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DESIGN AND FABRICATION OF ROOTS BLOWER FOR INDUSTRIAL AND AUTOMOBILE APPLICATION

Miss. D. B. Khadangale[1], Prof G.N. Wattamwar[2], Prof. H.K. Chaudhari[3]

[1,2,3]Department of Mechanical Engineering, Sanjivani K.B.P. Polytechnic,, Kopargaon (India)

ABSTRACT

Present paper is based on manufacturing of three lobe roots blower. Roots blower are positive displacement device. It consisting two or three lobed rotors which are rotating inside of an oval shaped casing. Roots blowers are widely used in industrial processes. They are suitable in huge number of applications including pressure and vacuum based systems. In this study, roots blower is used to increase the power efficiency of the engine. It is reliable, economical and having low maintenance cost.

***Keywords:Lobes, Power Efficiency Root Blower, Torque*.**

I INTRODUCTION

Twin lobe or tri-lobe blowers are types of roots blower. They have higher efficiency at moderate compression ratios and they are most efficient in the compression ratios of 1.1 to 1.2. They are used where constant flow rate at varying discharge pressures. These are generally available for capacities 10 m^3/hr to 10000m^3/hr for pressures up to 1Kg/cm^2 in single stage construction. The three lobe rotor belongs to the category of positive displacement blower. They consists of a pair of involute shaped lobes/rotors rotating inside a oval shaped casing, closed at ends by side plates. One end is a driving lobe which is driven by the external power source. These two rotors rotate one opposite to the other, their movement is synchronized by a set of timing gears. The geometric configuration of the lobes allows them to have, at any moment, a generatrix in common; due to very low machine tolerance, this common generatrix acts also as a seal device for both rotors. During the operation. One or two lobes of each rotor comes in contact with the internal surface of the casing, this create a chamber in which the gas is trapped. As the rotation continues, the trapped gas moves along until it reaches the position of discharging port. The two rotors makes six intake and exhaust cycles per revolution, therefore the capacity of the roots blower is determined by its operating speed and increase proportionally with the speed, but it is independent from the pressure differential between inlet and outlet ports.[1]

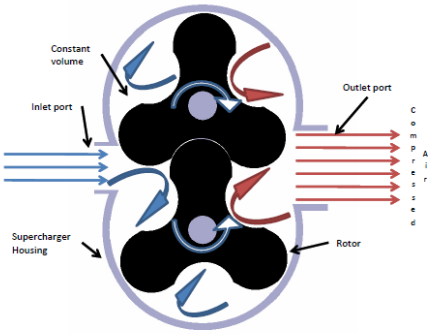

Fig. 01 Working Principle of Roots Blower

Due to these constructional features it has following distinct characteristics:-

1. The flow is depending upon operating speed.
2. The input power is totally depends upon the pressure across the machine.
3. The suction and discharge pressures are determined by the system conditions.
4. The temperature rise of the discharged air is largely dependent on the differential pressures across it.

II CONSTRUCTION OF ROOTS BLOWER

The manufacturing stages involves mainly manufacturing of housing, lobes, cover plates, shaft, gears. Initially the drawings of parts to be manufactured are prepared in 3D modeling software CATIA V5 and 2D drafting in Auto Cad.

2.1 Housing

To hold the subassembly, this part is used with the help of bearing. There are two types of housings in a blower assembly viz. BB housing and RB housing. BB housing supports ball bearing and RB housing supports roller bearing. Housing forms airtight assembly. Material used for housing is LM -6.

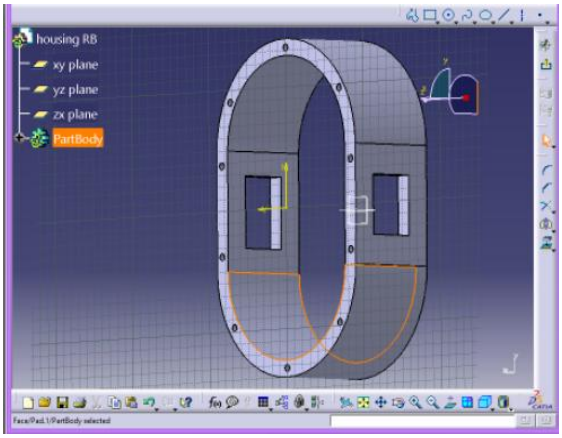

Fig. 02 Housing of roots blower.

2.2 Lobes

Lobes are manufacture such that they should rotate in opposite direction to entrap air by fixed volume. Material used for lobes is LM -6.

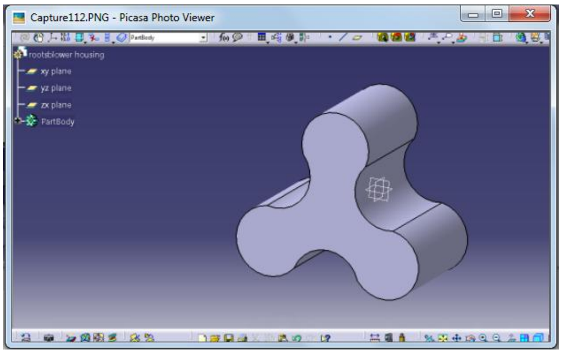

Fig.03 Three Lobes of Roots Blower

2.3 Gears

Two spur gears which are operated at synchronized condition are manufacture by using material EN-21 to give input power to drive shaft.

