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Vortex Tube Refrigeration System

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ABSTRACT: A vortex tube is a thermo-fluidic device, which generates both cold and hot gas from single injection of pressurised gas. Without any moving parts and chemical reaction within the tube, the interesting phenomenon of energy separation results only from fluid dynamic effects. The main part of vortex tube is a straight tube with tangentially entry, through which compressed gas is injected into the tube. There are two exit located at the different ends of tube. A controlled valve is positioned inside the tube, away from injection point, which has dimension smaller than the internal diameter of the tube and this allows the gas to escape from smaller gap between the tube and control valve. The cold exit is placed in the central part of tube near the injection valve. While the hot exit is the gap between control valve and the tube. When the compressed gas is injected tangentially into the tube hot gas will be exhausted from hot exit and cold air can be exhausted from cold exit. This phenomenon of energy separation in vortex tube is known as Ranque effect. As vortex tube does not use any harmful refrigerant, it is an Eco-Friendly component. This Eco-friendly nature and its compactness make Vortex tube to find it application in many fields like cooling the tool and work piece during machining in CNC and lathe.

KEYWORDS: CNC, vortex tube, controlled valve.

I. INTRODUCTION

Refrigeration is the branch of science which deals deal with the process of removing heat and maintain the temperature of space or material below the room temperature or given temperature. In other words, it is the process of removing heat. In air refrigeration system[2], air is used as refrigerant. In olden days' air was used widely in commercial application because of its availability at free of cost. Since air does not change its change i.e. remains gaseous throughout the cycle, therefore heat carrying capacity per kg of air is small as compared to vapour absorbing system. The air cycle refrigeration, as originally designed and installed are now practically obsolete because of their low co efficient of performance and high power requirements. However, this system continues to be favoured for air refrigeration because of the low weight and volume of equipment. allowed to circulate through the cooler and then return to the compressor start another cycle. Since the air is supplied to the refrigerator at atmospheric pressure, therefore volume of air to be handled by the compressor and expander is large. [3]Another disadvantage of the open cycle system is that the moisture is regularly carried away by the air circulated through the cooled space. This lead to the formation of frost at the end of expansion process and clog the line. Thus in an open refrigeration system, a drier should be used[6].

II. RELATED WORK

M. Yilmaz M. Kaya S. Karagoz Erdogan published a journal on A review on Design criteria for vortex tubes at Springer-Verlag on 16 October 2008 [1] explains the classification of vortex tube and some design criteria that has to be considered while designing Vortex tube. We have mentioned these design criteria in chapter-4(Important common results on design criteria of vortex tubes). This journals also explains some factors regarding selecting material for vortex tube.

Mohammad O. Hamdan, Basel Alsayyed, Emad Elnajjar published a journal on Nozzle parameters affecting vortex tube energy separation performance at springer-verlag on 27 November 2012 [2]. In this journal they increase the energy separation effect in Vortex tube by introducing number of nozzle. Later many number of tangential nozzle are placed in a device. In upcoming chapter, we have mentioned this number of nozzle as vortex Generator and we have



fabricated Vortex Generator. This journal also shows the results of Vortex tube under different condition (by increasing number of nozzle.

D. Li, J. S. Baek, E. A. Groll, and P. B. Lawless, 2000 [4], Thermodynamic Analysis of Vortex Tube and Work Output Devices for the Transcritical Carbon Dioxide Cycle , Preliminary Proceedings of the 4th IIR-Gustav Lorentzen Conference on Natural Working Fluids at Purdue

Van Deemter, J. J. (1952) [5]. On the Theory of the Ranque-Hilsch Cooling Effect An extended Bernoulli equation, adapted to turbulent flow, is applied to a model of the rotational flow in the Ranque-Hilsch vortex tube. It is shown that on the basis of this model a reasonable quantitative explanation of the cooling effect can be given. The experimental results of Hilsch and of Elser and Hoch agree for the greater part with this theory.

Saidi, M.H.; Valipour, M.S. (2003) [6]. Experimental Modeling of Vortex Tube Refrigerator. Journal of Applied Thermal Engineering an experimental investigation has been performed to realize thorough behavior of a vortex tube system. In this work attention has been focused on the classification of the parameters affecting vortex tube operation

Valipour, MS; Niazi, N (2011) [7]. Experimental modeling of a curved Ranque–Hilsch vortex tube refrigerator. International Journal of Refrigeration. Vortex tube is a mechanical device that operates as a refrigerating machine. This device separates a compressed gas stream into hot and cold streams. In this paper a series of experiments has been carried out to investigate the influence of uniform curvature of main tube on the performance of the vortex tube.

III. METHODOLOGY

Vortex tube was first discovered by Ranque and improved by Hilsch. The device they invented has the common name “vortex tube” or Ranque-Hilsch Vortex Tube (RHVT). The vortex tube or Ranque-Hilsch vortex tube is a non-conventional refrigeration system and is open refrigeration system .The vortex tube enables the separation of hot and cold air as compressed air flows tangentially into the vortex chamber through inlet nozzles. Separating cold and hot airs by using the principles of the vortex tube can be applied to industrial applications such as cooling equipment in CNC machines, refrigerators, cooling suits, heating processes, etc. The vortex tube is well-suited for these applications because it is simple, compact, light, quiet, and does not use Freon or other refrigerants (CFCs/HCFCs). It has no moving parts and does not break or wear and therefore requires little maintenance.

