EXPERIMENTS AND SIMULATION OF A VORTEX TUBE

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ABSTRACT

In a Ranque-Hilsch vortex tube a compressible fluid experiences an expansion process leading to a separation into a hot and cold flow. The comparison between measurements and a three-dimensional computational fluid dynamics (CFD) model is used to investigate the flow process and the energy separation to explain the temperature splitting phenomenon of a Ranque-Hilsch vortex tube. The model results propose the existence of a turbulent swirl flow with secondary circulation, comparable to Taylor-Görtler vortices, in the peripheral region of the device. The fluid behaviour dominates the temperature distribution inside of the tube. Experimental data are obtained from a laboratory vortex tube operating with room temperature compressed air. Temperatures inside of the device and the exit and entrance temperatures of the vortex tube are measured. The numerical results are in good agreement with the experimental data. Experimental data and numerical results are presented. Furthermore, a mechanistic model for the vortex tube is discussed. It comprises a heat pump powered by the three-dimensional pressure distribution inside the vortex tube and the secondary circulation with its special properties of heat transport.