# Multiphase Flow at Sulzer - insights into industrial processes

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## Abstract

The use of computational fluid dynamics (CFD) to model processes of fluid machinery gained considerable interest during the last couple of decades in the industrial environment. Simulations of flow phenomena provide an understanding on how a process functions and better yet give hints on how to improve it. Early work was limited to the analysis of single phase flow phenomena. Advancements to the science of modeling and the rapid growth in computer power now permit the ability to create comprehensive models of multiphase flows in real world fluid machinery. Theses achievements paved the way to introduce CFD for multiphase flows into the design and optimization processes in industry, see Sulzer Technical Review (2006).
Work presented includes the use of multiphase flow CFD for the divisions within the Sulzer Corporation. Therefore the focus is on multiphase flow predictions in pumping machinery, process engineering, powder production and coating applications. The use of such numerical methods in the design and development environment at Sulzer asks for highly reliable tools and a profound knowledge of their limitations for a specific application. Hence, a further focus is the validation of these methods.

Multiphase flows found in the division of Sulzer Pumps include cavitation, multiphase flow pumps for transporting liquids, gas and maybe even solids simultaneously. The prediction of the possible wear associated to these solid particles is also an important part of the multiphase flow CFD simulation. Pumps used in the paper industry need to be able to cope with fiber loaded liquids and for the design of optimal pump sumps the modeling of the free surface is of great importance. Using multiphase CFD for rotating machinery requires the formulation of the relevant equations in the rotating frame of reference. Furthermore, simulations of complete pump stages, which are common nowadays, need interfaces to correctly transfer flow data between the stationary and rotating frames of reference and vice versa.

The main pillars of Sulzer Chemtech are static mixers and separation columns, the latter one featuring many interesting multiphase phenomena. The vapors entering the columns are loaded with droplets. For the designer it is important to know, how these droplets are transported into the column and were they will end up. Therefore accurate prediction of features like droplets collecting on walls and building up a liquid film, re-entrainment of film liquid into the vapor flow or evaporation of droplets are of great interest and still a challenge for state of the art CFD codes. The simulation of liquid distributors needs to take the free surface into account. In order to have a properly functioning packing a good distribution of the liquid is absolutely necessary.

In thermal spray guns, as developed and marketed by Sulzer Metco, the powder is melted by a heat source and then propelled by high velocity gases onto the base material to from the coating. This highly complex process needs numerical modeling of the injection of particles into a supersonic gas flow, of the melting of particles and deformation during impact. Furthermore the extremely high temperatures and the low pressures, which may be present in a plasma spray process, may move the flow regime beyond the limits of the continuum regime.

Multiphase flows, as present in industrial processes quite often stretch the capabilities of the numerical codes available. Therefore good quality experimental data are of great importance for the validation process and the development of new numerical models. Moreover a good knowledge of the physics involved in these flows helps in the improvement of these tools. Current trends ask for the implementation of multiphase CFD modules into automatic optimization software. To be able to rely on such an optimized design, the validity of the numerical models has to be proved by rigid validation processes. Sulzer Innotec, the research and development facility of the Sulzer Corporation, acts as a center of competence for the validation, improvement and integration of multiphase flow CFD into the design processes of the divisions. Knowledge gained on a simulation application for one division can be fed into the development of a new tool for another division, thus stimulating an interdisciplinary environment.

## References

Sulzer Technical Review, Special Edition: Fluid Mechanics, 2/2006 (2006)