Systematic Integration of Computer Simulation and Laboratory Tests for Cost Effective and Valid Experimentation

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Abstract

Today, computer simulation plays a crucial role in product development processes. Because of high cost, quality, and time pressure on product life-cycle and availability of affordable and user friendly tools in the market, simulation is increasingly being used to substitute laboratory tests. Based on the “law of conservation of information," however, simulation results are only effective if the computer models can capture the physical processes involved realistically. Hence, verification and validation as well as the question of quality assurance in simulation processes, in a larger context, are getting ever more attention. This gets even more evident, when considering that companies today commonly outsource simulation. The question of responsibility, in case of severe economic or technical consequences because of incorrect simulation results, are important. There are standards such as DIN-EN-ISO-9001 and NAFEMS-QSS-001 that deal with quality assurance issues, especially in the FEM-Simulation, but a gap is still observed in practice. The typical industry approach is to validate computer simulation through laboratory experimentation. Repeated tests are needed to determine the result statistically. Such physical experiments are, however, generally expensive and in some cases impractical.

In this paper, systematic integration of computer simulation and laboratory tests for efficient and cost effective product-development process is analysed. The process will be illustrated with a help of selected simulation examples (FEM, CFD, MKS) and corresponding laboratory experiments. It is shown that the number of physical tests can be reduced significantly if a computer model of the system is built. Moreover, where results from laboratory experiments cannot be trusted blindly (e.g. sensor errors), simulations help to check their plausibility. Overall, physical experiments and computer simulation can corroborate each other effectively if managed systematically.