iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 6 **Issue:** VII **Month of publication:** July 2018

DOI:

www.ijraset.com

Call: 08813907089 | E-mail ID: ijraset@gmail.com

Experimental Analysis of Multi Inlet Vortex Tube

Mr. Vishal K. Thakare[1], Mr. Rahul S. Fartode[2] Mr. Shrikant S. Dandge[3] Mr. Somnath M. Tondare[4]
[1,2]*PG Student Department of mechanical Engineering Dr. Rajendra Gode Institute of technology and Research Amravati,India*
[3, 4]*Associate Professor Department of mechanical Engineering Dr, Rajendra Gode institute of technology and Research Amravati ,India*

Abstract: The age of chilly and hot stream from a solitary infusion in a vortex tube has been examined by numerous analysts, planning to characterize essential explanations behind the division. This postulation reports detail portrayal of the stream conduct inside a vortex tube which is affirmed by various exploratory systems including perception of the stream structure in a water worked vortex tube, admeasurements of speed profiles in both water and air-worked vortex tube. Estimation of the hypothetical temperature drop in light of the weight angle of a power vortex stream is tended to in this and great concurrence with the exploratory outcomes was watched.

Vitality investigation of the stream properties in an air worked vortex tube demonstrates that there is no outward vitality move in the hot area of the vortex tube. Besides the representing factor for the temperature rise is credited to the stagnation and blend of the stream structure in view of the proposed component, the anticipated execution of the vortex tube with variable geometrical parameters, were compatible with the trial comes about, supporting of the proposed instrument.

As we have taken the readings on three different L/D ratio 30,35,40 and three different cold end orifice diameter 5mm,6mm,7mm as well as three different input pressures 3bar,4bar,5bar and we obtained different results by giving four inlets nozzles of 4mm diameter .

I. INTRODUCTION

General refrigeration systems use very harmful refrigerants, as they are the major cause for depleting ozone layer. Major research work is focusing on to eliminate the use of very harmful refrigerant but side by side we are focusing on their efficiency or COP.

Vortex tube is one of the non-conventional systems where natural substance such as air is used as working medium to achieve refrigeration. Vortex tube has been used for many decades in various engineering applications, which is an interesting experimental object with high development potential in the emerging area of energy and refrigeration engineering. Due to unique combination of technological and operational properties, commercial aspect of vortex tube is widening day by day, because of its compact design and little maintenance requirements; it is very popular in heating and cooling processes.

II. LITERATURE REVIEW

The generation of two streams at different temperatures from the vortex tube was discovered in 1930's by Georges J. Ranque. Since then it has been known as the Ranque effect and has been a popular research topic within the scientific community. Ranque proposed the compression and expansion effects as the underlying reasons for the process of temperature separation in a vortex tube [3,4]. Later, the geometrical parameters and performance optimization of the tube were further investigated by Rudolf Hilsch [5].

Since Ranque's discovery of the tube in 1933, the vortex tube has been investigated experimentally, theoretically and numerically, aiming to identify the dominant factors for the thermal separation phenomenon and to improve tube performance. Investigations of the vortex tube have been focused on several aspects, such as exploration of the thermal separation, optimization of the geometrical parameters, theoretical analysis of the thermal separation, and numerical simulation of the flow process, etc. In 1954, the research history of the tube was summarized by Westley [6] and a total of 116 publications were analyzed in his paper. Other reviews on the investigation of the vortex tube and its applications were published by Curley and McGree [7], Kalvinskas [8], Dobratz [9], Nash [10], Soni [11], Hellyer [12], Gustol[13]and Leont'ev [14]. In 2008, Smith and Pongjet [15] published a detailed review of the vortex tube, in which experimental, theoretical and numerical investigations were summarized. Yilmaz et al. [16] published another review in 2009, in which experimental parameters and design criteria were summarized.

III. EXPERIMENTALSETUP

Compressed air for the vortex tube is generated using air compressor. The experimental set up consists of compressor, FRL unit, control valve, nozzles, vortex tube with cold end & hot end and anemometer.The experiment is designed so as to do the experiment in vortex tube. The materials used for the construction of this new type of vortex tube are inexpensive and easily obtainable in the

©IJRASET: All Rights are Reserved

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887
Volume 6 Issue VII, July 2018- Available at www.ijraset.com

market. Experiment is set up with taking the diameter of the vortex tube is constant which is 16 mm. In this experiment we are varying the length of the tube in the L/D ratio 30,35 & 40. So we vary this length as 480 mm, 560 mm & 640 mm. We vary the cold endorifice diameter 5 mm, 6 mm, 7 mm and also we vary the inlet pressure i.e. 3 bar, 4 bar & 5 bar. With this parameter record the temperature & discharge for both ends.

