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Review on Vortex Tube

Surjeet¹

Department of Mechanical Engineering, Vivekananda Global University, Jaipur, India¹

surjeet_yadav@vgu.ac.in¹

ABSTRACT: A vortex tube is a basic system that divides a hot and cold stream from a high pressure gas stream without chemical reactors or external energy supply. It is a mechanical structure with no moving elements. The temperature isolation effect is called flow to low and high temperature zones. Two basic parameters are the performing function of the vortex tunnel, firstly the working parameter such as the inlet pressure. The geometrical parameters of the two are: number of nozzles, nozzle diameter, cone valve angle, hot-side tube duration, cold aperture diameter and vortex tube material; and the other are geometrical parameters. The Vortex tube has a number of industrial uses and is used as a fridge in manufacturing for cooling spots.

KEYWORDS: Cone Valve Angle, Material, Nozzle, Vortex Tube.

I. INTRODUCTION

Refrigeration is that the application of thermodynamics where heat is transferred from coldness region to heat region through refrigerant which is that the working fluid. But the refrigerants used causes environmental problems like ozone depletion and heating which have gave us how to believe nonconventional systems.

Vortex tube is one among the non-conventional systems where air are often used as working fluid to realize refrigeration. Vortex tube may be a simple device without moving mechanical parts, which converts high gas stream into two separate flows of various temperatures (cold and hot). Vortex tube consists of compressor, pressure gage, and control valve, thermocouple and temperature indicator (figure 1). Compressed gas from the compressor enters into the vortex tube tangentially. Thanks to tangential entry of compressed gas into vortex tube swirling flow takes place in vortex chamber. The compressed gas expands in vortex tube and divides into cold and hot stream.

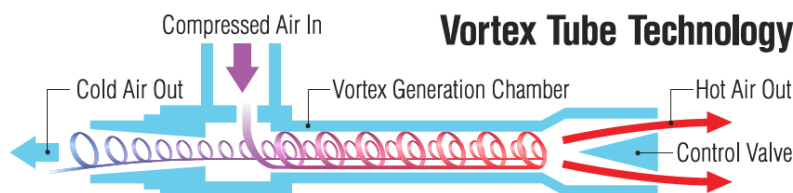


Figure 1: Vortex Tube[1]

The cold air leaves the cold end orifice which is near inlet nozzle and hot air discharges at far end of the tube i.e. hot end. Thermocouples measure temperature at cold end and hot end. Vortex tube has many advantages like no moving parts, no chemicals or electricity, low cost, light weight, maintenance free, durable, temperature adjustable. Vortex tube are commercially used for coldness applications like cool electronic parts, testing of thermal sensors, to line solders, cooling of

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electrical or electronic control cabinets, cooling of cutting tools. Other industrial application of vortex tube includes fast beginning the steam power station, nuclear reactors, gas separation and liquefaction of gas.

Room temperature compacted air is provided to the vortex tube. After entering the cylinder, the air goes through a spout intended to move the air digressively inside the cylinder, setting the air into a vortex movement. The turning air stream is along these lines constrained by the spout to alter its course and travel down the length of the cylinder as a turning shell. An uncommon tapered valve toward the finish of the cylinder permits a portion of the air to get away while redirecting the rest down the cylinder as a second vortex inside the bigger external vortex. This subsequent vortex at that point exits out the opposite finish of the cylinder.

While the external vortex drops down to one finish of the cylinder and the inward vortex moves the other way to the opposite end, both turn a similar way and with a similar rakish speed. Since the internal vortex has a more modest span, preservation of rakish force would have it pivot at a bigger precise speed. Accordingly, work was done to change its rakish energy and have it pivot at the more modest precise speed of the external vortex. The inward vortex loses precise force by interfacing with the external vortex and the motor energy that is lost appears as warmth in the external vortex. The external vortex turns out to be warm and the inward vortex is cooled. See reference (1) for a thorough investigation of how it functions.

