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Design and Fabrication of Hand operated Air Cooler

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ABSTRACT:

Now a day's compressed air is being widely used for so many engineering applications like automobile braking systems, spray painting, Vortex Tube Refrigeration system etc. But the preparation of compressed air involves so much of energy as well as cost. In this project an attempt has been made to minimize the energy consumption as well as cost by introducing a hand operated mechanism is to operate a compressor, with the help of suitable linkages .It contains a reciprocating piston cylinder arrangement, a cylindrical vessel which preserves the compressed air. It can be used to operate a Vortex Tube Refrigeration system. There is a problem for Ozone layer by using existing refrigerants. In order to protect the Ozone layer it would be better to select an eco friendly refrigeration system. The vortex tube is a non conventional cooling device, which operates as a refrigerating unit without affecting environment. It has capability to separate hot and cold air stream from a high pressure inlet air; such phenomenon is called as temperature or energy separation process. Periodically the pressure developed inside the cylinder is preserved, as soon as the required pressure is developed inside the cylinder it is diverted to operate a Vortex tube Refrigeration system which provides cooling air continuously.

KEY WORDS: Vortex tube, compressor, belt drive, pulley, Pillow bearings, storage tank , check valve.

1. INTRODUCTION:

An experimental study has been conducted to evaluate the effect of working parameters such as inlet air pressure (P_i), Cold mass fraction (μ) and length of hot side tube (L_h) on the performance of Ranque Hilsch vortex tube. In this work, the counter flow vortex tube has been designed, manufactured and tested. Different parameters were evaluated like temperature reduction on cold side, temperature rise on hot side, refrigerating effect and isentropic efficiency. The performance of vortex tube has been tested with compressed air at various inlet pressures from 510 bar which supplied through two tangential inlet nozzles. The L/D ratio of hot side tube varied from 1050 and cold mass fraction varied from 0.20 – 0.80. The schematic diagram of counter flow vortex tube is given in below , which has been designed and manufactured.

II. EXPERIMENTAL SETUP

Fig.2.1.hand operated mechanism

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Fig.2.2.vortex tube

Despite the simplicity of vortex tube's geometry, the energy separation phenomenon is quite complex and this has lead to the publication of several, semi conflicting theories regarding its operation. Some researchers have suggested that energy is transferred as work due to viscous shear between a fast moving, inner core and a slower moving outer annulus that is characteristic of a free vortex (e.g. Lewins et al., 1999). Other researchers have described internal, refrigeration cycles associated with fluid motion due to turbulent eddies (Hartnett et al., 1957), sound waves (Kurosaka, 1982), Göertler vortices (Stephan et al., 1983), and secondary circulation (Ahlborn et al., 2000). In this paper the behavior of the vortex tube is modeled more simply – as a nozzle in series with a counter flow heat exchanger, an idea originally attributed to Sheper (1951).

A semiempirical model of the vortex tube is described based on this concept and predictions made using this model are shown to agree well with some experimental data. Recently the vortex tube has received some interest as a potential component in a cryogenic Joule Thomson (Nash, 1991) or traditional vapor compression refrigeration cycle (Li et al., 2000). This paper uses the semiempirical model of the vortex tube to evaluate the potential cycle efficiency improvement that can be attained when a conventional expansion valve is replaced with a Counter flow vortex tube in these refrigeration cycles.

Design Parameters of Compressor:
Power:162Kw
Capacity:7.5bar
No. of Cylinders:2

III. SYSTEM OPERATION:

It is one of the nonconventional type refrigerating systems for the production of refrigeration. The schematic diagram of vortex tube is shown .It consists of nozzle, diaphragm, valve, hot air side, cold air side. The nozzles are of converging or diverging or converging diverging type as per the design. An efficient nozzle is designed to have higher velocity, greater mass flow and minimum inlet losses. Chamber is a portion of nozzle and facilities the tangential entry of high velocity airstream into hot side. Generally the chambers are not of circular form, but they are gradually converted into spiral form. Hot side is cylindrical in cross section and is of different lengths as per design. Valve obstructs the flow of air through hot side and it also controls the quantity of hot air through vortex tube. Diaphragm is a cylindrical piece of small thickness and having a small hole of specific diameter at the center. Air stream traveling through the core of the hot side is emitted through the diaphragm hole. Cold side is a cylindrical portion through which cold air is passed.

