Motion of a free cylinder inside a rotating water-filled drum

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Resumen

We report experimental results on the motion and levitation of a freely to-move heavy cylinder, of constant diameter and varying mass, inside a water-filled drum rotating around its horizontal axis. The resulting flow field and the cylinder dynamics were determined with the aid of flow visualizations and particle image velocimetry methods. The spatial tracking of the inner cylinder was done with the aid of Fourier cross correlation methods. The steady bulk flow field created by the drum rotation generated forces that make the inner cylinder to counter-rotate without contact with the drum walls. Testing different cylinder masses and rotating drum frequencies has shown that there exists a range of stable spatial positions of the inner cylinder describing an angular segment inside the drum flow. The cylinder frequency can be set to zero if we increase the drum frequency beyond a threshold value. Increasing the drum frequency produces a stronger secondary flow circulation which is the key-mechanism responsible of the counter-rotating cylinder frequency. At this point, the inner cylinder levitates with a constant separation from the drum walls close to half of its diameter. Tests on heavy hollow cylinders revealed that the fluid filling the cylinder remains at rest while the cylinder was under levitation with zero rotation frequency. (C) 2015 AIP Publishing LLC.

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