Cleaning Simulation Software for the virtual design of complex spray cleaning systems

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An efficient design of cleaning systems is a particular challenge for complex plants. The more complex the equipment to be cleaned, the more difficult it becomes to estimate the ideal positions of static and dynamic cleaning nozzles. Cleaning systems are often oversized or cleaning nozzles have to be adapted and repositioned several times with the help of complex tests. Both cause immense costs in the short or long term due to loss of time and resources. With the progressive digitalization of industrial processes, it is a worthwhile goal to virtualize the design of cleaning systems and thus validly predict the cleaning result.

The aim of the joint project "SIMKOR", which is based on two previous research projects, is to develop a tool that makes it possible to predict the cleaning effect and volume flow distribution of spray cleaning systems. It was decided to develop a CAD software, capable to import models in STEP format in which cleaning systems and nozzles from a database could be placed. The computing power required for the simulation should not exceed the standard performance of a desktop PC. In this way, the application engineer can determine the optimum positioning and parameterization at his workstation. Complex iterative cleaning tests will be reduced to a minimum.

Extensive cleaning tests, carried out by the Fraunhofer IVV Dresden, are forming the database for this simulation. Within these tests, the locally removed amount of contamination is determined inline depending on the cleaning time. This creates an image sequence of the cleaning process, used to teach the simulation. The impact pressure distribution and the volume flow distribution are important measures for the mechanical cleaning effect of spray nozzles. These were determined within the scope of this project by means of local force and volume measurements and assigned to the corresponding nozzles in the software. The interaction of spray jets, such as superimposition or extinguishing effects, were investigated and integrated into the simulation algorithm.