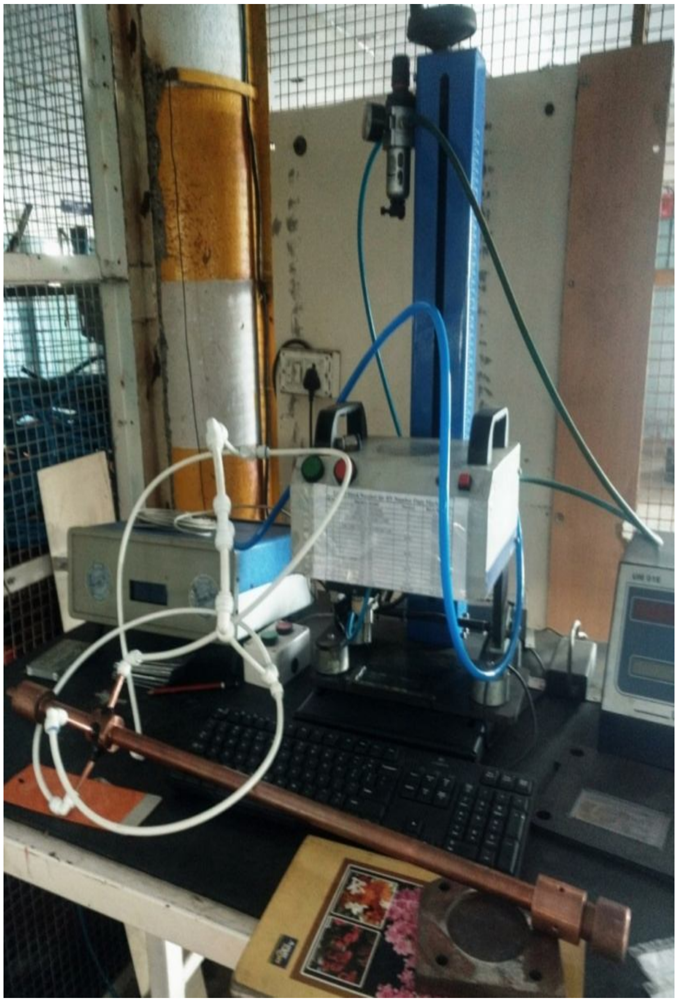


Fig.3.1: Experimental set up

A. Procedure

In this experiment compressed air from the compressor is given to the vortex tube through the pressure regulator ,pressure regulator regulates the flow that is we can select the required amount of pressure by pressure regulator, here in this experiment set up we considered 3 bar to 5 bar pressures. In this experiment setup we measured the cold end temperature and discharge with the help of Anemometer at different parameters. Compressed air from the compressor passes through the control valve and FRL unit and enters in the vortex tube tangentially. To ensure the tangentially entry of the compressed air in the vortex tube to have proper swirling of the air special care was taken. The compressed air expands in the vortex tube and divides into cold and hot streams. The cold air leaves the cold end orifice near the inlet nozzle while the hot air discharges the periphery at the far end of the tube i.e. hot end. In order to divide the compressed air uniformly a pneumatic connector is used which divide the incoming stream in to four separate streams and supplies to four nozzles of the vortex tube.

For recording the data firstly we select the length L_1= 480 mm and cold end orifice diameter is 5 mm. then initially compressor put on to get the compressed air at pressure 3 bar continuously from the receiver. The FRL unit is used to control the inlet pressure. After setting the inlet air pressure measure the temperature and discharge of cold end and hot end. Measure the same thing by varying the inlet pressure at 4 bar and 5 bar for same length & same orifice diameter. Repeat the procedure for same length but by changing the cold end orifice diameter. Take orifice diameter as 6 mm and 7 mm.

