Large scale MRI for imaging of processes

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Introduction: Process engineering plays a pivotal role in the production of many essential goods. Therefore, increasing the understanding of the underlying processes is crucial. Conventionally, this has been achieved through integral measurements and modelling. The use of tomographic techniques, especially Magnetic Resonance Imaging (MRI), can provide spatially resolved maps of many relevant parameters. While there has been significant work on process engineering problems recently, most of the work focuses on small lab-scale systems. Yet, many processes are large-scale and rely on gravity and the limitations posed by small-bore vertical or large-bore horizontal MRI magnets can significantly constrain research efforts in these areas.

System: To address these challenges, Hamburg University of Technology has introduced a vertical MRI system. This cryogen-free system boasts a field strength of 3 Tesla, a usable bore diameter of 40 cm, and is specifically designed to accommodate samples up to 3 meters in height. It can be equipped with tailor-made receive arrays, enabling the use of advanced acceleration techniques such as parallel imaging.

Fig. 1: The TUHH vertical MRI magnet.

Results and Discussion: This unique system enables the examination of significant process engineering systems, such as fluidized beds, trickle beds and stirred tank reactors in relevant scales. External devices such as motors and shakers can be placed in line with the experiment. Measurements of fluidized beds (with up to 30 cm diameter) and stirred-tank reactors reveal the possibility to observe process-relevant parameters such as flow and bubble sizes in these systems.

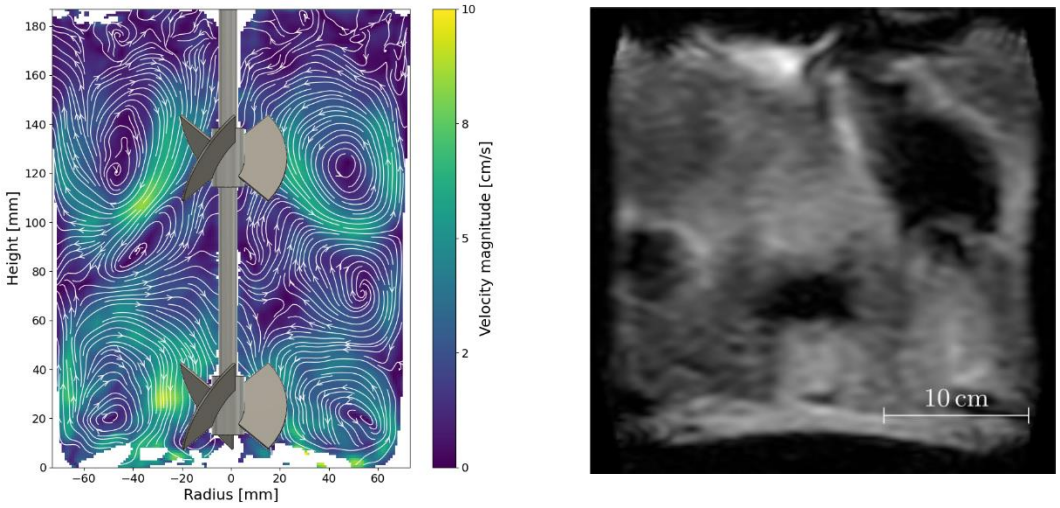

Fig. 2: Left: Flow measurement of a stirred tank reactors (130 mm diameter), Right: Measurement of a fluidized bed (300 mm diameter).

Conclusion: The TUHH MRI system allows for the exploration of process engineering systems on a larger scale than previously possible. Initial experiments across various systems demonstrate the potential to deliver valuable measurement parameters that can enhance process efficiency and effectiveness.