Hydrodynamic structure of the boundary layers in a rotating cylindrical cavity with radial inflow

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PHYSICS OF FLUIDS
Volumen: 28
Número: 3
Número de artículo: 033601
DOI: 10.1063/1.4943860
Fecha de publicación: MAR 2016
Ver información de revista

Resumen

A flow model is formulated to investigate the hydrodynamic structure of the boundary layers of incompressible fluid in a rotating cylindrical cavity with steady radial inflow. The model considers mass and momentum transfer coupled between boundary layers and an inviscid core region. Dimensionless equations of motion are solved using integral methods and a space-marching technique. As the fluid moves radially inward, entraining boundary layers develop which can either meet or become non-entraining. Pressure and wall shear stress distributions, as well as velocity profiles predicted by the model, are compared to numerical simulations using the software OpenFOAM. Hydrodynamic structure of the boundary layers is governed by a Reynolds number, Re, a Rossby number, Ro, and the dimensionless radial velocity component at the periphery of the cavity, U-o. Results show that boundary layers merge for Re << 10 and Ro >> 0.1, and boundary layers become predominantly non-entraining for low Ro, low Re, and high U-o. Results may contribute to improve the design of technology, such as heat exchange devices, and turbomachinery. (C) 2016 AIP Publishing LLC.

Palabras clave

KeyWords Plus: TESLA DISC TURBINE; FLOW; FLUID

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Financiación

Entidad financiadora	Número de concesión
CORFO Chile	Innova 10CEII-9007
CONICYT-Chile	FB0809
CONICYT- Chile	CONICYT-PCHA/Doctorado Nacional/2015-21150139

Ver texto de financiación

Editorial

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Categorías / Clasificación

Áreas de investigación: Mechanics; Physics

Categorías de Web of Science: Mechanics; Physics, Fluids & Plasmas

Información del documento

Tipo de documento: Article

Idioma: English

Número de acceso: WOS:000373600600030

ISSN: 1070-6631

eISSN: 1089-7666

Información de la revista

- **Impact Factor:** Journal Citation Reports®

Otra información

Número IDS: DI6HU