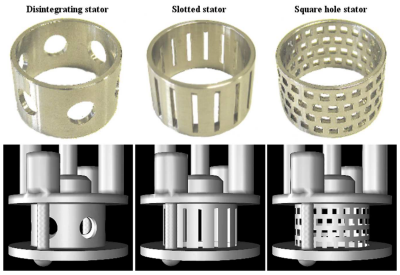
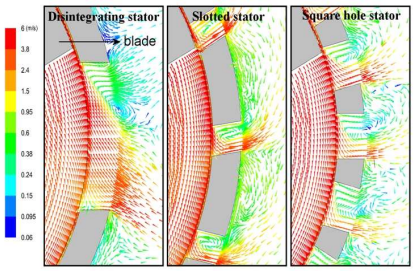
IT Services

Case Study

BlueBEAR provides a substantial computing resource that properly supports the research work of research staff and students at Birmingham. It provides a cost effective facility that optimises the effectiveness of research and ensures the University continues to be a world-class academic learning and research environment.

High shear rotor-stator mixers





Challenges

A rotor-stator mixer consists of a rotor closely surrounded by a stator with a small gap between the rotor and stator, typically in the order of 0.1 mm. High speed jets emerge from stator openings as the rotor rotates at a few thousands rpm. Rotor-stator mixers have been used extensively in industries to make products containing dispersed solid and/or liquid such as shampoo, body lotion, mayonnaise, lipstick, toothpaste, printing ink, etc. However, the interaction between the rotor and stator, the effect of rotor and stator geometries on the mixing performance and the scale-up procedure for rotor-stator mixer are still not well understood.

Method

CFD simulation (Fluent) was used to investigate the hydrodynamics in the rotor-stator mixer. The presence of a small gap between the rotor and stator and high speed rotor make the simulation of rotor-stator mixer a very challenging task. The rotor diameter is 2.82 mm and the gap between the rotor and stator is 0.175 mm. The CFD model was full 3-D with more than one million computational cells. Due to periodic nature of rotor-stator interaction, transient sliding mesh model with time step of 0.0005 s was used to simulate rotor rotation making this simulation very time consuming.

Results and Discussion

The flow patterns in the stator holes is characterised by emerging jets in the proximity of the leading edge which induce circulation flows behind them. Jets emerging from disintegrating stator (wide holes) move in the same direction as rotor, while those emerging from slotted and square hole stators (narrow holes) move against rotor. Laser Doppler anemometry was also used to measure time-averaged velocity profiles of emerging jets and good agreements with CFD predictions were obtained.

In all investigated stators the high energy dissipation rates occur in the proximity of the leading and trailing edges due to stagnations on those regions. Stators with narrow holes generate a more uniform energy dissipation rate in the holes than stator with wide holes suggesting that they can produce dispersion with narrow drop size distribution.

Two papers have been published from this work. Currently, the CFD simulation is used to simulate larger scale rotor-stator mixers to investigate the effect scale-up procedures, i.e. constant tip speed and constant energy dissipation rate.

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