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Flow and Mixing of Complex Fluids

Scope

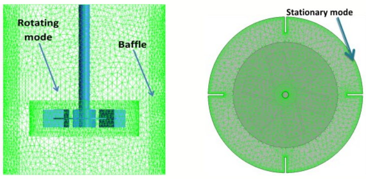
Mechanically agitated vessels are widely used in a wide range of industries such as nuclear, pharmaceuticals, minerals, food processing, household and personal care products. Complex fluids which may be single phase or multi phase are frequently encountered in these processes. Little work has been done to understand how to mix them effectively, mainly because of their opaque nature.

The aim of this project is to investigate the mixing of different types of complex fluids, such as viscoplastic fluids having shear-thinning (SN) or shear-thickening (ST) rheology numerically using CFD model and experimentally using positron emission particle tracking (PEPT) technique and their behaviour compared, for the first time.

In addition, four different types of impeller were investigated: Rushton turbine (RT), a radial flow impeller, pitch blade turbine (PBT), a mixed flow impeller, A310 hydrofoil impeller which produces axial flow, and the 'elephant ear' (ER) impeller, another type of axial flow impeller which was until recently considered good for the mixing of shear-sensitive fluids such as biological cultures.

CFD Calculations

Software	ANSYS CFX 14.5
Mesh	701,527 unstructured tetrahedral elements distributed non-uniformly
Method	Multiple frame of reference (MFR)
Validation	using PEPT and photographic imaging
Fluid	Herschel-Bulkley fluid (Carbopol)



The system used was split up into domains; these domains are a physical representation of where flow can occur, not the geometry itself. Two types of domains were used in these simulations, stationary and rotating as shown in the figure below.

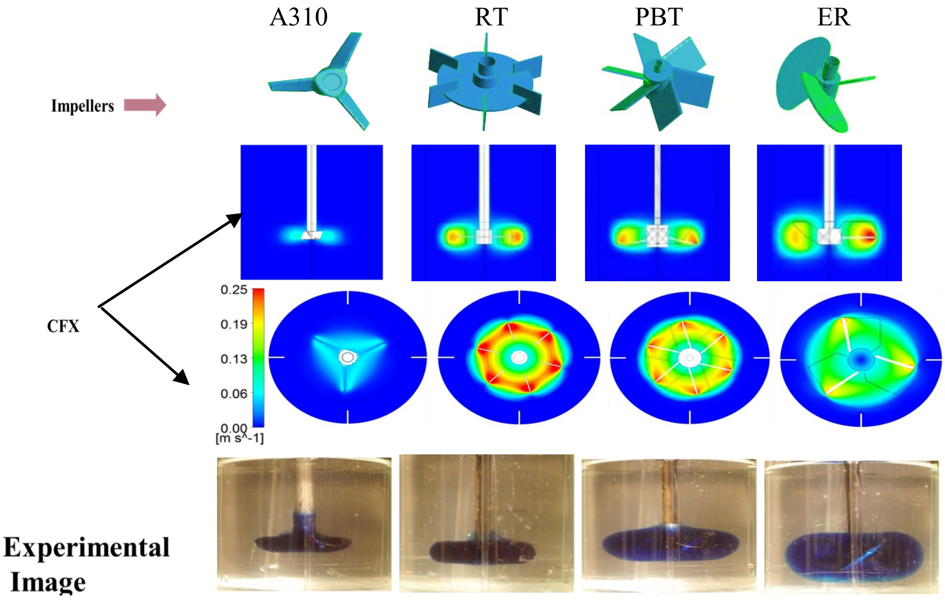


Fig 2: Comparison at the same power number Po=74

Outcomes to date

Cavern size predicted from CFD predictions showed a good agreement with experimental measurements. CFD provides 3D visualization of velocity vectors and iso-value contours that can't obtained easily from other experimental techniques. The results of these simulations was used to understand which type of impeller is most effective in mixing such fluids by giving larger and better mixed caverns.

Case study

Client Profile

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Product Used

Ansys ICEM-CFD
Ansys CFX
MATLAB signal toolbox

Funding

The Higher Committee of Education Development

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