2.4 Shaft

Shafts are manufactured by using material EN-8 to give motion to lobes. Input power is transmitted from engine to shaft through belt pulley.

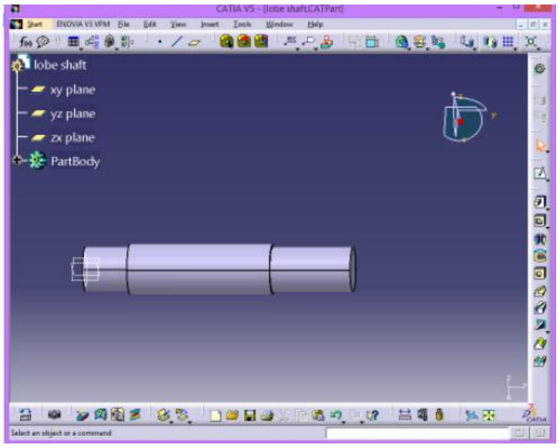

Fig. 04 Shaft of Roots Blower

2.5 Cover plate

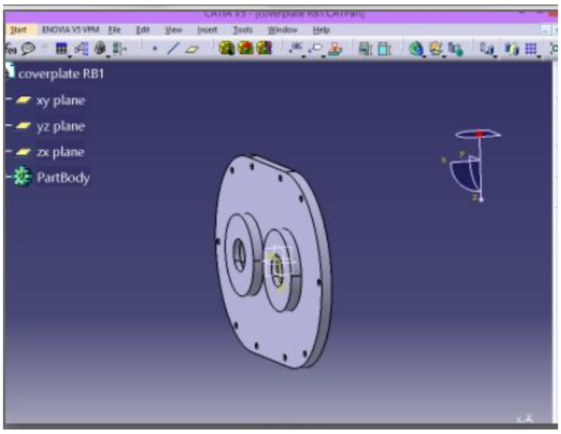

Fig. 05 Cover Plate of Roots Blower

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2.6 Working Air Volume of Roots Blower

In order to determine the change of properties at inlet and outlet of roots blower it is necessary to know the cross-sectional areas and working air volume.[3], pp.-127-128.

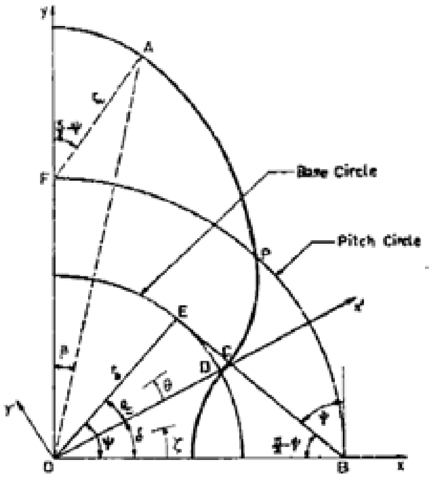

Fig. 06 Working air volume of roots blower

$r_p = 5.8$ cm

$\Psi = 30^0$ …(assume)

$r_b = 5$cm

$r_w = r_b \times \frac{\pi}{4} \times \cos\Psi$ …(1)

$= 5 \times \frac{\pi}{4} \times \cos 30^0$

$r_w = 3.40$cm

$D = 2*(r_p + r_w)$ …(2)

$= 2*(5.8 + 5)$

$D = 18.40$cm

$X_c = r_b \left[\frac{1}{\cos\Psi} - \frac{\pi}{4}\sin\Psi\right]$ ….(3)

$= 5\left[\frac{1}{\cos 30} - \frac{\pi}{4}\sin 30\right]$

$X_c = 3.81$cm

$Y_c = r_b \times \cos\Psi$ …..(4)

$= 5 \times \cos 30 = 3.4$cm

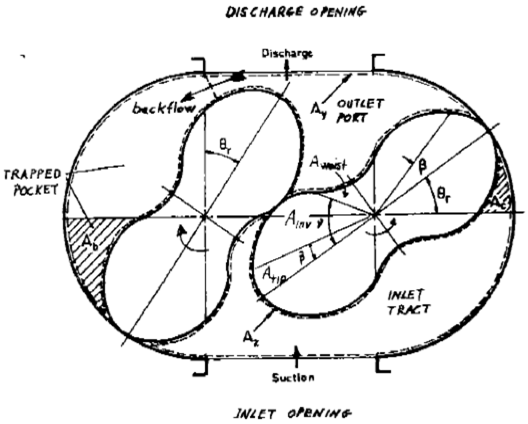

Fig.07 Roots Blower Geometry

Involute geometry angles θ_c and θ_A

$\theta_c = [\tan(180 - \Psi) - \frac{\pi}{4}]$ ….(5)

$\theta_c = [\tan(180 - 30) - \frac{\pi}{4}]$

$\theta_c = 0.2080^0$

$\theta_A = [\tan \Psi + \frac{\pi}{4}]$ ….(6)

