

Design and Fabrication of Vortex Tube

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Abstract— Design and fabrication of vortex tube In the application point of view the application of vortex tube it used in different small scale industries to get the two various type of gas flow which ever the application is important we can use as per our convience with same time. It saperates the flow of compressed air due to enegyry saperation effect. The main function of vortex tube is to convert the compressed flow air in to two different regions hot and cold side without moving any mechanical part. A vortex tube contains the different main parts vortex chamber inlet nozzle and cold trminal orifice, hot control valve and orifice. It works in such a way that the fluid enters in the tube circulates about an axis which is called as vortex. And that rotation creates a vortex from the compressed air and saperates that flow in two in air streams hot and cold. From its centre the supercooled air is passed and which is being deliverd though cold end port. The surface finish of nozzle and the tube i.e. hot end takes a important role in performance of Vortex Tube.in this paper the it is observe that the vortex tube with major values of surface roughness of cylindrical hot tubes are used to increase the efficiency of vortex tube . it results in C.O.P of vortex tube.

Index Terms— Vortex tube,vortex chamber, nozzles, digital thermometer, pressure gauge

1 INTRODUCTION

A vortex tube is element which can generate the flow without moving any mechani-cal component. which converts the gas flow in initially ho-mogeneous in temperature, in to saperate flow of dif-ferent temperatures. It separates the compressed glass stream in to a low temperature section and a high section such separation of flow in two regions low side and high side total temperature is considered as, the tempera-ture or energy separation effect. The vertex tube consists of the following parts one or more inlet nozzles, a vortex chamber, a cold side orifice, a hot control valve and tube. In general the vortex tube known by differ-ent names. The most well known name as is vortex tube ranque vortex tube.

In the days of power crisis much more importance should be given to power saving and energy conserva-tion. Efforts being concentrated on finding the new resource of energy or method of saving energy.

A very low cost, affordable, maintenance-free output to a different industrial cooling difficulties. Using main power source of compressed air , vortex tubes generates two differ-ent types of air flow , one section hot side other section cold side, without any roating component . Vortex tubes can produce:

Temperatures from -50° to 260°F (-46° to 127°C)
Flow rates from 1 to 150 SCFM (28 to 4248 SLPM)
Refrigeration up to 10,200 Btu/hr. (2571 Kcal/hr.)

Vortex Tubes is generally available in three different sizes. Each size gives a number of flow rates, as it is possible by a very small inner component name as generator. These three different sizes are low medium and high.With refrence to iis size it is being used in different heat pumps and refrigeration system as per the requirement of temperature of heating as as

same for cooling. Application of vortex tube is prefered in cooling of gas turbine rotor blades. Also used in different laboratories for cooling purpose.And the most appcable important purpose of vortex tube is used for heating and cooling application.

2 LITERATURE REVIEW

Refrigeration takes a major role in developing the countries generally it is preferred for food preservation of perishable goods also the mechanical refrigeration plays a very cruial role throught the cycle of their life. Also for providing the comfortable envirement especially it is used for commertial air conditioning and comfort air conditioning. It takes a vital role in storage of ice, blood medicines , preservation of photographic films archeological documents etc. by using Freon or R134a R-11 to R-50 as a refrigerant. Which the main source of deplating the ozone layer. After a long time a extensive re-search work is carried on for as a alternate refrigeration system. A vortex tube is found to be an excellet solution or alternate solution for refrigeration system. The vortex tube was first discovered by Ranque (1) Sony and Thomson gave the expression for design the vortex tube (2)Rudolf Hilsch [3] Con-ducted reasearch on vortex tube that highlighted on the thermal analysis with various inlet pressure and various geometrical parameters. In the previous years it was known that vortex tube is a simple and reliable and less cost maintainace free and an perfomative option for many spot cooling difficulties. Mohammad O hamdan (4) recently done the work on differents parameters of nozzles which effect the appearance of energy saperation In that case he experimentally do the analysis of appearance of vortex tube during energy saperation but the energy saperation phenomenon not completely understood clearly.Nimbalkr and muller (5) states that there will be an minimum cross section of the cold end orifice for performance of the maximum energy saperation.

The curret study investigate that the cooling effect and COP is get improved by increasing the internal surface roughness of cylindrical hot tube.

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3 WORKING PRINCIPLE

Initially the Compressed air from compressor at very large pressure is enters in vortex tube by passing from tangential nozzle. Due to this supply the air has very large velocity and it circulates at very large speed. due this reason the air is swirling r vortex roatation in vortex chamber.the focal core of the air is reserved by the implantation of conical valve which is preferably apply to maintain the internal pressure of the vortex tube. And the end of cold pipe which is made up with vortex chamber which is fix uwith washer that has half the diameter of pipe which is used. Also the washers of various sizes are preferred to manage the system. The outer stream exits the opposite end as hot air.

