Optimisation of Fluid Process Engineering by a Complementary Modelling Approach

E. Kenig*1

1University of Paderborn, Germany

Abstract

The requirements imposed on fluid process engineering operations are becoming more and more stringent. They have to be optimised with respect to economical, ecological and social criteria, and this concerns both classical unit operations and newer hybrid and integrated processes. Such an optimisation cannot be realised unless reliable and physically consistent process models are available. These models are expected not only to deliver sufficient information on process characteristics, but also to fill the gaps in understanding of the underlying transport phenomena.

In fluid systems, transport of momentum, mass and energy usually occurs simultaneously resulting in a complex interplay of velocity, pressure, concentration and temperature fields. Multiphase flows, multicomponent systems, complex thermodynamics, complex design and geometry of corresponding units, their intricate links and a large-scale difference between the characteristic dimensions of the phenomena involved - these features make rigorous modelling of fluid process engineering operations extremely difficult. As a result, the process is usually described based on severe assumptions and experimentally estimated gross parameters. However, efficient process optimisation can only be achieved with reasonable model accuracy, when the process rates are considered in a rigorous way, with respect to both transport phenomena and chemistry.

This dilemma can be solved with the aid of a complementary approach. Depending on the complexity of process fluid dynamics, different modelling ways can be applied, their rigour and complexity stretching over a wide range. Among these ways are a direct application of the equations of fluid dynamics, the hydrodynamic analogy method and the rate-based approach. These methods are complementary in the sense that, together, they are able to govern both simple and very complex process fluid dynamic conditions. Moreover, there is also another, and even more important, complementarity between the different approaches, namely, they can be applied in combination, for instance, by estimating process parameters by a more rigorous method and delivering them to the less rigorous
one.

In this contribution, the complementary modelling is discussed in detail and illustrated with several case studies.