$\theta_A = [\tan 30 + \frac{\pi}{4}]$

$\theta_A = 1.3627^0$

The area of the rotor lobe is calculated from the following equation

$A_r = 4(A_{tip} + A_{inv} + A_{waist})$ ...(7)

The areas of the various portions of the lobe may be calculated using the following integrals,

$A_{inv} = \int_0^{\theta} \frac{1}{2} r_b \theta^2 d\theta$ …..(8)

$= \frac{1}{2} r_b \int_0^{1.3627} \theta^2 d\theta$

$A_{inv} = 2.108722 cm^2$

$A_{tip} = \int_0^{\varsigma} r_p \cos\varsigma + (r_w^2 + r_b^2 \sin^2\varsigma)^{1/2} d\varsigma$ …(9)

$A_{tip} = \int_0^{7.5} r_p \cos\varsigma + (r_w^2 + r_b^2 \sin^2\varsigma)^{1/2} d\varsigma$

$A_{tip} = 5.266E\text{-}3 cm^2$

$A_{waist} = \int_0^{\varsigma} r_p \cos\varsigma - (r_w^2 - r_b^2 \sin^2\varsigma)^{1/2} d\varsigma$ …. (10)

$A_{waist} = \int_0^{7.5} r_p \cos\varsigma - (r_w^2 - r_b^2 \sin^2\varsigma)^{1/2} d\varsigma$

$A_{waist} = 1.43096 cm^2$

$A_r = 4(A_{tip} + A_{inv} + A_{waist})$ …..(11)

$A_r = 4[(5.266E\text{-}3) + 2.108722 + 1.43096]$

$A_r = 14.179792 cm^2$

$A_b = \pi r_b^2$ …..(12)

$A_b = \pi \times (5)^2$

$A_b = 78.539cm^2$

$A_c=\pi\times X_c\times Y_c$ ….(13)

$A_c=\pi\times 3.81\times 3.4$

$A_c=40.696cm^2$

The equation for A_y may be written as,

$A_y= [(\pi D^2/8)+Dr_p-A_r]+[A_b-A_c](20)$

$A_y= [(\pi 18.40^2/8)+(18.40\times 5.8)-14.179]+[78.539-40.696]$

$A_y= 263.3362cm^2$

The two rotors makes six intake and exhaust cycles per revolution, therefore,

$A_y= (263.3362/12)$

$A_y= 21.9446cm^2$

Length of the lobe = 7.5cm

Therefore, working air volume is,

$V=A_y\times 7.5$ ….(14)

$V=21.9446\times 7.5=164.5845cm^3$

2.6.1 Blockage factor

Blockage factor is defined as ratio of rotor cross-sectional area to the area of a circle with a diameter equal to the rotor diameter. The volume of air deliver in each cycle is proportional to the blockage factor. For maximum delivery blockage factor should be low.

$B = (\cos\Psi)^2[\pi+\frac{2}{3}(\theta_A^3- \theta_c^3)]/\pi(1+\frac{\pi}{4}\cos\Psi)^2$

$=(\cos 30)^2[\pi+\frac{2}{3}(1.36273\text{-}0.2080^3)]/\pi(1+\frac{\pi}{4}\cos 3)^2$

$=3.6169/8.8686$

$B =0.4078$

Total area between the casing and the lobes is,

$A_t=(\pi D^2/4)+(2r_pD)-8(A_{tip}+A_{inv}+A_{waist})$

$=(\pi\times 18.40^2/4)+(2\times 5.8\times 18.40)-8[(5.266E-3)+2.108722+1.43096]$

$=265.9044+213.44-28.359$

$=$ 450.9854

III CONCLUSION

From this study, we can conclude that it is possible to install roots blower in case of commercial two wheelers which theoretically increases their power on average about 20% more than the original engine. So, roots blower can be installed where maximum power and torque is desired and complete fuel consumption can be possible.

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REFERENCES

[1] S.S. Salaskar, Dr. K. H. Inamdar, " Design and manufacturing of twin lobe roots blower using steel shaft", July-August2012, vol.2, Issue 4, pp.266-270,.

[2]E. Codan, C. Mathey, "Emissions – A new Challenge for Turbocharging", paper no.245, 25th CIMAC Congress, Vienna 2007.

[3] S.Ucer, I.Celik, "Analysis of Flow Through Roots Blower Systems", International Compressor Engineering Conference School of Mechanical Engineering1980, paper-319, pp.126-132.

[4] StefenHenneberger, Conrad Latham, "Theoretical and Experimental Study on Energy Efficiency of Twin Screw Blowers Compared to Rotary Lobe blower",pp.2-5.

[5] Yashvir Singh, Nishant Kr. Singh, Rakesh Prasad, Hemant Kr. Nayak, "Performance analysis of supercharging of two wheelers",vol.2,Issue 2, May-July2011, pp.63-69.

[6] V. B. Bhandari, "Design of machine elements",2nd Ed., McGraw- Hill,pp.323-340, 522-543, 668-689.