A Design Approach for Automatic Tyre Inflation System

Mayur Ghagare[1] Chaitanya Buradkar[2] Sourabh Kamdi[3] Anup Junankar[4] Chetal Gupta[5]
[1,2,3,4]U.G. Student [5]Assistant Professor
[1,2,3,4,5]Department of Mechanical Engineering
[1,2,3,4,5]Priyadarshini College of Engineering, Nagpur, India

Abstract— In ancient time, after the discovery of wheel by man, it has been used extensively for various purposes and it is vital part of human life for ages. These wheels runs human life faster and faster with new technology and one such technology is on board air inflation system used in automobiles. Tyres are the second-highest cost for the trucking industry. The on board air inflation system is used to maintain the pressure of tyres in running condition. The environmental conditions varies according to region, seasons because of this, it require maintaining the tyres pressure for better performance according to conditions. The most important application of this system is in military vehicle. For the military vehicle, the environmental condition, land conditions are continuously varying and they have to face very worst condition like heavy rainfall, snowfall, deserts. At that remote place no such devices are available for maintenances of the tyres. At some crucial times like war conditions or any flood conditions there is no time to filling the air. Thus there arises a need for automatic tyre inflation system. This can be done by employing appropriate technique. This paper deals with the design approach of automatic tyre inflation system.

Key words: Automatic Tyre Inflanation System, Speed of tyre, Design of Shaft

I. INTRODUCTION

It consists of compressor, which supplies air and air tank is used to stored air at constant pressure. This pressurize air can be filled into tyres through flexible ducting with the help of rotary bearing. The pressure conditions are achieved by pressure gauges.

II. PROBLEM IDENTIFICATION

When tyres are under inflated, the thread wears more quickly. This equates to 15 percent fewer miles you can drive on them for every 20 percent that they're under inflated. Under inflated tyres also overheat more quickly than properly inflated tyres, which cause more tyre damage. The faded areas below indicate area because tyres are flexible; they flatten at the bottom when they roll. This contact patch rebounds to its original shape once it is no longer in contact with the ground. This rebound creates a wave of motion along with some friction. When there is less air in the tyre, that wave is larger and the friction created is greater -- and friction creates heat. If enough heat is generated, the rubber that holds the tyre's cords together begin to melt and the tyre fails. Because of the extra resistance on under inflated tyre has, when it rolls, your car's engine has to work harder. Statistics show that tyres that are under inflated by as little as 2 psi reduce fuel efficiency by 10 percent.

III. DESIGN APPROACH

A. Speed of Tyre:

Given,
RPM of motor (N_1) = 1440 rpm
Diameter of pulley on motor shaft (D_1) =2 inch
Diameter of pulley on wheel axle (D_2) =12 inch
Radius of tyre (R) = 0.6 m.
From formula,
$N_1D_1 = N_2D_2$
$1440 * 2 = N_2 * 12$
$N_2 = 240$ rpm.
Now,
$N_2 D_2 = N_3 D_3$
$240 * 2 = N_3 * 12$
$N_3 = 40$ rpm
$V = (R*2\pi N)/60$
$= (0.3*2\pi* 40) /60$
=1.25 m/s
Hence, Speed of tyre = 4.52 km/hr.

B. Design of Shaft:

For the designing of shaft, we have to find out the diameter of shaft -
Given data:
Power = P = 1 HP = 745.70 W
N = 1440 rpm;
Shear Stress for Mild Steel = τ = 110 N/mm^2
Diameter of shaft =?
Torque = $(P \times 60) / (2\pi \times N) = (745.70 \times 60) / (2\pi \times 40) = 4.94$ N.m $= 4.94 \times 10^3$ N.mm
We also know that torque transmitted by the shaft (T) –
$4.94 \times 10^3 = (\pi / 16) \times (\pi \times d^3)$
$4.94 \times 10^3 = 57.6 \times d^3$
d = 20.078 mm
Hence, we select the shaft having 25mm diameter.

C. Design of Bearings:

1) Large Bearing:

For the selection larger ball bearing, we have to follow the design procedure.
Assume, Life of bearing = 5 years
To find the life of bearing in terms of Hours, assume 1year = 325working days and machine daily working time = 10hrs
Total life of bearing = $L_H = 5 \times 325 \times 10 = 16250$ hrs.
Radial load = W_R = 2000N
Axial load = W_A = 1000N
No. of rev. = N = 1440rpm
$W_R / W_A = 2000/1000 = 2$
$W_A / C_0 = 650/ C_0$ = Not known
Assume, $W_A / C_0 = 0.5$
$W_A / W_R = 1000/2000 = 0.6$
Here, $(W_A / W_R) > e$ (e=0.5)

(From Table No. 27.4 & pg. no. 1008 & Machine Design by Khurmi and Gupta)
Hence, for single row ball bearing,
X = 0.35 & Y = 0.57
Rotational Factor = v = 1 for all types of bearings.
Dynamic Equivalent load →
$W = X.v.W_R + Y.W_A$ = (0.35 x 1 x 2000) + (0.57 x 1000) = 1270N
Now,
W x (Service factor for uniform and steady load) = 1270 x 1.0 = 1270 N
(Take the service factor from Table No. 27.5 & pg.no. 1012 & Machine Design by Khurmi and Gupta)
Basic Dynamic load rating →
$C = W (L / 10^6)^{1/k}$
$L = 60 \times N \times L_H = 60 \times 1440 \times 16250 = 1404 \times 10^6$
Hence,
$C = 1270 \{(1404\times 10^6) / 10^6\}^{1/3} = 1270 \times (1404)^{1/3} = 1270 \times 11.19 = 14576$ N
C = 14.576 KN
For C = 14.576 KN, select Bearing No. 206 having
C = 14.576 KN; Width = 17mm; Bore = 25mm; Outer Diameter = 62mm
(Take bearing No. 206 from Table No. 27.6 & Page no. 1013 & Machine Design by Khurmi and Gupta)

