Unsteady simulation of the painting process with high speed rotary bells

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Abstract

High-speed rotary bells are widely used in automotive industry, as they provide high quality paint films. To obtain reasonably high transfer efficiencies, the paint droplets are charged immediately at the atomizer, leading to an additional electrical force on the droplets directing them towards the grounded target.

As an extension of previous work of the authors related to the simulation of electrostatically supported painting, this paper describes new results of the true dynamic painting process with moving atomizers. As before, the commercial program FLUENT has been used as a vehicle, with complementary subroutines to account for the unsteady charging of the droplets, the calculation of the static electric field and the space charge effect. The dynamic meshing approach has been chosen to calculate the unsteady grid between moving atomizer and fixed target. The calculation domain has basically been divided into a static zone (fixed target), a moving zone (moving atomizer) and a dynamic zone outside the major spray cone.

Concerning the main purpose of these calculations, i. e. the local thickness of the paint film on the target, the dynamic calculations presented herein deliver a very good agreement with experimental results. Local differences even on complex targets are typically less than 2 µm, which is within the reproducibility of the experiments.

In general, this approach can be used to simulate the painting process of almost arbitrary geometries. The dynamic mesh model presented is, together with all the extensions described above, compatible with the current FLU-ENT code and can be fully parallelized. Nevertheless, there are still several steps to go before this approach can be used directly to solve industrial problems. On a state of the art PC-type computer, CPU time is several days to calculate 1,5 m of atomizer movement

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