DEVELOPMENTS IN HIGH-PRESSURE POLYMERIZATION TECHNOLOGY

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ABSTRACT

Product development for high-pressure polymerization processes is a specifically demanding task for two main reasons. First, it appears difficult to transform technical operation modes into miniaturized high-pressure equipment on lab-scale. Second, cost efficient high-pressure polymerization processes operate on a scale of multiple 100 kT/á production capacity. For this reason potential developments face significant steps of scale-up. Both, the significant scale-up as well as the technical limitations of high-pressure lab equipment represent the actual challenges that have to be overcome in product development in high-pressure polymerization technology nowadays.

For the actual trend two main lines of action can be identified. For production facilities on world-scale the question about coupling of process conditions and polymeric micro-structure of the product is the main task. In this respect the objectives are the optimization and systematic stepwise improvement of application properties. The tools for this are simulation methods that make use of kinetic models being based on elementary reaction kinetics. Such models are validated by adaptation-free application to various process variants. The predictive potential of such models is of specific interest. Another topic of interest is the extent of detail about the polymeric micro-structure such models can deliver. In order to optimize the performance of such models hybrid techniques come into focus that combine the advantages of deterministic and stochastic modeling. Both aspects will be demonstrated using examples.

For middle sized production rigs having a capacity of about 150 kT/á the main task is conserving the competitive ability. Using the economy of scale is no longer an option for which reason the development of higher value products comes into focus. Options are either strategies using alternative chemistry by additives or new variants of the process. Simulation studies certainly can help to predict trends. However, the experimental demonstration is indispensable. High-pressure mini-plants are very versatile for this purpose. Breaking down the full process in to its basic elements can act as an additional strategy. In both cases the proper scale-up need special attention, specifically the fact that the polymeric micro-structure is not flawed by effects of the larger surface to volume ratio. Using novel reactants such developments have to be finalized by a safety assessment, assuring safe implementation at process conditions. Something that cannot be mapped is the change of a CSTR as a typical mini-plant reactor to a tube as a large scale production reactor. In this instance again simulation models can be helpful.