A vortex tube may be a thermal device, which generates two streams at different temperature from one injection. Injected into the vortex tube tangentially, the gas is then divided into two parts and exhausted from the exits at temperatures lower and better than the inlet gas, respectively. During this way, cold and hot streams are generated by only the vortex tube with none additional components. The structure of a counter-flow vortex tube also because the proposed flow behavior inside the tube. Importantly, because the vortex tube contains no other part inside the tube, the separation of two streams at different temperature by the vortex tube can only be attributed by the consequences of fluid dynamics.

In previous investigations, the vortex tube has been shown to facilitate in cooling, heating and mixture separation. On comparison with other industry-based technologies, the many advantages of the vortex tube, like having no moving parts, being small, low in cost, maintenance free and having adjustable instant cold and hot streams, encourage the on-going investigations into the mechanism of this easy device, with the target of improving the tube performance and identifying of the first factors underlying its operation[2].

Several hypotheses are proposed for the essential of the temperature separation. These includes the pressure gradient within the vortex tube, internal friction of the fluid and friction between the working fluid and therefore the inner wall of the vortex tube, turbulence of the working fluid, the static gradient within the vortex tube, secondary circulation and acoustic streaming. Detailed discussions and analytical results of those hypotheses those reported in previous review indicate that a well-accepted explanation for the thermal phenomenon within a vortex tube has not been forthcoming thanks to the complex internal flow mechanisms.

Recently, Liew et al. reported that the adiabatic compression and expansion caused by the turbulent eddies, form the essential for the temperature separation, and supply a theoretical prediction of the temperatures supported the pressures at the exits. However, as reported within the previously published work, compression of the working fluid can't be considered because the reason for the temperature rise, because the pressure inside a vortex tube is usually less than the inlet pressure. This is often well supported by the measured pressure distribution along the vortex tube in both this and other research work[3].

This paper reports a completely unique explanation for the generation of hot and cold streams during a vortex tube and is predicated on partial stagnation and mixture thanks to the character of the multi-circulation occurring within the rear a part

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of the tube, and therefore the pressure gradient near the injection port[4]. The reason was firstly raised within the review of previous hypotheses, then improved during the series experimental investigations.

In this work, the detailed description of the reason is presented, which is well supported and validated by the experimental and analytical results of the flow behavior and flow properties inside the vortex tube. Visualizations of the flow structure, and measurements of the speed components in both air- and water operated vortex tubes, show that the proposed flow structure forces the flow to be divided into two streams at different temperatures[5]. The validity of the proposed explanation is additionally supported by comparison of the estimated temperature drop and its correlation with experimental data within the cold a part of the tube. Exergy analysis performed along the tube also shows that there's negligible energy transfer between different flow layers, which indicates the energy transformation of the peripheral flow is that the primary think about facilitating the temperature rise via the proposed flow structure. The working rule of the vortex tube is discussed in reference to the proposed mechanism, and is validated by the many correlation existing between the theoretical value and experiment results, which are obtained within the course of this study[6].

II. LITERATURE REVIEW

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III. RESULT AND CONCLUSION

For energy separation during a vortex tube the inlet pressure is that the necessary driving unit. Higher the inlet pressure greater is that the temperature difference of the outlet streams. The performance of the vortex tube is additionally influenced by the cold fraction. Energy separation and energy flux separation efficiencies are suitable for measuring the parameters to recover the characteristic properties of the vortex tube. Because the length of the vortex tube increases thus the magnitude of energy separation increases but only up to the critical length, however an extra increase within the length doesn't improve the energy separation. Because the diameter of the vortex tube increases the magnitude of angular velocities decreases and thus the magnitude of energy separation decreases.

Performance degradation occurs thanks to secondary the cold end orifice diameter. The utmost energy separation are often achieved by an optimum diameter of cold end orifice. The utmost value of performance factor is attainable at 60% of the cold fraction regardless of the inlet pressure and orifice diameter. The facility of cooling increases because the number of nozzles increases while the temperature at cold end decreases moderately. A rise of 8.7% are often observed just in case of 8 nozzles over a system with 2 nozzles. The second law efficiency improves with increase in nozzle diameter while the exergy destruction decreases. The temperature and therefore the variation of the temperature along the surface of the vortex tube helps locating the stagnation point along the axis of the vortex tube along the flow field.

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