Study of single stage rotary vane vacuum pump

Amit Singh$, Saloni Patil$, Manpreet Singh$, S.P. Wadkar†

$UG Student, †Assistant Professor, Department of Mechanical Engineering, MIT College of Engineering, Kothrud, Pune, Maharashtra, India.

Email: amit80274@gmail.com, patilsaloni18@gmail.com,mp.singhh87@gmail.com, swapnil.wadkar@mitcoe.edu.in

Abstract

In a vacuum apparatus vacuum pump is the most fundamental component which is used to achieve necessary vacuum in the sealed system. It removes gas from the confined system. Vacuum pumps have wide range of applications based on required vacuum level which is measured in cfm. This paper is based on the extensive study of single stage oil sealed rotary vane vacuum pump. It emphasizes actual structure and working of singe stage vacuum pump. It also indicates the benefits and drawbacks of this pump.

Keywords: Vacuum pump, Rotary vane, cfm, Oil sealed.

1. INTRODUCTION

Vacuum is a negative gauge pressure, usually referenced to the existing standard barometric pressure where the equipment will operate. This means vacuum is a differential reading between the surrounding atmospheric pressure and the pressure in the system evacuated. In the simplest terms, any reduction in atmospheric pressure in a closed system may be called a partial vacuum. *

A vacuum pump converts the mechanical input energy of a rotating shaft into pneumatic energy by evacuating the air contained within a system. Internal pressure level inside the vacuum pump becomes lower than the atmospheric pressure. The amount of energy produced depends on the volume evacuated and the pressure difference produced. Mechanical vacuum pumps use the same pumping mechanism as air compressors, except that the unit is installed so that air is drawn from a closed volume and exhausted to the atmosphere. A major difference between a vacuum pump and other types of pumps is that the pressure driving the air into the pump is below atmospheric and becomes vanishingly small at higher vacuum levels. Vacuum pumps are divided into two main type positive displacement pump and momentum transfer pump.*

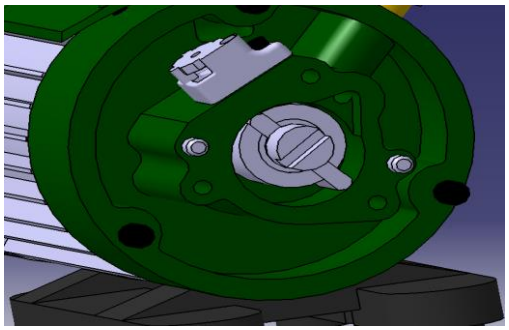

Fig. 1 Rotary vane vacuum pump

The positive displacement vacuum pumps are used to create low vacuums. This rotary vane vacuum pump expands a cavity which allows the gases to flow out of the sealed chamber. After that, the cavity is sealed and causes it to exhaust it to the atmosphere. The principle behind positive displacement vacuum pump creates a vacuum by expanding the volume of a container.*

In the rotary vane pump, the gas enters the inlet port and is trapped by an eccentrically mounted rotor which compresses the gas and transfers it to the exhaust valve. The valve of rotary vane vacuum pump is spring loaded which allows the gas to discharge when atmospheric pressure is exceeded. Oil is used to seal and cool the vanes. The pressure achievable with a rotary pump is determined by the number of stages used and their tolerances.

2. Design

A. Oil circulation

The oil sealed pump consist of an oil chamber which is completely sealed using rubber gasket. This chamber has integrated transparent oil level indicator so that required amount of oil can be maintained. To circulate this oil throughout the pump, an oil circulation pump is provided. This oil circulation pump is also a rotary vane pump which is mounted on the vacuum pump. The oil from the chamber is sucked in because of the partial vacuum created inside the circulation pump due to the eccentric rotation of the circulation vane. This oil is then transferred through the circulation exhaust port to the vacuum pump. Proper lubrication is essential for correct working of the pump also the wear and tear of vane and other rotating parts reduces.

B. Pump

The Rotary vane pump consist of a rotor in which groove is provided for vane. This rotor is connected to

motor. To keep continuous contact between vane and wall of pump, springs are provided. The rotor is attached to the pump with some offset. Rotor and vanes divide the working chamber into two separate spaces having variable volumes. As the rotor turns, expanding suction chamber is filled with the gas until it is sealed off by the second vane. The enclosed gas is compressed until the outlet valve opens against atmospheric pressure. The inlet valve is connected to sealed system under consideration, and outlet valve is opened to atmosphere.

3. Design considerations

Efficiency of pump can be obtained from (1),

$$\acute{\eta} Q_{(act)} / Q_{(th)}$$

Where, $Q_{(act)}$: Actual Discharge, $Q_{(th)}$: Theoretical Discharge, $\acute{\eta}$: Efficiency of the pump.

TABLE I DIMENSIONS OF THE PUMP

Frequency	50 Hz
Free air displacement	1.8 CFM
Motor Power	150W
Ultimate Vacuum	2 Pa
Dimensions(mm)	258*122*225

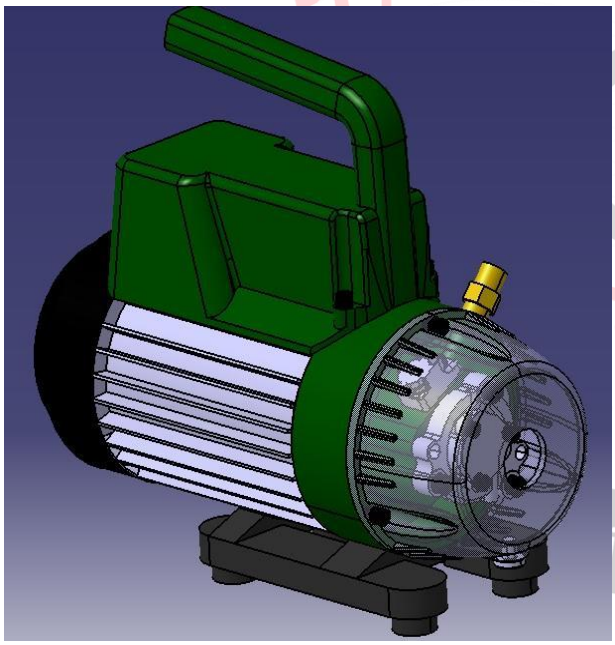

Fig. 2 Single Stage Rotary Vane Pump

4. Concluding Remarks

The vacuum pump has many industrial application in many fields which makes it an essential component. The selection of pump is done according to the application i.e. the vacuum requirement. Positive displacement vacuum pumps used when low vacuum pressure is required. Performance of a pump is measured in terms of pumping speed and time. In case of positive displacement pump proper lubrication is necessary as there is relative motion between mating parts. Efficiency of pump is based on discharge.

5. REFERENCES

[1] H. M. Akram, "Selection of Precise vacuum Pumps for the Systems with Diverse Vacuum Ranges," Global Journal of Researches in Engineering: A Mechanical and Mechanics Engineering, Volume 14, 2014.

[2] http://www.ppipumps.com/all_about_vacuum_pump.html

[3] http://www.machinedesign.com/motorsdrives/vacuum-pumps

[4] http://www.vacuumpumpsuk.com/2SOLRV.html

[5] http://www.sh-vacuum.com.tw/mswoosung/TRPseries.html

[6] http://www.gobizkorea.com/catalog/product_view.jsp?blogId=1999-a0086&objId=989829

[7] https://vacaero.com/information-resources/vacuum-pump-technology-education-and-training/1039-an-introduction-to-vacuum-pumps.html