Ansys + Toronto Metropolitan University

"The utilization of Ansys solutions in the numerical analysis of coaxial mixer performance, specifically for dispersing gas into non-Newtonian fluids, has significantly enhanced our understanding of complex mixing behavior. Ansys CFD simulations provided invaluable insights by analyzing flow patterns, shear environments, bubble size distributions, viscosity profiles, mass transfer characteristics, and local gas holdup profiles. Moreover, numerical simulations enabled us to identify and mitigate poor mixing in bioprocesses, which ensured uniform gas distribution across the vessel, prevented localized oxygen depletion, and optimized process performance. In fact, Ansys solutions provided essential tools for advancing research and optimizing gas-liquid mixing processes."

— **Paloma Lins Barros**
Ph.D. Candidate, Fluid Mixing Technology Research Lab **/** Toronto Metropolitan University

CFD-aided Characterization of Effective Gas Dispersion in Complex Non-Newtonian Fluids Using Coaxial Mixers

Given the extensive use of gas-liquid mixing systems, particularly in pharmaceutical bioprocesses, a comprehensive characterization of these operations becomes essential. Engineering simulation is crucial to providing the insights necessary for understanding the process's sensitivity to operating conditions and addressing the challenges in multiphase systems, including the mixing of non-Newtonian fluids. This detailed analysis is valuable for process design and scale-up.

Challenges

Due to challenges in experimental analysis arising from the unfeasible measurement of certain variables, numerical simulation became essential to fully explore gas dispersion within non-Newtonian fluids. To accurately characterize gas-liquid mixing performance using computational fluid dynamics, it was imperative to utilize software capable of handling the complexities of the system.

Technology Used

- Ansys Fluent

Engineering Solutions

- Utilized engineering simulation for multiphase flow analysis to characterize the local volume fraction distribution
- Incorporated a population balance model to predict bubble sizes, considering breakage and coalescence mechanisms
- Employed the Herschel-Bulkley model for modeling complex non-Newtonian biopolymers
- Facilitated easy scale-up of geometry by a geometrical factor
- Leveraged detailed post-processing features for a comprehensive comparison of mixing performance, fluid flow visualization, and calculation of variables using CFX Expression Language
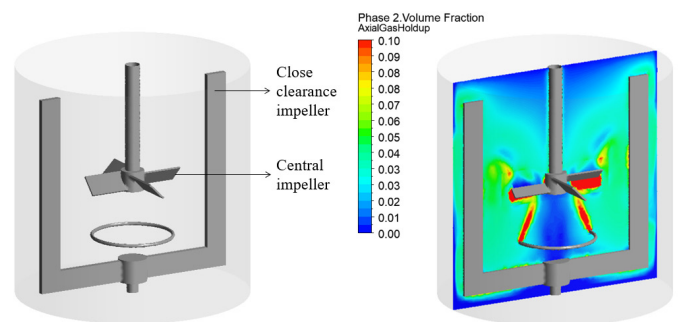

Figure 1. Coaxial mixer utilized for dispersing gas into a non-Newtonian fluid (left) and the characterization of the gas distribution (right)
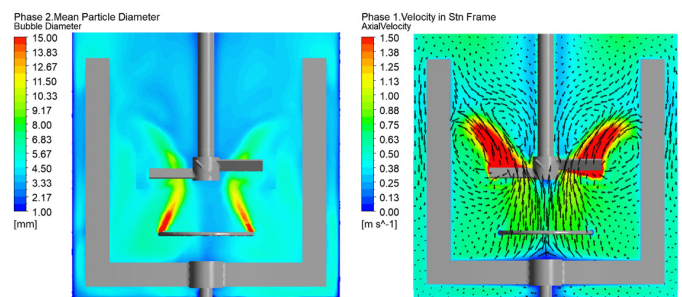

Figure 2. Prediction of the bubble size distribution (left) and flow pattern within the mixing system (right)

Benefits

- Identified optimal operating conditions for mixing performance using engineering simulations within a specified range for anchor-PBT coaxial mixer
- Achieved multiple performance characterizations, including the evaluation of stagnant area, fluid flow, and distribution of bubbles' volume fraction
- Improved process effectiveness in terms of overall gas volume fraction by 71.1%
- Reduced power consumption by 24.8% compared to the maximum power consumption within the range of operating conditions
- Enabled significant time savings for numerical simulations in the design and optimization process, contributing to more efficient research outcomes

/ Project Description

As a Ph.D. candidate at Toronto Metropolitan University, Paloma Lins Barros is actively engaged in research at the Fluid Mixing Technology Research Lab, which has a legacy of over 15 years. This advanced facility at the university enables researchers to investigate multiphase flow systems, non-Newtonian fluid flow, complex mixing operations, and granular flow. Her academic journey has primarily focused on multiphase fluid flow analysis.

ANSYS, Inc.
Southpointe
2600 Ansys Drive
Canonsburg, PA 15317
U.S.A.
724-746-3304
ansysinfo@ansys.com

When visionary companies need to know how their world-changing ideas will perform, they close the gap between design and reality with Ansys simulation. For more than 50 years, Ansys software has enabled innovators across industries to push boundaries by using the predictive power of simulation. From sustainable transportation to advanced semiconductors, from satellite systems to life-saving medical devices, the next great leaps in human advancement will be powered by Ansys.

Ansys and any and all ANSYS, Inc. brand, product, service and feature names, logos and slogans are registered trademarks or trademarks of ANSYS, Inc. or its subsidiaries in the United States or other countries. All other brand, product, service and feature names or trademarks are the property of their respective owners.

Visit **www.ansys.com** for more information.