Effect on unsteady flow on a particle orientation process in rotating container under high magnetic field

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Because of recent development of superconducting magnet, attention has been given to magnetic alignment. This technique aims at improvement of physical properties by controlling the direction of particles and crystals. When a particle with magnetic anisotropy is applied a rotating magnetic field, the smallest axis of magnetic susceptibility is aligned to the axis of rotation. In current studies, a container with particles which are dispersed in solvent is rotated in a static magnetic field in order to apply a rotating magnetic field. When a container with liquid is started to rotate or stopped, unsteady flow occurs in the suspension. Therefore, we have simulated unsteady flow of the suspension in a rotating container by CFD and examined the effect of the unsteady flow on the magnetic orientation process through numerical simulation[1].

This study considered the flow of fluid in a cylindrical container filled with liquid without particles and assumed axisymmetric flow. The size of the container is $r_0 = h$ =20 mm, the angular velocity of the container is $\Omega = 2\pi$ rad/s and the solvent is water. Figure 1 shows the streamline in a rotating container at t = 1 s from the start of rotation. This result indicates that the flow occurs in vertical section of a rotating container. Next, we investigated the effect of the flow on an oriented rod-like particle under rotating magnetic field $\boldsymbol{B}$. We assumed polyethylene fiber[2] with a diameter d and a length l and anisotropic susceptibility $\Delta\chi < 0$, as shown in Figure 2. In case of continuous rotating magnetic field, a rod-like particle is finally aligned parallel to the axis of rotation because the unsteady flow disappears as time goes by. However, in case of modulated rotation magnetic field[3, 4], the unsteady flow occurs each time the angular velocity is modulated. As a result of this, an oriented rod-like particle will always be affected by the unsteady flow.

Reference
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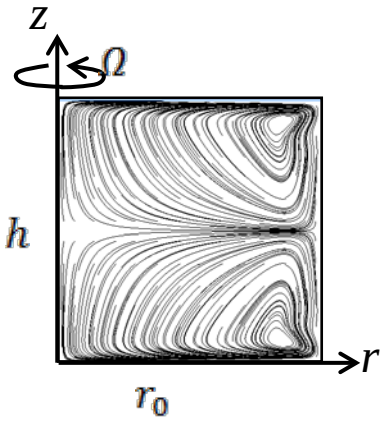

Fig. 1 The streamline in a rotating container at t =1 s.

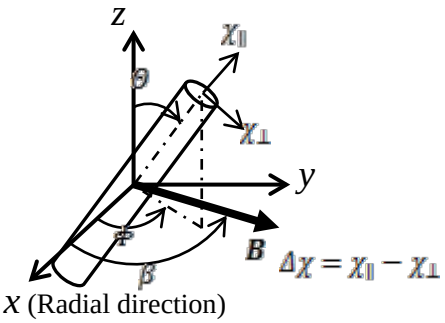

Fig.2 An axisymmetrical particle.