IV. PRINCIPLE INVOVLED:

Joule Thomson (JT) cryogenic refrigerators rely on expansion through a throttling valve yet do not necessarily operate in the vapor dome. These refrigeration devices are used in low cost applications or in situations where reliability is of paramount importance such as tactical cryocoolers for infrared detectors, refrigeration for electronics, cryotherapy probes, and cryo coolers for space borne detectors. Figure illustrates schematically the Joule Thomson cryogenic refrigeration cycle and Figure 8 illustrates the cycle qualitatively on a Ts diagram. Notice that the JT cycle relies on the fact that a temperature drop is produced during the isenthalpic expansion through the valve (from state 2 to state 3). This allows a small warming of the refrigerant as it accepts the refrigeration load (from state 3 to state 4) before entering the recuperative heat exchanger. In order to be viable, the JT cycle must operate in a region where the Joule Thomson coefficient, the partial derivative of temperature with respect to pressure at constant enthalpy, is positive.

V.WORKING OF COMPRESSOR AND ITS TYPES:

(a) Based on principle of operation
(b) Based on number of stages
(c) Based on Capacity of compressors
(d) Based on highest pressure developed

VI. ADVANTAGES:

1) It uses air as refrigerant, so there is no leakage problem.
2) Vortex tube is simple in design and it avoids control systems.
3) It is light in weight and requires less space.
4) Initial cost is low and its working expenses are also less, where compressed air is readily available.
5) Maintenance is simple and no skilled labour are required .

VII. APPLICATIONS:

1) Vortex tubes are extremely small and as it produce hot as well as cold air. It may be of use in industries where both are simultaneously required.
2) Temperature as low as –5˚C can be obtained without any difficulty, so it is very much useful in industries for spot cooling of electronic components.
3) It is commonly used for body cooling of the workers in mines.

VIII. CONCLUSION:

A simple model of the Vortex Tube is described that captures the physics related to one possible operating Mechanism. The model is shown to faithfully reproduce a limited set of data if two empirical parameters are adjusted. The semi empirical model is subsequently used to evaluate the potential performance benefit associated with replacing the throttling valve in a refrigeration system with an approximately optimized Vortex Tube. An experimental study on the temperature separation in the Vortex Tube has been carried out and this research finding can be summarized as follows –

1. Temperature difference increases with increase in Inlet Pressure.
2. Availability destruction decreases with increase in tube length due to the increase in temperature difference.
3. Efficient working point of the existing design is at a cold mass fraction 0.84 for an inlet pressure of 5bar.
4. Availability destruction is less in the case of Vortex Tube operation with two nozzles than with one nozzle due to the increase in temperature difference.
5. The increase of the number of inlet nozzles led to higher temperature separation in the Vortex Tube.
6. Using the tube with insulation to reduce energy loss to surroundings gave a higher temperature separation in the tube than that without insulation around 23°C for the cold tube and 25°C for the hot Tube.
7. A small cold orifice (d/D=0.4) yielded higher backpressure with a large cold orifice (d/D=0.7, 0.8, and 0.9)allowed higher tangential velocities into the cold tube, resulting in lower thermal energy separation in the tube.
8. The performance of a conventional vapor compression refrigeration cycle cannot be augmented through the application of a Vortex Tube because no temperature separation can occur beneath the vapor dome.

IX.RESULT:

A temperature difference of 3-4 degrees is observed between the cold side and hot side. As it is a proto type large area cannot be cooled but further analysis and development of this type is useful in future for manufacturing eco-friendly refrigerators and air conditionars.

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