Patterns of convection in THETACO, the large turbulent thermal Taylor-Couette facility

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Several studies have been dedicated to the investigation of the flow regimes for deferentially heated cavities. Eckert and Carlson [1] experimentally studied the flow produced for air in a differentially heated rectangular cavity. Thomas and De Vahl Davis [2] carried out the numerical study of the convection flow between two concentric cylinders maintained at different temperatures. Three heat transfer regimes have been identified (conduction, transition, convection). Between concentric vertical cylinders, in the Taylor-Couette configuration, the nature of the heat transfer regime is determined by a criterion involving the radius ratio η, the aspect ratio Γ and the Rayleigh number $Ra = \alpha g \delta T d^3/\nu\kappa$ where α is the thermal expansion coefficient, δT is the temperature difference, ν is the kinematic viscosity and κ the thermal diffusivity [3]. The aim of this presentation is to present our work conducted in the convective flow regime obtained in the thermal turbulent Taylor-Couette facility *(THETACO)* [4] designed for the study of the turbulence generated by differential rotation and radial temperature gradient.The inner radius of the outer transparent glass cylinder is 152.5 mm and the outer radius of the inner black anodized aluminium cylinder is 132.5 mm, providing a gap width of 20 mm and a radius ratio $\eta = 0.869$. The height of the system is 1 m and $\Gamma = 48.75$. The cylinders were stationary and the working fluid was water with $Pr \approx 7$. The temperature of the outer and inner cylinders were set in order to obtain a temperature gradient $0.5 < \delta T < 20°\mathrm{C}$ and a Rayleigh number ranging from $5.2 \cdot 10^4$ to $3.3 \cdot 10^6$. Based on the work of Lopez et *al* [3], for our system, the transition value between the conductive and the convective regimes is $Ra^* = 2.08 \cdot 10^4$. Therefore, our study is performed in the convective regime. We will present visualizations, temperature and velocity fields for the different patterns observed in this convective regime. Linked to the abstract a figure that represents a spatio-temporal diagram for a high Rayleigh number. We can see two patterns, the ascendant pattern covers 60% of the height, the descendant one covers all the height and in the top of the facility, we can see the interaction between them both.

References

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