©IJRASET: All Rights are Reserved

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887
Volume 6 Issue VII, July 2018- Available at www.ijraset.com

IV. EXPERIMENTAL RESULT

Sr. No.	Orifice Diameter (in mm)	Length (in mm)	L/D	Tin (in ^{0}c)	Pin (in bar)	Tc (in ^{0}c)	Th (in ^{0}c)	Δtc	Δth	Efficiency (in %)
1	5	480	30	27	3	21.6	31.00	5.4	4.00	75.00868
2	5	560	35	28	3	21.7	33.90	6.3	5.90	84.38476
3	5	640	40	28	3	20.9	34.20	7.1	6.20	95.10029
4	5	480	30	27	4	20.4	32.50	6.6	5.50	75.32933
5	5	560	35	28	4	20.2	34.80	7.8	6.80	85.84609
6	5	640	40	28	4	19.2	35.80	8.8	7.80	96.852
7	5	480	30	27	5	19.4	33.90	7.6	6.90	76.86099
8	5	560	35	28	5	19.1	35.70	8.9	7.70	86.79369
9	5	640	40	28	5	18	36.50	10	8.50	97.521
10	6	480	30	27	3	21.8	31.80	5.2	4.80	72.23058
11	6	560	35	28	3	21.9	33.60	6.1	5.60	81.70588
12	6	640	40	28	3	21.1	33.90	6.9	5.90	92.42141
13	6	480	30	27	4	20.6	32.20	6.4	5.20	73.04662
14	6	560	35	28	4	20.5	34.80	7.5	6.80	82.54431
15	6	640	40	28	4	19.5	35.20	8.5	7.20	93.55022
16	6	480	30	27	5	19.6	32.80	7.4	5.80	74.83834
17	6	560	35	28	5	19.4	35.70	8.6	7.70	83.86806
18	6	640	40	28	5	18.3	36.00	9.7	8.00	94.59537
19	7	480	30	27	3	22.1	31.30	4.9	4.30	68.06343
20	7	560	35	28	3	22.2	33.10	5.8	5.10	77.68756
21	7	640	40	28	3	21.4	33.40	6.6	5.40	88.40308
22	7	480	30	27	4	20.8	32.80	6.2	5.80	70.76392
23	7	560	35	28	4	20.8	34.60	7.2	6.60	79.24254
24	7	640	40	28	4	19.8	34.90	8.2	6.90	90.24845
25	7	480	30	27	5	19.9	33.60	7.1	6.60	71.80435
26	7	560	35	28	5	19.7	35.30	8.3	7.30	80.94243
27	7	640	40	28	5	18.6	36.80	9.4	8.80	91.66974

V. CONCLUSION

The vortex tube is a mechanical device operating as a refrigerating machine without any moving parts, by separating a compressed gas stream into two low pressure streams, the temperature of which are respectively higher and lower than inlet stream. Such a separation of the flow into regions of low and high total temperature is referred to as the temperature (or energy) separation effect.

An experimental set-up is developed to carry out the experiments of four nozzle vortex tubes using air as the working fluid. Vortex tubes have been designed and tested. This vortex tube is tested at various operating conditions with air as working substance. We take the three different L/D ratio as 30, 35 & 40 and three different cold end orifice diameter 5 mm, 6 mm & 7 mm. We also vary the Input pressure as 3 bar, 4 bar & 5 bar. With these all parameter a series of experiments are performed to evaluate the performance of the system and to optimize the geometrical parameters.

Three L/D = 30, 40 & 50 and three cold end orifice diameter 5 mm, 6 mm & 7 mm are tested and the optimum value of

L/D ratio is found to be 40 and cold end orifice diameter is 5 mm. This optimizedvortex tube with four numbers of inlet nozzles and cold end orifice diameter of 5 mm gave the maximum cold end temperature drop of 10° C and maximum efficiency of 97.5% at pressure 5 bar.

