Simulation of centrifugal pumps based on MPS solver (PARTICLES 2021)

Feng Wang*, Zhongguo Sun†, Yijie Sun, Ziqi Zhou, Peidong Han, Guang Xi

School of Energy and Power Engineering
Xi'an Jiaotong University, Xi'an 710049, China
e-mail: sun.zg@xjtu.edu.cn, tel15578832344@stu.xjtu.edu.cn

ABSTRACT

In this article, a three dimensional full-scale centrifugal pump is, for the first time, simulated using the moving particle semi-implicit method(MPS). The genetic smooth wall boundary(GSW) is used and extended to three dimension to deal with the complicated wall shape and thin blades in turbo-machines. The non-surface detection technique(NSD) based on conceptual particles is combined with this wall model to avoid the loss of particle number density near wall boundaries. A local wall particle refinement method is developed. Fine particles and coarse particles are applied to curved surface and flat surface respectively so as to reduce the computational cost while maintain the high discretization precision. The fully developed velocity inflow and pressure outflow boundary conditions are proposed. Three typical cases including hydrostatic cases with complicated geometry, flows over a two-dimensional backward-facing step, and flows in a three-dimensional tube are tested to verify the proposed models. This paper constructs a framework for the simulation of incompressible fluid machines, in which 3D complex revolving bodies can be integrally discretized and interactions between the stator and rotor can be integrally solved within a single coordinate. This paper provides a particle-based solver for incompressible fluid machinery and has the potential to study its inner flow with multiphase or phase change.

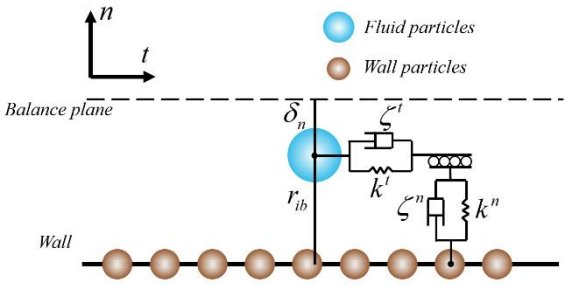

Fig.1 The wall-particle contact model in the GSW boundary

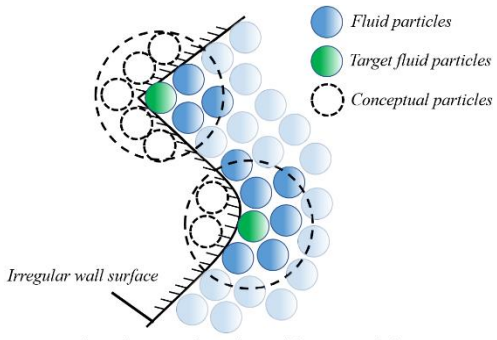

Fig.2 The GSW boundary with NSD technique

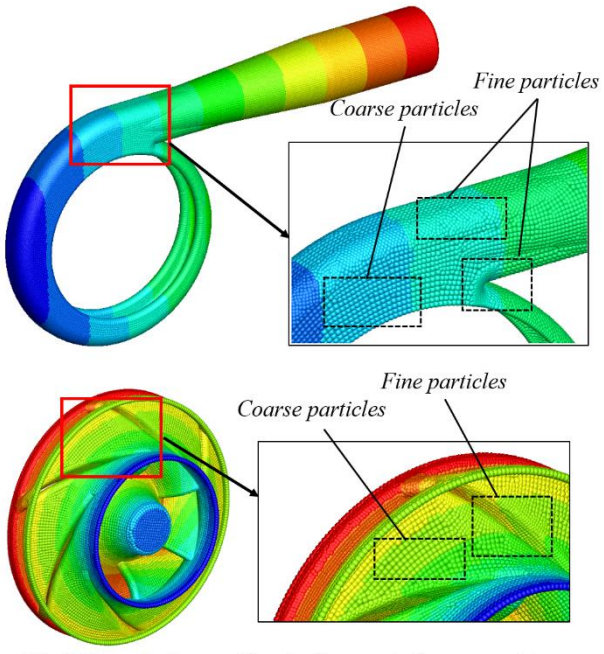

Fig.3 Discretization and local refinement of pump model

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