

Boundary condition influence on instabilities in a low Reynolds free surface rotating flow

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- Fixed cylindrical cavity of radius R
- Rotating disc at the bottom
- Filled with a height h of water or water/glycerol mixture
- Free surface at the top
- Low rotation speed Ω

$$\Rightarrow \text{Aspect ratio } G = \frac{h}{R}$$

\Rightarrow Small Reynolds number

$$Re = \frac{h^2 \Omega}{\nu}$$

\Rightarrow Small Froude number

$$Fr = \frac{R \Omega^2}{g} \ll 1$$



1



2



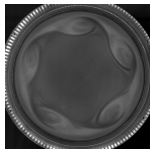
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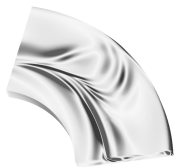


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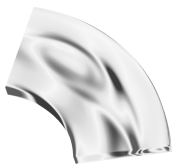


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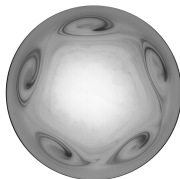
$h = 10\text{mm}$, $\Omega = 8\text{rpm}$,
 water + Kalliroscope,
 $Re = 84 (> Re_{cXP})$.



Free Surface, 1st branch



New boundary condition, 2nd branch



Experimental Result

⇒ Huge discrepancies on critical Reynolds number

⇒ “Free surface” is maybe too ideal to modelize the experimental boundary condition at the top.

- New α weighted Robin condition :

$$0 = \alpha * V_{r_{surf}} + (1 - \alpha) * \omega_{surf}$$

⇒ Highlighting a new instable branch

⇒ Qualitatively much more satisfying numerical visualizations

⇒ Numerical critical Reynolds number divided by two

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For any question, remark or discussion, come meet me near this poster ⇒

ABSTRACT

The experimental study of low Reynolds number flow in a liquid domain rotating with free surface is investigated in this work. The influence of the boundary conditions applied at the top surface is studied.

NUMERICAL METHODS

Two-dimensional axisymmetric numerical simulations are performed using the OpenFOAM software. The flow is modeled using the $k-\epsilon$ turbulence model. The free surface is modeled using the Volume of Fluid (VOF) method. The numerical results are compared with the experimental data.

EXPERIMENTAL METHODS

The experimental setup consists of a rotating tank with a liquid domain and a free surface. The flow is visualized using a laser sheet and a camera. The experimental data are compared with the numerical results.

REFERENCES

[1] J. Martin Witkowski, Y. Duguet, and Y. Fraignas, "Boundary condition influence on instabilities in a low Reynolds free surface rotating flow," *Journal of Fluid Mechanics*, vol. 850, pp. 1-20, 2018.

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INTRODUCTION TO FREE SURFACE ROTATING FLOW

Free surface rotating flow is a complex phenomenon. It involves the interaction between the rotating liquid and the free surface. The boundary conditions at the top surface play a crucial role in determining the flow characteristics.

RESULTS

The numerical results show that the boundary conditions significantly affect the flow stability. The critical Reynolds number for the onset of instability is lower for the free surface boundary condition compared to the rigid lid boundary condition.

CONCLUSION

The present study highlights the importance of the boundary conditions in the simulation of free surface rotating flow. The free surface boundary condition leads to a more stable flow compared to the rigid lid boundary condition.