Study of the Process, Design, and Operating Parameters Effect on the Efficiency of the Process Mill

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Abstract

The study is dedicated to a computational model for the process mill using COMSOL Multiphysics® software for finite element modeling. The process mill (see Figure 1) consist of a horizontal cylindrical shell (stator) equipped with renewable liners and rotating hammers (rotor) for milling of drill cuttings. A finite element model of the process mill was constructed using dimensions similar to the actual process mill (see Figure 2). The physics interface Rotating Machinery, Laminar Flow (rmspf) in the COMSOL CFD Module was used. The Frozen Rotor study was employed in the simulation. Boundary conditions such as the rotating wall, wall, and flow continuity were clearly defined as shown in Figure 3. The Figure 4 (a) - (f) shows the different components as they were introduced during the building of the geometry. The model was simulated under the current operating conditions of the process mill and was referred to as the reference simulation in this work. This gave us the basis for comparing the various effects on the relevant parameters on the process mill. The simulation was extended to cover the effects of some selected design, process, and operating parameters on the velocity (the speed of the spinning material in the process mill drum) magnitude, the velocity profile as well as the effect on the efficiency of the process mill.

A major advancement in this regard was the different graphical display of results after computing the model with COMSOL Multiphysics®. The study of several parameters within affordable computational time was dependent on the mesh size.

Furthermore, an algorithm was developed in order to determine the response time of temperature change inside the process mill through a particular location in the simulation domain. The effect of relevant process parameters (such as process temperature and temperature change within the process mill) and the thermocouple tip position on the lag in temperature transmission was studied for models without liners and models with tungsten carbide liners.

The visualization of complete simulation data for each FE model was devised in Microsoft Excel®.

The effect of viscosity, hammer thickness, angle between adjacent hammers, distance between

adjacent hammers, rotational frequency and number of hammers on the velocity magnitude and the efficiency of the FE model of the process mill were also studied through simulations.

Reference

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Figures used in the abstract

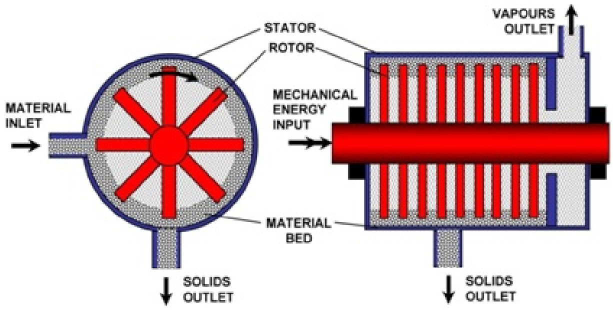

Figure 1: Principle sketch for TCC (Source: Kleppe, 2009).

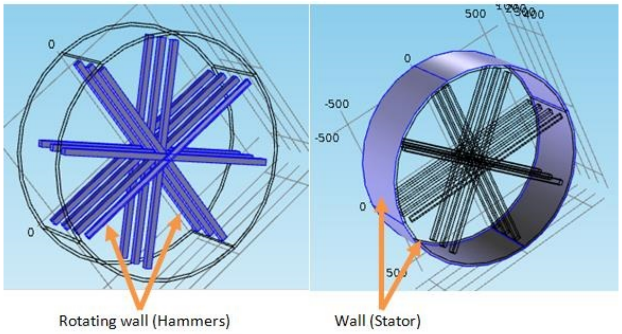

Figure 2: Model of the process mill.

