

Reactor Technology

August 2010

The last 20 years of research in reactor technology has led to substantial improvements in both design of new processes as well as retrofitting and optimisation of existing plants.

Our main activities in this area have focused around:

- Development of a wide variety of mathematical models, ranging both in complexity (CSTR to CFD), and scale (micro reactors to production units).
- Building lab scale and pilot plant equipment in order to measure parameters needed in the models.
- Statistical experimental design for kinetic modelling and parameter estimation
- Development of measurement techniques and devices

Examples of new technologies where we have been involved:

- A process for production of olefins in turbulent fluidized bed
- A process for production of lactic acid from lactose by using lactobacillus entrapped in alginate beads.

Fluidized bed reactor

In recent years there has been a trend towards higher gas velocities in fluidized beds. The main reason is that the heat and mass transfer efficiencies are thereby increased. These efficiencies are functions of operational parameters, such as superficial gas velocity, temperature, particle size and density, and static bed height. The efficiencies are also strongly affected by the flow patterns inside the reactor.

At SINTEF/NTNU a 4m high pilot plant fluidized bed reactor has been built in order to study the detailed flow phenomena inside the reactor more specifically. Removable columns with different diameters (15, 30 and 50 cm) make it possible to study scale effects, see picture.



Sophisticated measurement devices for tracking gas flows, bubble and particle movement have been used. These include tracer gases, fibre-optical and capacitance probes. Recently, a proprietary fibre optical probe has been developed, which tracks both particle and bubble velocities simultaneously. (See separate fact sheet)

A broad spectrum of mathematical models has been developed for fluidized beds. These are used for calculations in various chemical reactors, ranging from micro reactors to large scale production units.

Slurry bubble columns

In cooperation with an industrial partner we have in recent years studied the hydrodynamics of slurry bubble columns in pilot scales up to diameters of 0.5m and heights up to 17m. As part of our on-going studies of bubble columns, in concert with NTNU, we are currently focusing our attention to the studies of heterogeneous structures in large diameter bubble columns (up to 3m).

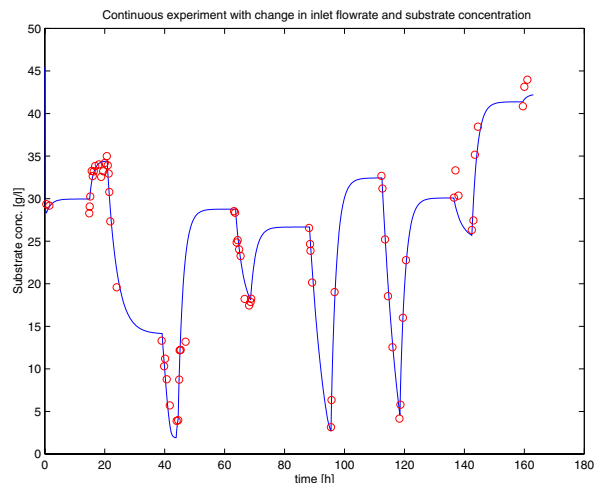
Immobilized lactic acid

In biochemical reactors immobilization of the biomass may give significant advantages over the conventional free biomass process. These advantages are mostly related to the downstream processing leading to a more simplified and effective separation of biomass and products. Also contamination of additives required for biomass proliferation may be reduced or even eliminated. Entrapment in spherical polysaccharide gels is commonly used for immobilization of biocatalysts.

Nutrients and products are transported by diffusion within these spherical particles. Both internal mass transfer in the gel and external mass transfer in the liquid film surrounding the particle influence the concentration profile of substrates and products in a biocatalyst particle. The mass transfer of solute in and out of the polysaccharide gel beads can be modelled by an effective solute diffusion coefficient D_e , a distribution constant K_p , and a liquid film mass transfer coefficient k_L .

Non-steady state measurements in a CSTRs were used to determine both the diffusion coefficient D_e and the distribution constant K_p . The liquid-film mass transfer coefficient was predicted by employing suitable empirical correlations available in the literature. In figure 2, these parameters, together with the model are compared with measurements in a long term experimental run where both step changes in composition and flow rate were included. Our strength: experience and cooperation.

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Our close cooperation with NTNU is symbolized by the fact that we have 15 NTNU professors as advisors and together we have coordinated or formed part of several research programs focused on theoretical and experimental studies of reactor systems; REPP (1996-2002), CARPET (2001-2004) and HiPGaS (2001-2005).

Each of these programs has had a budgets of approximately 4MNOK per year. Together these programs have/will result in approximately 15 Ph.D. theses and 3 post.docs.



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