International Journal of Analytical, Experimental and Finite Element Analysis (IJAEFEA), Issue. 1, Vol. 2, March 2015.
e-ISSN: 2394-5141, p-ISSN: 2394-5133, pp 44-46

Pneumatic Operated Machine for Removal of Tyre

Shubham K.Ambekar[1]
shubhamambekar@gmail.com
Rajesh H.Dandekar[2]
Gaurao B.Dhandare[3]
gauraodhandare26@gmail.com
Swapnil N.Jediwar[4]
Sahil G.Kudegave[5]
Azizullah S. Khan[6]
Prof. P. H. Jaiswal
spankaj_jaiswal@yahoo.com

Department of Mechanical Engineering,
BCYRC'S Umrer College Of Engineering, Umrer, India.

Abstract- **This project is based on manufacturing of conceptual model of tyre removal from rim of vehicle without human effort. It is very difficult to remove tyre manually and it required lots of time and effort. Purpose of our project is to reduce that time, human effort and making model in such a way that it can easily purchase in cheapest cost by buyer. The mechanism of machine is simple where the tyre will rotate in a minimum speed of about 20 rpm using worm gear drive and a tyre can be removed from the rim with help of pneumatic arrangement on a long tool which can be inserted into a tyre. An analytical and finite element analysis of machine is discussed in paper.**

Index terms- Speed reduction, gear box, motor, cylinder, tool, FEA.

I. INTROUCTION

A flat tyre or puncture is most often caused by glass, thorns, flints or nails when they cut through the outer rubber tread of the tyre and damage the inner tube internal abrasion on metal parts. Rough edges from tube liners or worn internal surfaces in tyres. Incorrect seating of the tube Manufacturing faults excessive wear of the tyre tread allowing explosive tyre failure or allowing road debris to tear through it. Rubbing of the tyre against the road, ripping the tyre, or separation of tyre and rim by collision with another object.

In this paper, the author try to discuss design and fabrication of such type of machine called as tyre removal machine. It has a supporting frame on which a tyre with rim has been mounted to remove. Tyre will rotate with help of motor having speed reduction of worm gear box of 30:1. A tyre can be removing by tool which moves to and fro with the help of cylinder. A conceptual model is shown in figure 1 and its technical specification is listed in table 1.

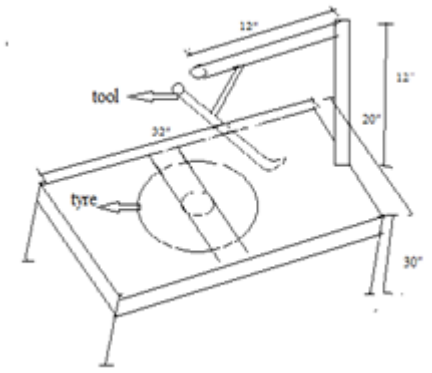

Figure1. Conceptual sketch of Tyre Removal Machine

TABLE 1. TECHNICAL SPECIFICATION

Sr. No.	Component	Qty.	Specification
1	Motor	1	1hp
2	Gear box	1	30:1
3	Cylinder	1	45mm×125mm
4	Shaft(tyre)	1	12.7cm

The main objectives of this paper are as follows:

- Safely remove a vehicle tyre from a rim.
- Light weight machine.
- The machine work without human effor.
- The machine will be of cheapest cost so it possible to purchase small garage mechanic.

II. LITERATURE REVIEW

Francis Du Queens,[1] (Mar. 4, 2003), Apparatus which mainly consist of a 6300structure, of a turntable with jaws between which the wheel is fixed, of a control element which permits the jaws to be moved and the turntable to be rotated, of a vertical column fitted upon said structure, of a horizontal arm mounted transversally in aforementioned column and having the possibility of sliding and being fixed there in, of a rod with tool for fitting and removing the tyre, this rod having the possibility of being adjusted and fixed in height, of a relatively complicated means for adjusting the tool, both in a horizontal and in a vertical plane, to predetermined distance from the fixed wheel, in such a manner as to avoid interference between the wheel and the tool.

Reno corgi, (Mar. 4, 2003) [2], An automatic bead release device. Device for tyre removal machines, comprising, for supporting theWheelrim complete With tyre, rotary means associated With a frame Which supports a bead release disc in contact With the tyre just external to the flange of the Wheel rim, a shaft parallel to its axis of rotation, on Which said frame slides to approach and Withdraw from the Wheel rim, means for moving said frame along said shaft, and means for lightly inserting said disc below the fang of the Wheel rim after it has come into contact With it.

