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Process tomography validates CFD calculations

When Synetix needed to validate the CFD simulation of a new design of fixed-bed reactor it turned to the new technology of process tomography.

Synetix, the catalysis company recently acquired by Johnson Matthey, wanted better energy efficiency and decided to test a low-cost approach - by reducing the pressure drop across a reactor The company decided to convert a gas phase, fixed bed reactor from axial to radial flow

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In this case the catalyst bed, with its nonuniform porosity, made it specially hard.

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So Synetix used new technology: process tomography, provided by Manchester-based Industrial Tomography Systems (ITS), to validate the CFD model.

Just as a modern hospital scans the human body to check for irregularities, so process tomography can see what's going on inside process plant.

Synetix and ITS worked with a substantial-size model of the proposed new reactor: 1m high

and the same in diameter.

The idea was that reactants would enter the vessel downwards and axially.

Then they would flow radially inwards through the catalyst bed into a new central collector for downward exit.

For tomography with the model, water replaced gas as the background fluid (because process tomography measures resistance and needs a fluid that conducts electricity); sodium chloride solution was injected in short bursts to look at the flow.

16 electrodes were arranged symmetrically in a plane around the circumference of the reactor model; they were in contact with the process fluid but didn't disturb the flow.

A small AC current was applied between electrode pairs: the resistance of the circuit depended on what the fluid between the two electrodes contained.

Current applied in a predetermined sequence between the 16 electrodes can give 100 independent measurements every 25ms.

This provides a real-time picture of the capacitance of the process fluid.

To monitor the whole vessel, extend the array of electrodes to, say, eight planes, each with a set of 16 electrodes.

Across a single plane the sodium chloride pulse initially appears at the edges, moves towards the centre, eventually occupies the whole area and then exits through the central collector.

Combining these results for all eight planes gave results that matched the CFD plot reasonably well.

Flow velocity measurements made with both systems also corresponded well.

Synetix team leader for the project, chemical engineer Hugh Stitt comments, "Tomology is a powerful technology with great potential use in the process industries".

ITS Managing Director Ken Primrose adds, "We have been working under cover of confidentiality with a number of companies on validations like this.

Process tomography offers an economical technique to test CFD predictions and, if necessary, see how changes impact on the flow".

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