2) Smaller Bearing:

For the selection smaller ball bearing, we have to follow the design procedure [2] –
Assume, Life of bearing = 5 years
To find the life of bearing in terms of Hours, assume 1year = 325working days and machine daily working time = 10hrs
Total life of bearing = L_H = 5 x 325 x 10 = 16250 hrs.
Radial load = W_R = 1600N
Axial load = W_A = 650N
No. of rev. = N = 1440rpm
$W_R / W_A = 1600/650 = 2.46$
$W_A / C_0 = 650/ C_0$ = Not known
Assume, $W_A / C_0 = 0.5$
$W_A / W_R = 650/1600 = 0.6$
Here, $(W_A / W_R) > e$ (e=0.5)
(From Table No. 27.4 & pg. no. 1008 & Machine Design by Khurmi and Gupta)
Hence, for single row ball bearing,
X = 0.35 & Y = 0.57
Rotational Factor = v = 1 for all types of bearings.
Dynamic Equivalent load →
$W = X.v.W_R + Y.W_A$ = (0.35 x 1 x 1600) + (0.57 x 650) = 930N
Now,
W x (Service factor for uniform and steady load) = 930 x 1.0 = 930 N
(Take the service factor from Table No. 27.5 & pg.no. 1012 & Machine Design by Khurmi and Gupta)
Basic Dynamic load rating →
$C = W (L / 10^6)^{1/k}$
$L = 60 \times N \times L_H = 60 \times 1440 \times 16250 = 1404 \times 10^6$
Hence,
$C = 930 \{(1404\times 10^6) / 10^6\}^{1/3} = 930 \times (1404)^{1/3} = 930 \times 11.197 = 10413$ N
C = 10.413 KN
For C = 10.413KN, select Bearing No. 204 having
C = 14.576 KN; Width = 17mm; Bore = 20mm; Outer Diameter = 60mm
(Take bearing No. 204 from Table No. 27.6 & Page no. 1013 & Machine Design by Khurmi and Gupta)

D. Length of Belt:

Given,
Radius of pulley= r_1=2.54 cm
Radius of pulley= r_2 = 15.24 cm
Central distance between pulley = 40cm
Now,
Length of belt (L) = $\pi (r_1+r_2) + 2x + (r_2-r_1)^2/x$
$= 3.14(2.54+15.24) + 2 * 40 + (15.24 – 2.54)^2/40$
=140 cm =1.40 m
Hence, length of belt is 1.40 m
Assembly parts and specifications:

1) Motor:

Power = 1 hp
Current = 7 amp
Voltage = 200-230 V
RPM = 1440

2) Wheel:

Tyre used- Indica Vista
Diameter = 60 cm
Pressure = 40 psi
Pressure Gauge = 0-150 psi
Control valve Qty = 2 Pulleys
Qty = 4 (12 inch and 2 inch diameter)

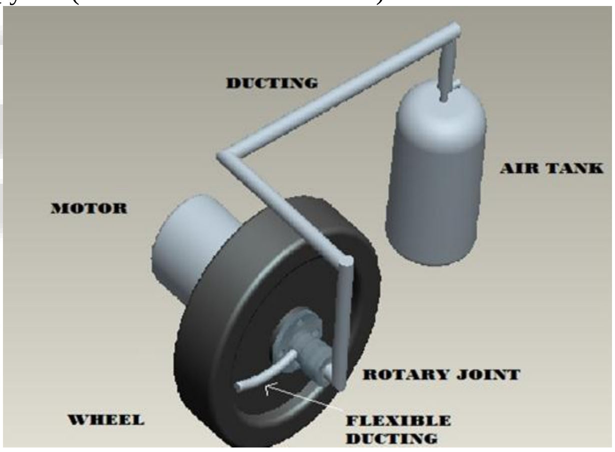

Fig. 2: Proposed Model

IV. RESULT AND CONCLUSION

We applied all these techniques to reduce the process time and human efforts of the conventional manual air filling system. The system helps to reduce cost and friction between surface of tyre and road so that will reduce the wastage of tyre material. As a result, It will increase the life of tyre.

After fabrication of automatic tyre inflation system, the result obtained that if the system utilization will be executed in proper by taking and concerning all the relevant according to the project demand the process time, cost and human efforts can be reduce in a great manner.

REFERENCES

[1] "Design Data Book", complied by Faculty of Mechanical Engneering, PSG College of Technology, Pg.No. 7.21-7.70, Edition, 2012

[2] "Design Procedure of Shaft", Textbook of "Machine Design" by R.S. Khurmi & J.K. Gupta, Pg. No. 509-557,14th Edition, 2010
[3] "Design Procedure of Ball Bearing", Textbook of "Machine Design" by R.S. Khurmi & J.K. Gupta, Pg. No. 996-1020, 14th Edition, 2010
[4] "CAD Software Details", Textbook of "Machine Design" by N.D. Bhatt & V.M. Panchal, Pg. No. 332-333, 41st Edition, 2006
[5] "Welding Process- An Electric Arc Welding Process", Textbook of "Manufacturing Technology", By P.N. Rao, Pg. No. 356-360, Volume-1, Third Edition, 2011
[6] Theory of Machne by R.S. Khurmi & J.K. Gupta
[7] Stength of Material by R. K. Rajput
[8] Automobile Engineering Vol. 1 & 2 by Kripal Singh
[9] Principles of Feedback Control System by R. A. Barapate