Maurizio Bononcini, [3] (May 23, 2006), A machine for fitting/removing tyres and Wheel rims for vehicles, comprising a frame for supporting elements for coupling and turning a rim, onto/from Which a tyre is to be fitted/removed, about a rotation axis, and a Working assembly that is movably supported by the frame and

comprises a Working head for rototing and removing the rim/tyre associated With a first translational actuation, and is provided With a tubular pusher transverse to the rotation axis, and associated With an abutment surface associable With a tyre side, and With at least one tyre removal tool associated With a second actuation for alternate movement between an inactive configuration at least partially Within the pusher, and at least one active configuration, protruding at least partially from the pusher

David A. Voeller[4], An improved vehicle tyre changing system for servicing a vehicle wheel assembly consisting of a tyre and rim, configured with one or more imaging sensors to accurately measure distances, dimensions, and characteristics of features associated with a vehicle wheel assembly during a tyre mounting, tyre dismounting, or tyre mount altering procedure.

III. WORKING & METHODOLOGY

Our project consist of chassis, stepany, motor, gear box, cylinder, valve etc. for removal of tyre, tyre is mounted on the chassis with the help of shaft.Then it rotates with help of 3phase motor.There is reduction of speed with the help of gear box as it 30:1 reduction ratio. Then tool is attached to the cylinder which will move to and fro motion. Tool is inserted into the tyre, as mechanism started tyre will rotate and tool move to and fro, during this mechanism tyre going to remove gradually when tool will in forward direction and tyre will fitted when tool will in reverse direction.

Single phase motor, tyre, gearbox, cylinder and valve has main components. The motor has capacity of 1hp power and 1440rpm speed and generated the power of 0.75kw. It will rotate shaft which has tyre attached on them. Cylinder has 45mm bore diameter and 250mm in length. It will create a force of 1249N and having a pressure of 8kg per cm^2. The valve has five ports. The gear box used for reduction of speed of motor. It has worm and worm gear with reduction ratio of 30:1 that is teeth on worm is 7 and on worm gear is 30.the material used in gear is phosphorus bronze.

Figure 2. Gear box having worm gear

A. Design Consideration

1) Design the shape and size model of project
2) Design the Rectangular frame for chassis.
3) Finding the force required to take out the tyre from position and capacity of the pneumatic cylinder
4) Finding the selection of motor to rotate the wheel.
5) Fabrication of different components for experimental set up according to design.
6) Performance on the experimental set up.

TABLE2. FINAL OUTPUT OF DESIGN

Component	Formula	Result
Motor	$\eta=\frac{\text{output}}{\text{input}}$	78%
Gear box	$\frac{Nw}{Ng}$=VR	Ng=17rpm Nw=500rpm Tw=7teeth Tg=30teeth
Worm gear	$\eta=\frac{\cos 19.59-0.034*\tan 12}{\cos 19.59+0.034*\cot 12}$	84.83%
Cylinder	Force= pressure × area	F=1249N, D=4.5cm, P=8 kg/cm^2
V-belt	$\frac{pd}{pwer/belt}$	1

IV. FINITE ELEMENT ANALYSIS OF TYRE REMOVAL MECHANISM

The FEM of tool is shown in fallowing figures and procedure is as fallow. A three dimensional model of tool required to analyze in ANSYS is made in Creo parametric 2.0 which is imported in IGES file format in FEA software. For the meshing of whole part describe, 10 node SOLID 187 and 20 node SOLID 186 elements are used with fine meshing shown in figure 4. These elements have properties of hyper elastic, creep, stress stiffening, large deflection, and strain capabilities. The element has three degree of freedom in x, y, z direction. For the analysis purpose face of cylindrical part is fixed at its end and the force 4450N is applied tangentially on the tool. Meshing model of tool and joint with 1504 elements and 3516 nodes and boundary condition applied is shown in figure 3. The finite element analysis of tool in the form of maximum shear stress and equivalent stress of tyre removal machine is shown in figures 5 and figure 6.

