UNIVERSITI TEKNOLOGI MARA

PERFORMANCE STUDY OF MODIFIED DESIGNS OF A RANQUE-HILSCH VORTEX TUBE USING GEOMETRY PARAMETERS AND HELICAL TAPES IN THE HOT TUBE

NURHASANAH ISMAIL

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ABSTRACT

This thesis contains a study about the effect of basic parameters (inlet pressure, orifice diameter, conical valve angle and nozzle height) and the addition of helical tapes in a hot tube on the performance of the Ranque-Hilsch Vortex Tube model A20400. There are two types of investigation that have been conducted in this study: (1) experimental and (2) numerical investigation. In the experimental investigation, the inlet pressure, orifice diameter, nozzle's height and conical valve angle were tested and their effects on the performance of the Ranque-Hilsch vortex tube were analyzed. From the experiment, it was observed that the swirl generator gave the most significant effect (isentropic efficiency 21%) on the performance of the Ranque-Hilsch Vortex Tube compared to other parameters. The phenomenon of vortex flow in the tube gave significant impact to the performance of Vortex Tube in terms of temperature separation. Then the research continued with improving the performance using numerical investigation by adding helical tapes in the hot tube of the Ranque-Hilsch Vortex Tube. Three revolutions numbers of helical tapes were used: 1.5 revolutions, 2.5 revolutions and 3 revolutions. The results show that by adding the helical tape on the tube wall, it helps to expand the cold temperature region that is located at the center of the tube and it reduces the temperature at the cold end of the Ranque-Hilsch vortex tube. In this study, the 1.5 revolutions helical tape resulted in the most expanded cold region and resulted in the lowest temperature compared to the others.

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CHAPTER ONE
INTRODUCTION

1.1 BACKGROUND OF STUDY

Ranque-Hilsch vortex tube (RHVT) is a mechanical device which is simple, light and compact (see Figure 1.1). It has one inlet and two outlets. The two outlets are located at both right and left end of the tube. A compressed stream enters the vortex tube through the inlet which then splits into cold and hot streams and exit from the tube through the outlets. At the outlet, the cold stream is colder than the inlet stream while the hot stream is hotter than inlet stream. In a RHVT, the cold end is located closer to the inlet compared to the hot end. The separation of the streams into cold and hot is referred to as temperature separation effect [1].

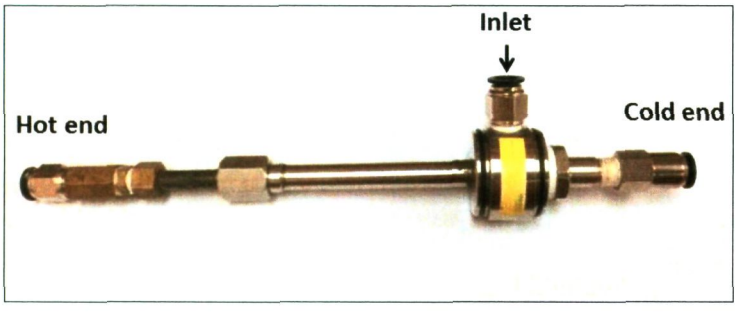

Figure 1.1: Ranque-Hilsch Vortex Tube (RHVT)

In 1933, a French physicist and metallurgist Georges Ranque invented a vortex tube which produced hot and cold fluid streams from compressed air. The effects of compression and expansion as the main cause for the temperature separation was proposed [2]. This vortex tube was then improved by German physicist called Rudolf Hilsch by aiming at improving the efficiency of the vortex tube by his own comprehensive experimental and theoretical studies. The effect of the inlet pressure and the geometrical parameters of the vortex tube was examined systematically on its performance [3].