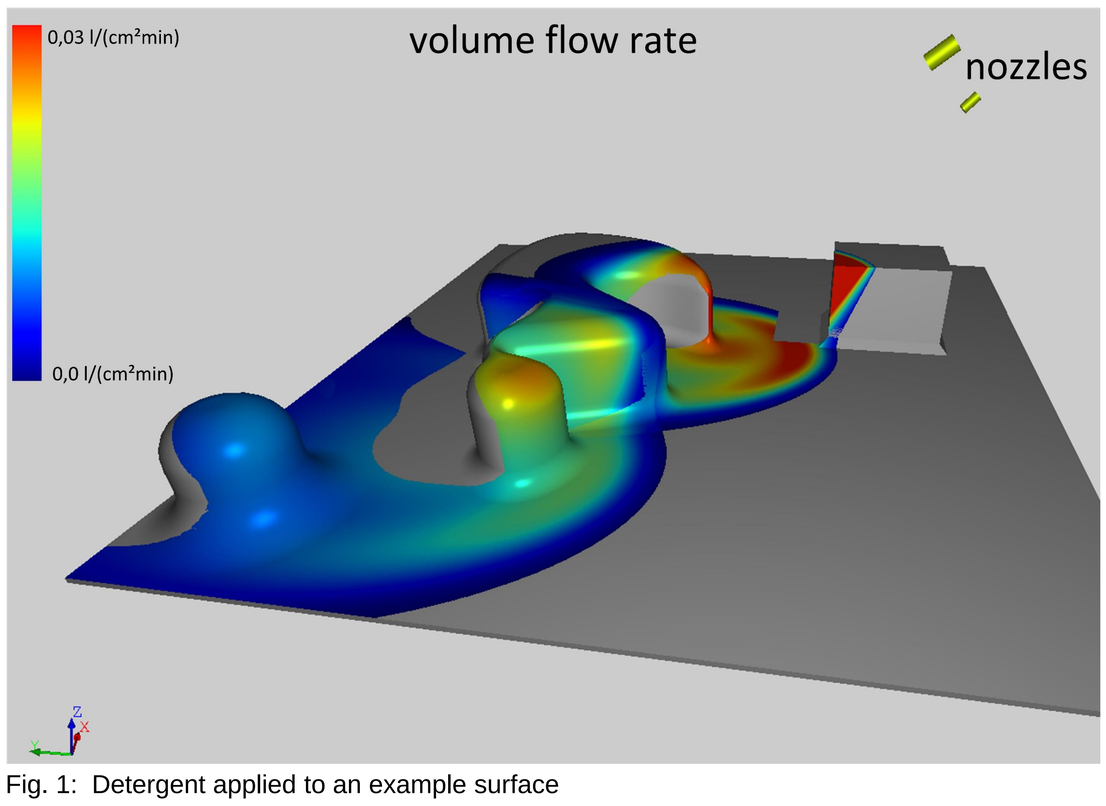

Fig. 1: Detergent applied to an example surface

The result is a user-friendly CAD software with a preview mode and a simulation mode. When positioning the nozzle in the preview mode, the volume of detergent applied to the surface is displayed in real time for each point on the surface (Figure 1). Not only the direct impact area, but also the footprint of the cleaning nozzle is considered. In the following simulation mode, the duration of cleaning and its subdivision into simulation intervals can be set. The calculation takes place due to a new simulation approach within a few minutes on a normal desktop PC. The result of the simulation is, in addition to the accumulated local detergent volume (Figure 2), the spatially resolved representation of the theoretical cleaning effect. The simulation results, represented by the color scale, provide information about the locally occurring cleaning effect, which results from the direct impact of the spray jet and the draining detergent. If the critical areas are detected early, the cleaning system can be adapted or a design change can be considered.

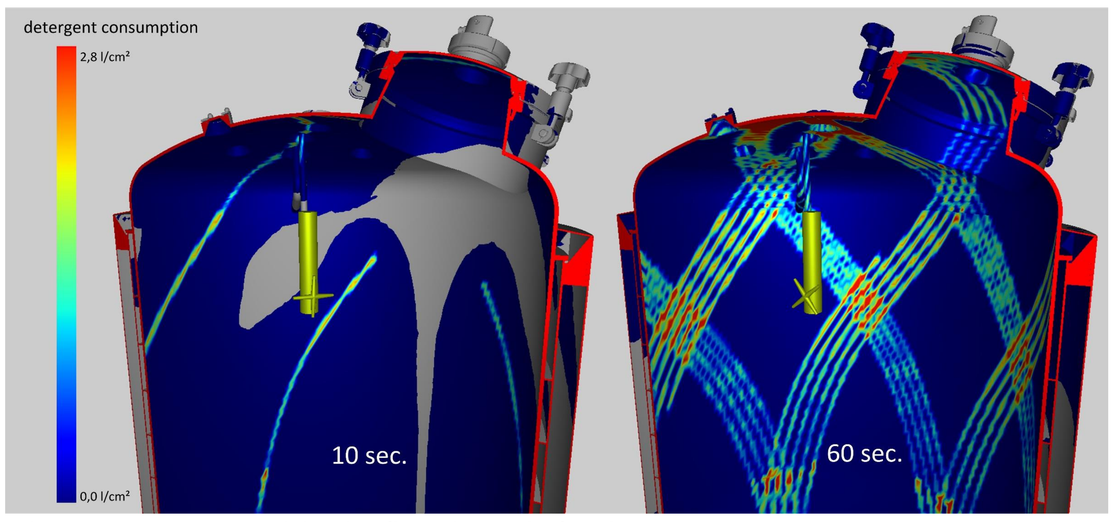

Fig. 2: Two steps out of the timeline of a Tank cleaning process

Once a critical area has been identified, even minor adjustments to the nozzle orientations can result in significant cleaning improvement and lead to time savings. It can be carried out a quick and inexpensive review of various cleaning systems, which provides a first substantiated statement about the corresponding cleaning result.

The 3-year project will end in December 2018 and the release of the developed software will be in the second quarter of 2019.

Benefits

- Calculation reliability as well as time and cost savings in plant planning
- Early recognition and consideration of cleaning-critical areas in the constructive development process
- Virtual comparison of variants - fast and cost-effective way to the best cleaning system
- Avoidance of costly iterative adjustments to the prototype and permanent oversizing
- Savings in cleaning time and detergent thanks to optimized cleaning systems

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