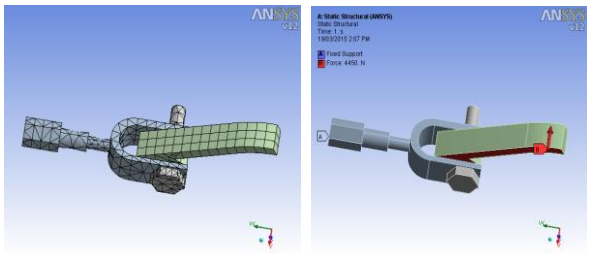

Figure 3. Mesh model of tool with boundary condition

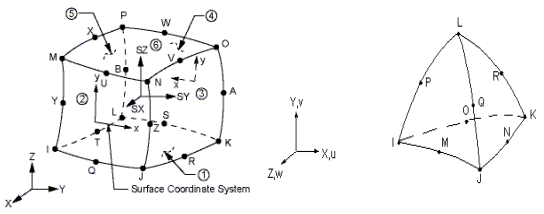

Figure 4: Solid 186 hexahedral and Solid 187 tetrahedral element

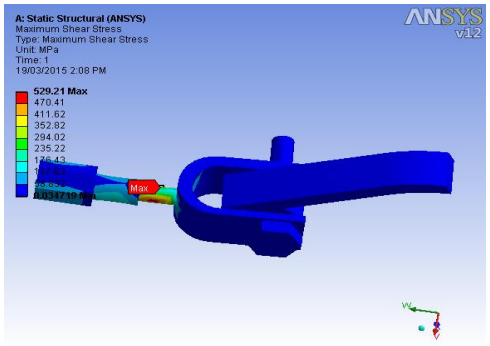

Figure 5. Maximum Shear Stress (529.21mpa) on Joint

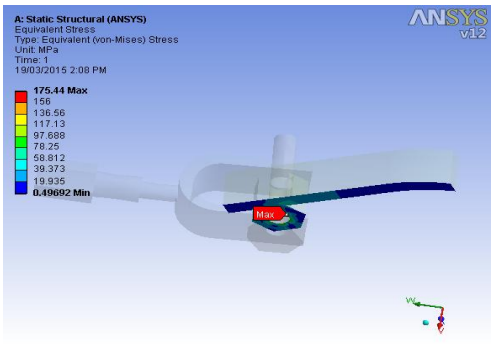

Figure 6. Equivalent Stress (175.44mpa) on tool.

TABLE 3. RESULTS FOR FINITE ELEMENT ANALYSIS OF TOOL

1.	Equivalent stress on tool	175.44 MPa
2.	Maximum shear stress on joint	529.21 MPa

V. EXPERIMENTATION AND TESTING

After successful design of experimental setup of tyre removal machine, it is tested for successful removal and fitting of tyre over the rim. For the successful removal and fitting the machine has been optimize for different speed of driven shat of worm gear i.e. speed of shaft at rim bore. The machine is optimizing for output speed of 40 rpm, 30 rpm, 17 rpm and 8 rpm. During experimentation and testing it is observe that at different speed of driven shaft different torques are develop shown in table 4 and the effect on tyre removal systems are shown in table 5.

TABLE 4. TORQUES DEVELOP AT PULLEY AND GEAR BOX SHAFT

Sr.No	Component	Driver	Driven	Torque Develop
1	Pulley	1440rpm	212rpm	33.60Nm
2	Gear Box	212rpm	8rpm	891Nm

During observation it is also found that, for different speed of tyre shaft such as 40rpm, 30rpm, 17rpm and 8rpm, the failure are occurs at various components.

TABLE 5. DEVELOPING TORQUE AT VARIOUS SPEEDS

SR. NO.	Speed of motor	Speed of shaft at tyre	Torque develop	Force on tool	Remark
1	1440 rpm	40 rpm	178 Nm	890 N	Develop less torque and welding failure occurs at larger tool as well as greater possibility to damage rim and tyre
2	1440 rpm	30 rpm	283 Nm	1415 N	Develop less torque and welding failure occurs larger tool as well as greater possibility to damage tyre
3	1440 rpm	17 rpm	420 Nm	2100 N	Develop more torque and try to avoid welding failure by using smaller tool. Still the possibility to fail a tool and damage tyre arises.
4	1440 rpm	8 rpm	891 Nm	4455 N	Develop more torque and less possibility of damaging tyre and successfully removal and fitting of tyre.

VI. CONCLUSION

The conceptual design of tyre removal machine is to be used for removal of tyre pnumaticaly.by this concept tyre removes within the minute. Also it fitted the tyre by rotating tyre in reverse direction.it does not required any manual effort. Price is keep within the 8 to 10,000.The criteria for system design had been outlined and the system was implemented and Tested. However, there is much scope for system improvement in the future to remove the tyre and fitting of tyre. Based on the objective for effortless tyre removal system, a machine has been design and fabricated for future exposure. From the analysis it is observed that the tyre has fail the tool of steel material at very high speed of about 40 rpm and it is required to reduce its speed. The tool size is also the great importance as it also fails tyre and rim and is use for removal and fitting of tyre. The tool size of 110mm length, 20mm width and 5mm thickness has been decided and applied for experimentation and it is found that, it remove and fit a tyre easily. From finite element analysis of tool system, it is found that the tool is acquiring a load of tyre but may fail at the joint.

REFERENCE

[1] Rernocorghi, “Wheel Rim Locking Device For Tyre Removal Machines”, Correggio (IT), Prior Publication Data US 2001/0042601 A1,vol.1, march 2003.
[2] Maurizio Bonacini, “Machine for Fitting and Removing Tyres and Wheel Rims For Vehicles”, Correggio (IT), Prior Publication Data, US 2004/0221964 A1, pp. 25/128, may 2006.
[3] B.D. Shiwalkar, “Design Data Book For Machine Element” Denett & Company Publication, 3rd ed., pp. 39.
[4] R. S. Khurmi, “Machine Design”, S. Chand Publication Design Data Book, vol.1, pp.1101, Jan 2002.