Mechanical Engineering Master's Defense

Optimized vortex tube bundle for large flow rate applications

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abstract

A vortex tube is a device of a simple structure with no moving parts that can be used to separate a compressed gas into a hot stream and a cold stream. Many studies have been carried out to find the mechanisms of the energy separation in the vortex tube. Recent rapid development in computational fluid dynamics is providing a powerful tool to investigate the complex flow in the vortex tube. However various issues in these numerical simulations remain, such as choosing the most suitable turbulent model, as well as the lack of systematic comparative analysis. LES model for the vortex tube simulation is hardly used in the present literatures, and the influence of parameters on the performance of the vortex tube has scarcely been studied.

This study is aimed to find the influence of various parameters on the performance of the vortex tube, the best geometric value of vortex tube and the realizable method to reach the required cold out flow rate 40 kg/s . We first set up an original 3-D simulation vortex tube model. By comparing experiment results reported in the literature and our simulation results, a most suitable model for the simulation of the vortex tube is obtained. Secondly, we perform simulations to optimize parameters that can deliver a set of desired output, such as cold stream pressure, temperature and flow-rate. We also discuss the use of the cold air flow for petroleum engineering applications.

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