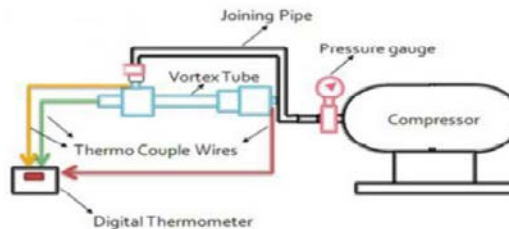


Fig 2 Experimental setup of vortex tube

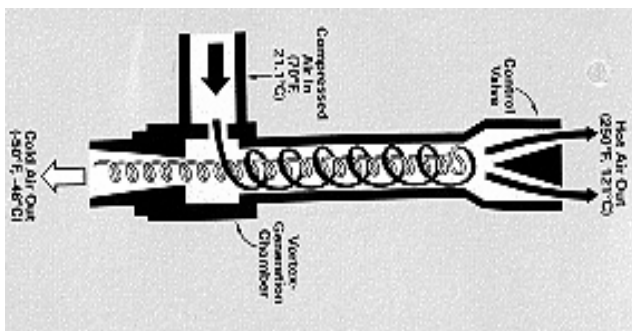


Fig. 1 Internal Structure Of Vortex Tube

Cold airflow and temperature are smoothly manage by adjusting the slotted valve in the hot section air outlet. Opening the valve decreases the cold airflow and also decreases the temperature of cold air. If we shut down the valve increases the cold airflow and also the cold air temperature. The percentage of air directed to the cold outlet of the vortex tube is called the "cold fraction". In most supplications, a cold snippest of 80% generates for mixer of cold flow rate and temperature drop that results in exeucation of refrigeration, or Btu/hr. (Kcal/hr.)

4 EXPERIMENTAL SETUP

The experimental structure includes compressor, vortex tube and temperature measurement device. A stoppers is provided at compressor reservoir at exit which control the inlet supply of air at the vortex chamber and the intenal pressure is detected with the help of pressure gauge and temperature of air at inlet and outlet (i.e. hot side and cold side and the compressed air from compressor is to be deliberate with the help of digital thermocouple.the fig 1 shows the operational appearance of vortex tube, During experimental procedure the compressor is run about 15 mins in intial stage to get the constant supply of compressed air up to 4 bar. Then the temperature of air at different location is captured and entered in tabulated form then same set of different values of pressure are temperature is recorded. The temperature of aircold and hot end is majorparameter that determine the C.O.P. of vortex tube and the experiment is perfoemed with different surface roughness values.

4.1 INNER SECTION OF VORTEX TUBE

A 2-D presentation of vortex tube is shown in figure bellow and when the temperature of compressed air which is compressed from compressed is preferably used as main power source at different inlet pressure. When the compressed amount air is entered in the centre portion of the vortex tube that section is called as vortex chamber and it segregates the air in to various sizes of inlet nozzles that provides the production of vortex flow inside the vortex generator.

Vortex flow is get devide in to two outlets where the cold side air exits from central portion of the vortex and the hot side air exits from the exterior parameter of vortex.

The experimental performance is performed in similar manner by procedure in which the compressor rotates for 30 minutes to reach the constant pressure of compressed air. The pressure of inner tank is maintained at constant pressure at 4 bar by using th pressure gauge we can adjust the pressure as per our requirement.

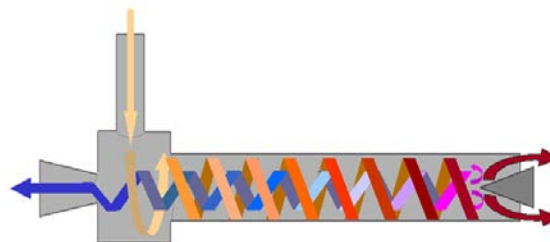


Fig 3 D Section Of Vortex Tube



Fig 4 Section of Vortex Tube Inlet Nozzle

All experimental runs are conducted in similar manner following a specific procedure,. Incase pressure drop inside the tank below 4 bars the test is being stop untill pressure is reached up esired level of air tank. A small plastic cable is used join the

connection at cold/hot outlet to allow fixing the thermocouples and to reduce the effect of heat transfer.

5 MATHEMATICAL ANALYSIS

The appearance of vortex tube is generally presents in terms of C.O.P.

