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MODELLING OF INTERACTION BETWEEN SUSPENSION AND STRUCTURE IN A TUMBLING MILL

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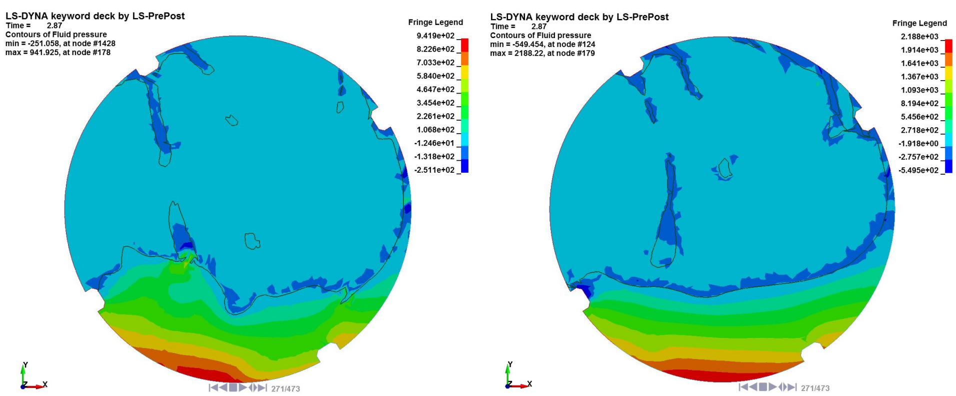
Fluid-structure interaction (FSI) problems and problems involving free-surfaces occur in many engineering applications and are often rather difficult to handle numerically. FSI problems includes interaction of deformable and or moveable structures with surrounding or internal fluid flows. Development of accurate methods to simulate FSI would have many benefits in numerous industrial applications e.g. reducing the need for experimental testing and recent efforts have been made in this field, [1]. Hydro power turbines, aerodynamics of wind power turbines and lubrication of mechanical components are examples of applications where FSI play an important part. This work investigates the possibility to use the new Incompressible Computational Fluid Dynamics (ICFD) solver implemented in the R7.0.0 version of LS-Dyna. The studied case is a tumbling mill, used in the mining industry, partly filled with different fluids. The interaction between the rigid cylinder casing and the fluid inside the mill and the behaviour of the free surface are studied topics. Modelling of wet milling is a complex multi-physics problem and usually a combination of different numerical methods are used, [2].

The studied tumbling mill, see Figure 1, has a volume of $31.8 \cdot 10^{-3} m^3$ and was filled with two different fluids, water and a suspension of magnetite in water. The mixture of magnetite and water was considered as one homogeneous fluid with the density $2500 kg/m^3$ and dynamic viscosity of $267 mPa{\cdot}s$, compared to water with dynamic viscosity of $1 mPa{\cdot}s$. The mill was filled to 30% of its total volume.

One of the main purposes of this work was to investigate how well the ICFD solver in LS-Dyna could handle free surfaces and to reproduce the behaviour of two different fluids. Different rotational velocities for the grinding mill was evaluated. From performed simulations it was possible to make a comparison between experimentally measured torque on the mill casing and torque calculated with the ICFD-solver. For lower rotational velocities the results shows a similar trend of increasing torque with increasing velocity and dynamic viscosity. A comparison between the development and handling of free

Figure 1: Tumbling mill used in experiments



(a) Water (b) Magnetite suspension

Figure 2: Free surface representation in mill at 28 rpm.

surfaces with the two different fluids is shown in Figure 2. In Figure 2 the line represents the free surface of the fluid, the formation and interaction of fluid that has separated from the main region can also be seen as droplets falling from the mill casing and impacting the fluid surface. The contours of the plots shows the fluid pressure.

The ICFD-solver shows good potential in handling FSI and free-surface problems when it comes to results and calculation times. Compared to other previously used methods for solving complex FSI problems, such as smoothed particle hydrodynamics (SPH), the ICFD-solver can be beneficial due to, in some cases, shorter computational time.

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