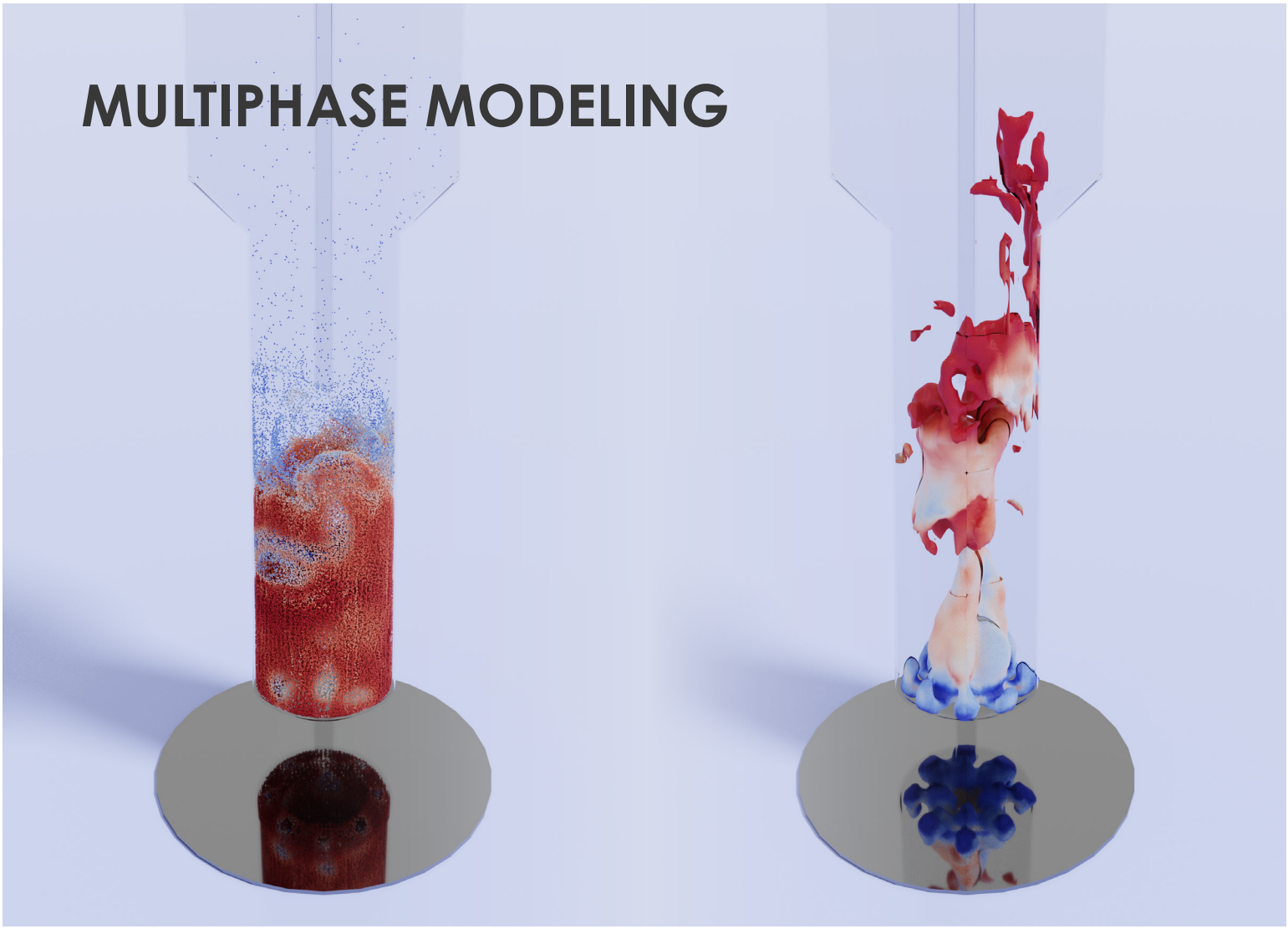
MULTIPHASE MODELING



Program 142, July 2024

NATIONAL ENERGY TECHNOLOGY LABORATORY

OVERVIEW

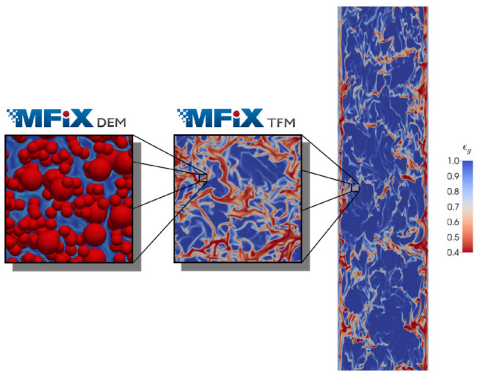
Understanding the performance of energy, environmental and chemical process devices based on multiphase flow physics is very challenging. Having the means to impact their design early in the development process is critically important to control costs and reduce the risk of not meeting performance goals. Approximately 75% of the manufacturing cost of any product is committed at the conceptual design stage, even when the incurred cost might be very small. Using computational models to simulate a multiphase device can provide insight into its performance before the design is finalized, thereby reducing cost. Computational models are valuable when empirical scale-up information is not available and when reactors at the appropriate scale have not been built. Furthermore, traditional scale-up methods do not work well for multiphase flow reactors. A critical need exists for science-based models with quantified uncertainty that reduces the cost and time required for development of multiphase flow devices. NETL's Multiphase Flow Science (MFS) research program is a strategic combination of computational modeling expertise and experimental facilities for the development and validation of science-based reacting multiphase-flow modeling tools.

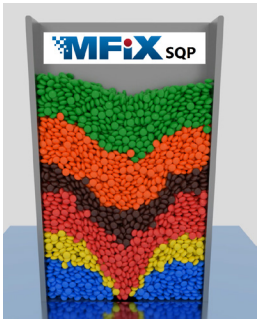
MFS research and development at NETL is funded by the U.S. Department of Energy (DOE), primarily from the Office of Fossil Energy and Carbon Management (FECM) with additional support from the Office of Energy Efficiency and Renewable Energy (EERE) and the Office of Science. MFS research at NETL is performed by a crosscutting team of engineers and scientists who are skilled in development and application of multiphase computational fluid dynamics software and multiphase experimentation. The Multiphase Flow Team consists of more than 20 researchers from U.S. and international multiphase flow academic and industry research programs.