©IJRASET: All Rights are Reserved

VI. ACKNOWLEDGMENT

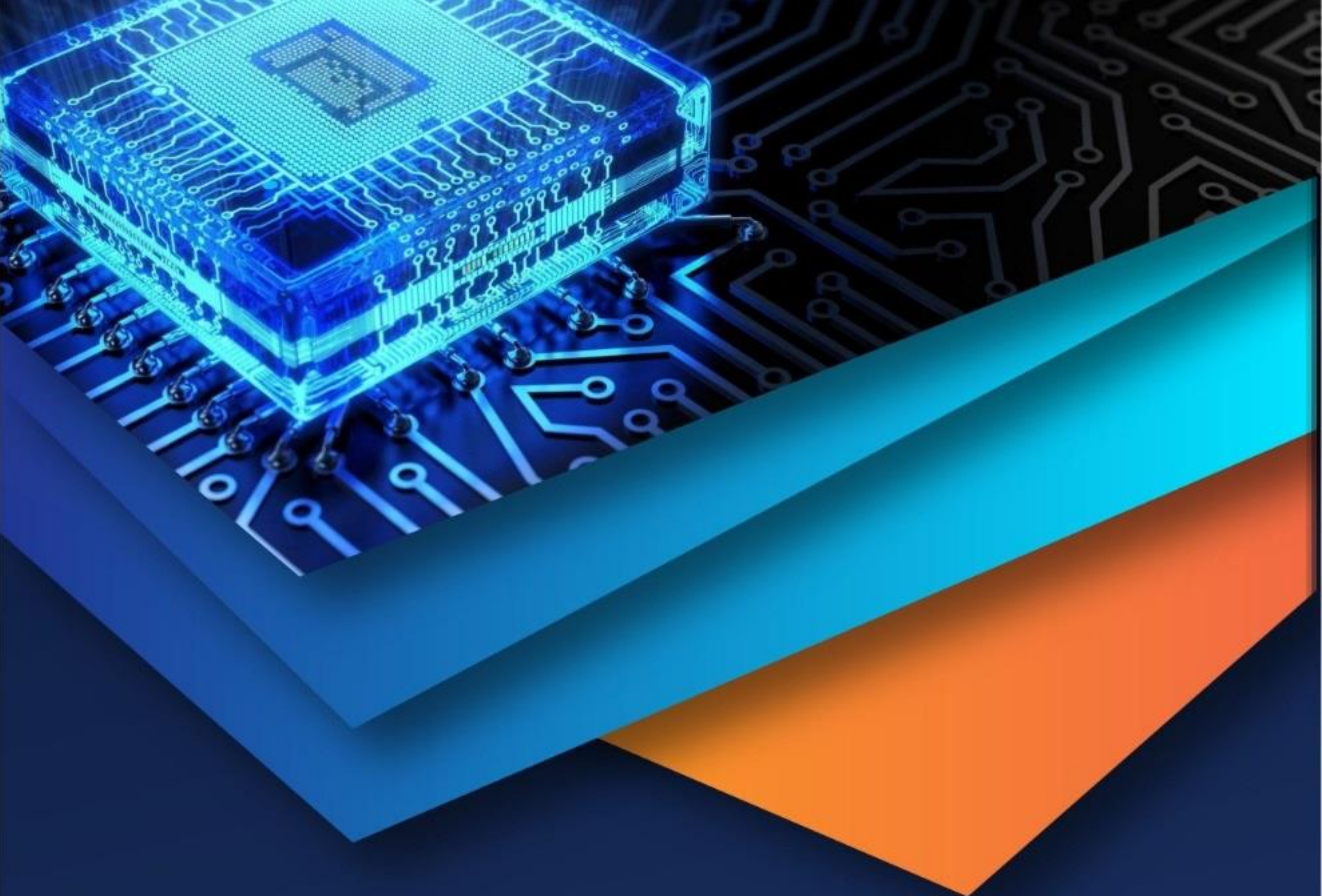
I am deeply grateful to Professor S. M. Tondare for giving me the opportunity to work on this project. I also would like to thank Prof. S. S. Dandge and Prof.K.R.Gawande for academic support throughout the whole course of this work & also thankful to Mr. Rahul S. Fartode for his support.

REFERENCES

[1] Sankar Ram T.,Anish Raj K. An Experimental Performance Study of Vortex Tube Refrigeration System ISSN: 2321-9939
[2] Gao C., Experimental Study on the Ranque-Hilsch Vortex Tube, PhD Thesis, TechnischeUniversities Eindhoven.
[3] G.J. Ranque, Method and Apparatus for Obtaining from A Fluid under Pressure Two Outputs of Fluid at Different Temperatures, in, US, 1934, pp. p. 28
[4] G.J. Ranque, Experiments on expansion in a vortex with simultaneous exhaust of hot air and cold air, J Phys Radium, 4 (1933) 112.
[5] R. Westley, A bibliography and survey of the vortex tube, College of Aeronautics. Cranfield note, UK, (1954).

.

©IJRASET: All Rights are Reserved



10.22214/IJRASET

INDEX COPERNICUS
45.98

IMPACT FACTOR:
7.129

IMPACT FACTOR:
7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Call : 08813907089 (24*7 Support on Whatsapp)