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Viscous fluid rotation arising as a result of outside recurrent force influence

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Viscous fluid behavior has been considered in a cylindrical tank vibrating harmonically. Surface effects were supposed negligible, that corresponds to view point location far from free surface. On the basis of nonlinear Navier-Stokes and continuity equations the condition of increasing of weak azimuth velocity perturbations has been obtained. When considered the expression has been assumed connecting pressure and velocity in case of viscous fluid:

$$p = p_0 - \rho g z - \alpha(\rho, \nu)\mathrm{v}^2, \tag{1}$$

where decomposition coefficient $\alpha(\rho, \nu)$ depends on kinematic viscosity and density of a fluid. Formula (1) is analogue of Bernoulli law [1,2] for the case.

So, the condition of fluid rotation arising is

$$\frac{\omega\nu\rho^2}{2\alpha(\rho,\nu)rK_0} \leq 1, \tag{2}$$

where driving periodic force can be represented as $\mathrm{K} = \mathrm{K}_0 \cos\omega t$.

Computer simulation of the process has been carried out also (see also [3]) and time dependences have been built for transversal and longitudinal velocity components.

Fig. 1. a) Model water motion in vibrating tank; b) v_t is the velocity component normal to driving force direction, v_l is the velocity component parallel to driving force direction.

References

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