Droplet generation and reduction in absorption and distillation equipment – the TERESA approach

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Thermal separation processes, such as distillation, absorption or evaporation, are core unit operations in almost all areas of the process industries. It is estimated that about 3% of the world primary energy demand and 40% of the process industries energy demand go to thermal separation processes. Therefore optimum design and operation of these separation processes and equipment is mandatory for energy and resource efficient production processes.

The separation effect in absorption, distillation or evaporation operations utilizes the differences in volatility of the components to be separated. An ideal separation also builds on a perfect phase separation of liquid and vapor phases. In this respect, the undesired generation of small droplets and their entrainment with the vapor phase presents a specific challenge to the design and operation of separation equipment. Four most critical problem areas may be identified: flashing feeds in the feed line to the column, the feed section within the column, the bottom section of a column with the two-phase return from the bottom reboiler and the column head section. The collaborative research project “Droplet generation and reduction in mass transfer equipment – TERESA” addresses process situations in these four most critical areas. Mechanisms, equipment and process conditions promoting droplet generation are identified as a basis for an optimized design and operation. In laboratory scale units droplet generation and reduction are investigated aiming at a characterization and fundamental understanding of the governing mechanisms. This knowledge is then transferred to pilot scale test units where scalable experiments with optimized equipment at beneficial operating conditions are conducted. Advanced measuring techniques for droplet detection and characterization as well as phase distribution in combination with Computational Fluid Dynamics calculations are employed to shed light on the complex two-phase vapor/liquid flow situations in such equipment. Ultimately, the results of the research work are condensed into engineering design tools and guidelines supporting the designing engineer in her/his struggle for energy efficient processes with minimized droplet entrainment.

The collaborative research project incorporates 13 industrial and academic partners. It is funded by the Federal Ministry for Economic Affairs and Energy for three years with a total budget of 4.4 Mio Euro of which 2.6 Mio Euro are covered by BMWi. The contribution will present the overall setup of the collaborative research project and will introduce the individual research areas.