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THEME: (please keep one item)

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MODELLING AND SIMULATION OF PARTICLE MILLING IN A STIRRED TANK USING A COUPLED APPROACH CFD-PBE

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Milling process is a common operation unit in many industries such as pharmaceutical, food, paint industries. In nuclear industry, one of the step to produce MOX fuel is the milling and the mixing of oxide powders. This step needs to be optimized in order to increase the rate of production and the homogeneity of the resulting powder. It has been shown that wet grinding allows to reduce the time required for milling and also to yield energy saving compared to classic dry grinding [1]. In the present study, numerical simulations of a new wet milling process for oxide powders are carried out. The aim is to predict the time evolution of oxide powder granulometric distribution under different operating conditions. The prototype used for milling, is composed of a stirred tank with a central impeller and spherical grinding medias.

These simulations are based on a coupled approach with computational fluid dynamics (CFD) and population balance equation (PBE). The convection term of the equation, often neglected, is taken into account in our model. CFD gives local information on the flow to compute the source term of the PBE. Aggregation of particle is neglected, only breakage is considered. Moreover, we suppose that the breakage only occurs when particles are involved in a collision between two grinding beads. Fluid shear or particle collisions do not lead to breakage. Thus, the kernel of breakage is modeled by the collision frequency of grinding medias corrected by an effective factor taking into account the capture probability and the breakage probability. These data are provided by the CFD simulations (Figure 2).

The simulations are carried out with the numerical software Neptune_CFD. Eulerian-Eulerian approach is used to simulate the two-phase flow: an equivalent fluid (composed of the carrier fluid and the powder to be milled) and the grinding beads. The rotating part of the geometry is taken into account by the approach described in [2] (Figure 1). The PBE is implemented in the software using the class method. Hydrodynamic validations are done

by comparison with experimental data given by [3]. Moreover, powder granulometric distribution evolution is compared to experimental data to verify the accuracy of the model and to determine the breakage distribution function through the method proposed by [4].

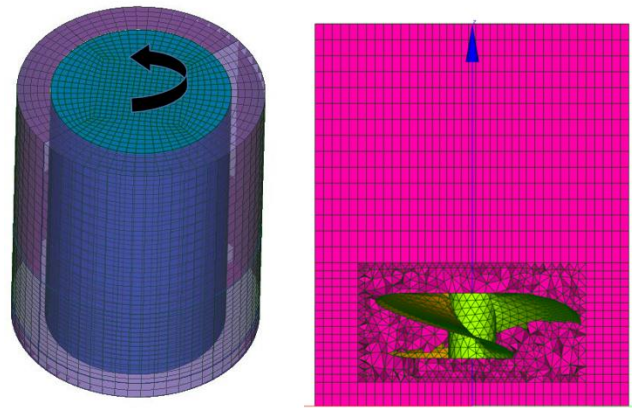


Figure 1: Mesh grid the simulation domain. (Left figure) the outer cylinder is fixed (Stator) while the blue cylinder is rotated around Z axis (Rotor). (Right figure) A tetrahedral mesh is use around the blade (fig2).

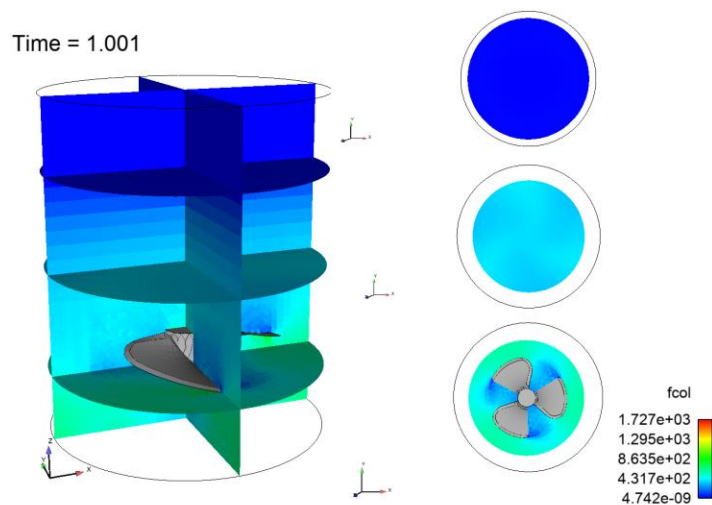


Figure 2: Spatial distribution of the collision frequency of zirconium beads (5mm) from numerical simulation (stirring speed : 600rpm). The carrier fluid is liquid nitrogen.

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