C.O.P. – output /input

When the vortex is use as a cooling media cold section then the apparatus is called as refrigerator. the C.O.P. is generally is tabulated by deviding the output of cooling load on demanded input (energy of compression). The compression energy is tabulated by isothermal constant temperature process which present the minimum work.

$$(COP)_R = \text{Cooling load/Isothermal compression energy}$$

When the tube is worked as hot end the apparatus is called as heat pump and the value of C.O.P. on hot side is determined by

$$(COP)_{HP} = \text{Heating load/Isothermal compression energy}$$

TABLE 1
READING OF PRESSURE AND COP

S:NO	Pressure Pi(bar)	Cold temperature Tc (°C)	Hot temperature Th (°C)	COP
1	4	20	43	0.0992
2	5	18	44	0.1078
3	6	17	45	0.1067
4	7	15	47	0.1214
5	8	14	48	0.1266

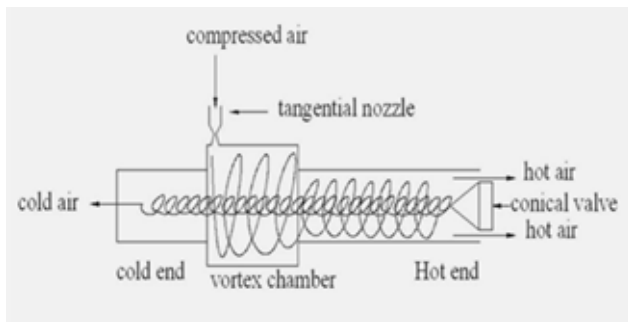


Fig 5 Conceptual Constructional diagram of Vortex Tube Inlet Nozzle

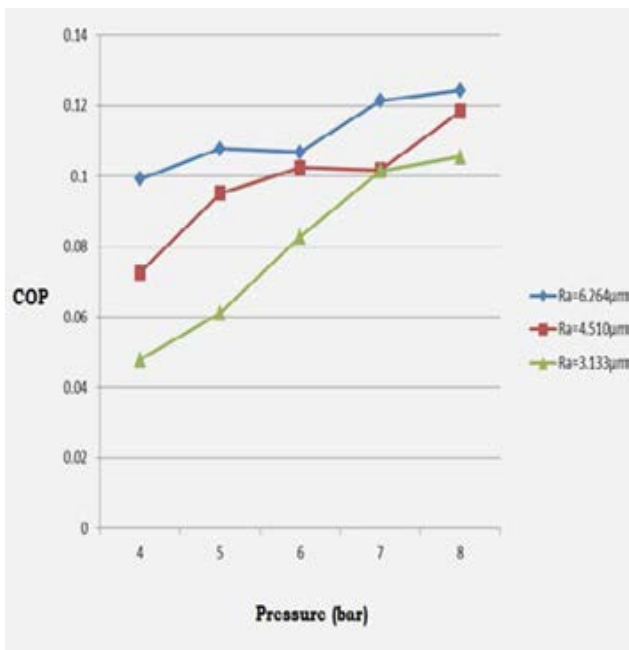


Fig 6 Graph of Inlet Pressure Vs COP

6 RESULT & DISSUSSION

We observed the tabulated data obtained above if we supply the internal pressure of air at 4 bar at the equal instant we appear the temp at cold side is 20(oC) and the temperature at hot side is 43 (oC) from the above tabulated data if we carefully observe when we improve the pressure at the same time the temp of air at cold end is decreases while the temperature of air at hot side is increases. If we consider in term of COP the value of COP is increases as well when the pressure is increases. From above calculations we can identify the highest value of C.O.P. which is seen in above calculation at 8 bar pressure.

7 CONCLUSION

Different experimets has been performed to find out the effective way of achieving the high performance of vortex tube under the different design parameters which are (1) internal pressure (2) Cold mass fraction (3)Total quantity of nozzle (4)proper location of Vortex stopper (5) Different angles of internal nozzles. The internal pressure is the main power source for the energy saperation. After a lot of experimental analysis it is being seen that larger temperature variation and larger C.O.P. is obtained as the internal pressure is increses in the overall performance of C.O.P. is also depend on the different parameter which is related to vortex tube.

In this paper it is conclude that the appearance of cyllindreceal hot tubes is identified form some of the experi- mental analysis which results in drop of cold end temperature and also improve the C.O.P. the cold tempratue is increases by increasing inlet pressue of compressed and from the experi- mental anylisis it is found that efficiency of vortex tube is achieved by increasing the surface roughness value of cyllindrical hot tubes. the surface roughness value of cyllindl hot tubes and nozzles plays a role to increase the efficiency of vortex tube.

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