Comparison of Wear Models using a Lagrangian Approach

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ABSTRACT

The use of renewable energies such as electricity generated by waterpower is becoming more and more popular. The generation of electricity by waterpower brings with it a number of problems. One of these is abrasive wear of the hydraulic machinery. The decrease of the efficiency of a hydraulic machinery, e.g. a pump, by abrasive wear is not negligible [1]. Of course, there are several other mechanisms which can also cause the damage of a hydraulic machinery. In this work the main interest are fluids with particle loading and the analysis of abrasive wear. The working fluid transports so called abrasive particles which cause a damage of the surface of the hydraulic machinery. We present an approach for predicting abrasive wear, which is able to handle the fluid particle interaction as well as the prediction of abrasive wear on the boundary, e.g. a bucket of a pelton turbine.

There are different approaches for modeling abrasive wear. Depending on the level of detail of the simulation various methods are applied. In several studies grid based methods are used or the combination of grid based and grid less methods. Of course there are projects which use only grid less methods for resolving mechanism of abrasive wear like chip building in detail [2]. The disadvantage of an approach like this is the huge number of required particles for larger scenarios. In this work we also use grid less methods and for the prediction of abrasive wear we use wear models. In this way we are able to resolve large simulation scenarios. Advantages of the grid less methods are the natural handling of the interface between the fluid or the solid particles and the description of the free surface of the fluid with particle loading. We describe the fluid with the Navier Stokes Equation and apply the Smoothed Particle Method (SPH) for the discretization. The discretization can be summarized in two steps in the kernel approximation and the particle approximation [3]. The solid particles the loading of the fluid are modeled with the Discrete Element Method (DEM) [4]. Also, the boundary geometry is discretized with special DEM particles which are also applied for the prediction of the abrasive wear. We use different wear models, e.g. the Finnie model [6], for predicting the abrasive wear.

The simulation methods are implemented in the software package Pasimodo [5]. We will briefly discuss the simulation methods and then go into more detail for our approach for coupling the simulation methods and the prediction of the abrasive wear. We investigate our approach for handling of the interface and the modeling of the abrasive wear and present the results. Another crucial point concerning particle simulations in general are the computational costs of particle simulations. We will present our strategy for the parallelization of the software package Pasimodo and presents some results of the simulation on the supercomputers of the High Performance Computing Center Stuttgart.

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