The work emphasizes energy and environmental applications including biomass and waste plastic gasification, carbon capture using solid sorbents or liquid solvents and chemical-looping combustion of gaseous and solid fuels. MFS research also supports DOE's Office of Environmental Management for analysis of thermochemical processes for environmental remediation of radioactive wastes. Details about the various research programs and projects in the Multiphase Flow Science portfolio can be found at mfix.netl.doe.gov.

MFS R&D combines development and application of multiphase computational fluid dynamic (CFD) models with small-scale, well-resolved experiments to provide validated and accurate modeling tools. These tools and experimental data are made available to the multiphase flow science community as open-source software and public domain datasets.

NETL's suite of multiphase CFD software includes Multiphase Flow with Interphase eXchanges (MFiX) and its Exa-scale offering (MFIX-Exa) that are central to NETL's multiphase flow reactor modeling effort. These codes have been developed specifically for modeling reacting multiphase systems. This open-source suite of software tools has more than three decades of development history and more than 8,600 registered users worldwide and can be downloaded at mfix.netl.doe.gov. Software is often the standard test bed for comparing, implementing and evaluating multiphase flow constitutive models. They are applied to an extremely diverse range of applications involving multiphase flows. The successes achieved in modeling complex problems have led to new and improved models that are now available to the MFiX community.





NETL is a U.S. Department of Energy (DOE) national laboratory dedicated to advancing the nation's energy future by creating innovative solutions that strengthen the security, affordability and reliability of energy systems and natural resources. With laboratories in Albany, Oregon; Morgantown, West Virginia; and Pittsburgh, Pennsylvania, NETL creates advanced energy technologies that support DOE's mission while fostering collaborations that will lead to a resilient and abundant energy future for the nation.

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