TYPES OF VORTEX TUBE:

Vortex tubes are classified by their main design features and flow configuration for the positioning of the cold exhaust, there are two different types:

- Counterflow vortex tubes and
- Parallel flow (uniflow) vortex tubes

COUNTERFLOW VORTEX TUBES

The gas is tangentially injected into vortex tube via inlet nozzles positioned next to the cold exhaust. A strongly swirling flow is created and the gas proceeds along the tube. The outer region of the flow is found to be warmer than the inlet gas, while gas towards the centre of the tube experiences cooling. Part of the gas in the vortex tube reverses for axial component of the velocity, and it moves from the hot end to the cold end. An orifice positioned just behind the flow inlets separates the cool central gas, which then exits the tube at the left- hand side. The warm peripheral flow leaves at the right- hand side of the tube, where a valve is positioned to allow regulation of the relative quantities of hot and cold gas.

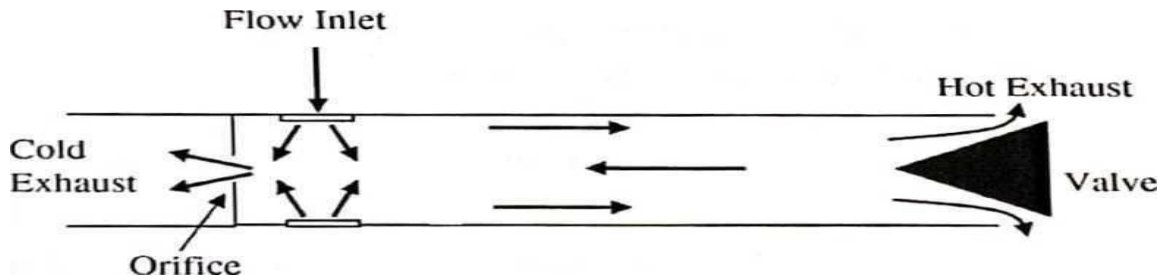


Fig 3.1 Counter Flow VortexTube

IV. EXPERIMENTAL RESULTS



Fig 4.1 Vortex Tube

A steel cylinder is taken and is cut into two pieces. Both cylinders are bored separately as per the dimensions shown in design of vortex chamber. A nozzle of diameter 6mm is placed between the two cylinder and then welded. Now the welded cylinder with tangential nozzle is turned in lathe machine. M16 thread of pitch 1.25 is made internally in both the hole (i.e. one hole is for joining hot tube and another hole is for joining cold end) of the vortex chamber. Vortex chamber. Air from compressor enters the vortex tube through 8mm house. Two thermocouple are placed at the two outlets of vortex tube. These thermocouples are connected to digital temperature indicator. Hot and cold end temperatures can be measured using these thermocouples. Inlet pressure can be measured pressure gauge which is fixed at compressor's outlet. The velocity of air coming out from both ends can be measured by anemometer. The hot end temperature, cold end temperature and velocity can be measured using thermocouple and anemometer respectively and the readings are tabulated.

V. CONCLUSION

COP of vortex tube is high when inlet pressure is high and when the hot end opening is small It is clear that always the performance of vortex tube is directly proportional to inlet compressed air. Placing a tangential nozzle in cylinder is complicated job, this complication can be avoided by Vortex generator. Vortex generator doesn't need tangential nozzle. Compactness, environment friendly, no wear and tear makes vortex tube to find its application in many places. The effect of number of nozzle is very important for improvement of COP.

REFERENCES

- [1] Maxwell's Demon in the Ranque-Hilsch Vortex Tube in the "physical review letter "dated 3 August 2012 explains the energy separation is due to appearance of pressure gradient inside the Vortex tube.
- [2] M. Yilmaz M. Kaya S. Karagoz Erdogan published a journal on A review on Design criteria for vortex tubes at Springer-Verlag on 16 October 2008.
- [3] Mohammad O. Hamdan, Basel Alsayyed, Emad Elnajjar published a journal on Nozzle parameters affecting vortex tube energy separation performance at springer-verlag on 27 November 2012.



- [4] D. Li, J. S. Baek, E. A. Groll, and P. B. Lawless, 2000, Thermodynamic Analysis of Vortex Tube and Work Output Devices for the Transcritical Carbon Dioxide Cycle , Preliminary Proceedings of the 4th IIR-Gustav Lorentzen Conference on Natural Working Fluids at Purdue.
- [5] Polihronov, J.; Straatman, Anthony G. (2015). Vortex tube effect without walls. in a recent publication it was proposed that rotational cooling is due to angular propulsion. S.Bhuvaneshwari, T.S.Subashini, “Automatic Detection and Inpainting of Text Images.
- [6] Polihronov, J.; et al. (2015). The maximum coefficient of performance (COP) of vortex tubes. This Xiaqing Liu and Jagath Samarabandu, “Multiscale Edge-Based Text Extraction From Complex Images”, IEEE Trans., 1424403677, 2006 .
- [7] Yunpeng Xue, Maziar Arjomandi, Richard Kelso (2010) A critical review of temperature separation in a vortex tube .



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