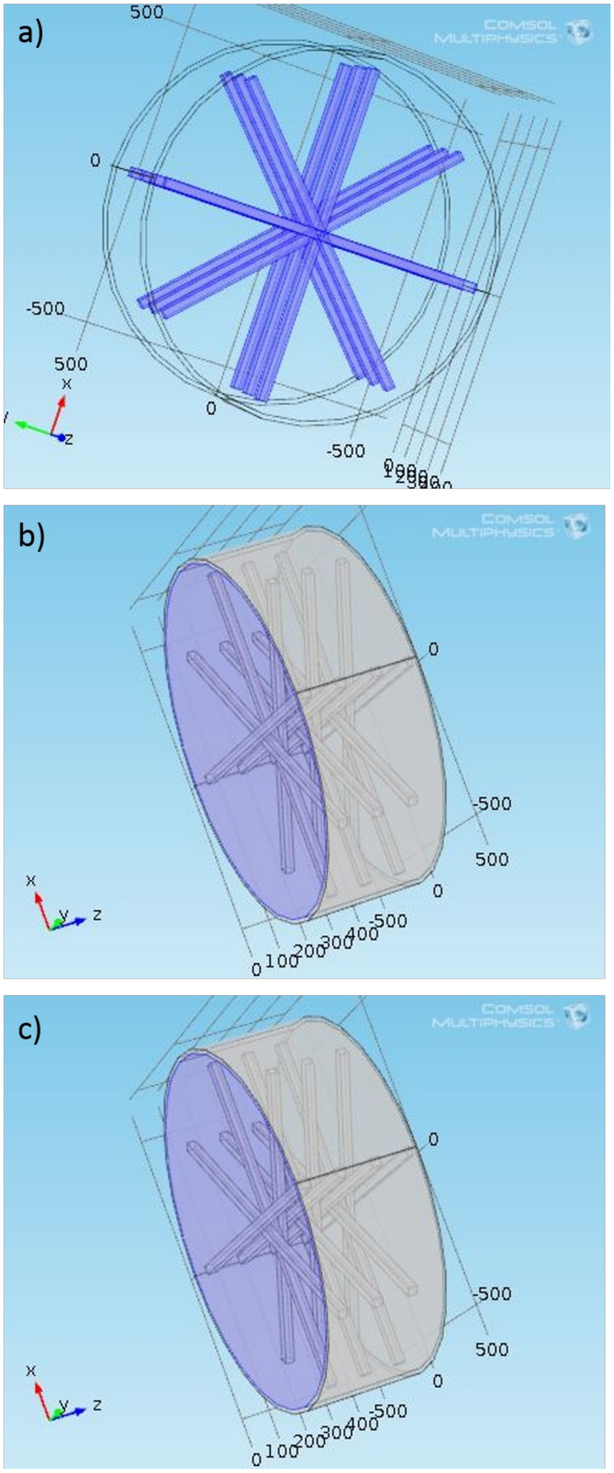

Figure 3: Boundary conditions applied at the highlighted boundaries: a) Rotating Wall; b) Wall; c) Flow continuity.

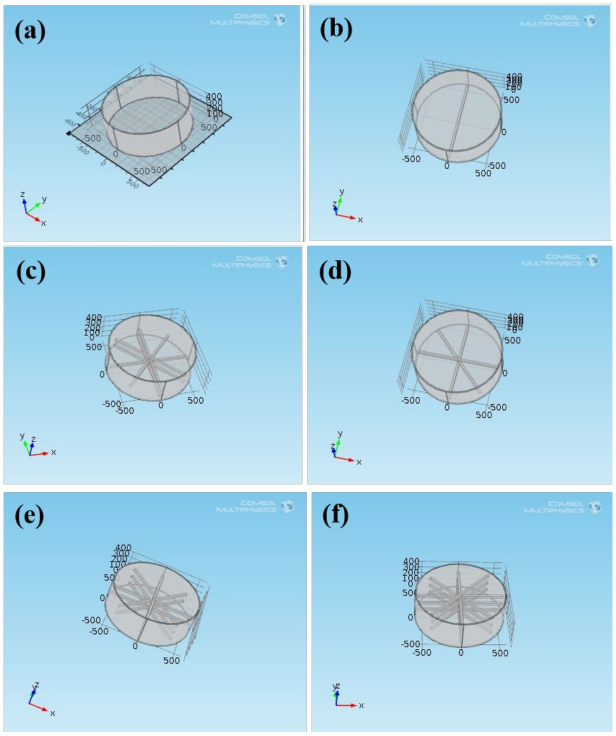

Figure 4: Different geometries used in the study.