

Torsion Improvement in Transmission System of Mini tractor - A review paperProf. M.K. Khunti¹, Prof. Dr. P.P Rathod²¹PG Mech. Eng., Govt. Engineering College Bhuj India, mkkhunti@yahoo.co.in²Associate Professor Mech. Eng. Departments, Govt. Engineering College Bhuj India

Abstract—Present day need of farmers with farming operation is to operate machining function by power take off in an efficient manner. Many research have been done in this field to analyse overall performance and design to improve torsion at PTO shaft with specific speed of engine. Power take off have been widely used in other automobiles and high horse power tractor for many years. These offers high specific fuel consumption and uneconomical for small farmers holding only few acres of land.

In this review study, many papers of PTO performance, design, FEA has been studied to check possibilities of using PTO for tractor to adding value in transmission system of tractor. It is found that PTO is a very effective way to transfer engine power to machine (Rotavator, Generator, Pump, Turbo Atomizer and Disc Fertilizer Spreader etc.) with all farming needs.

Keywords- Tractor, PTO shaft, FEA

I. INTRODUCTION

Tractor is well known to farmers for using all bullock driven implements for agricultural needs and hence no special improvements for tractor are necessary but cannot run additional machines like pump, rotavator, generator etc. If power take off shaft introduce in transmission system of mini tractors it will satisfy all need of farmer by delivering specific speed and torque for available horse power of tractor engine which can transfer power from engine to machine.

Power take off for mini tractor (up to 18 H.P.) is economical and fuel efficient which satisfies all farming needs as well as utilize engine power by machine and reliable in operation. A comparison was made between PTO and PTOE to manage tractor implements. The introduction of PTO in transmission line making continuous progress and working significantly higher output as compare to high horse power tractor. Mini tractor is a bridge in gap between power tiller and high horse power tractor, where it offers all the advantages of tractor at a lower price and fuel economy.

II. LITERATURE REVIEW

S. K. SUMER et al (2010) [1] determine differences between the standard 540 rpm power take-off (PTO) revolution in tractors and its alternative, namely "the economical PTO revolution (540E)." Loads were applied to three tractors (JD 5625, NH TD85, MF 3085) with similar technical specifications, by means of a PTO dynamometer (Eddy-current) under laboratory conditions. Measurements were made of tractor PTO torque, engine fuel consumption, specific fuel consumption, and engine exhaust gas and cooling water temperatures on the basis of load (power kW) steps applied at a constant PTO revolution of 540 rpm. Data analysis showed an average fuel saving was performed with the 540E PTO of 27.18%, 18.62% and 15.88% for the JD 5625, MF 3085, and NH TD85 tractors, respectively. Fuel savings decreased with the increase in PTO load. Engine-PTO speed rates were also found to be effective in fuel saving. The torque values for the three tractors varied directly proportionally to the increase in the PTO load steps. Exhaust gas temperature data showed that coercions had occurred in the tractor engines when certain load values were exceeded when using the 540E operation (35 kW, 20 kW, and 30 kW, respectively for JD 5625, MF 3085, and NH TD85 tractors). In conclusion, the economical PTO operation was shown to have important advantages, particularly in terms of fuel and specific fuel consumptions for many power-driven machines.

Tsukasa TESHIMA et al (2014) [2] experimentally revealed that work power could be estimated based on measured values for engine speed and exhaust-gas temperature during the operation of an agricultural tractor. Based on these results, we developed a prototype which indicates the operating conditions to the operator to reduce the fuel consumption of agricultural tractors. This device employed five operating areas according to engine speed and work power and was designed to indicate changes in operating conditions (travel speed gear, PTO gear and engine speed) to ensure the tractor would operate within a region enabling high fuel efficiency and low exhaust-smoke density. The device was mounted on a 24 kW tractor, and indoor tests, rotary tillage tests, mole drainage tests, fertilizing tests and inter row cultivating tests were all conducted. Consequently, by following the notification of the device, fuel consumption was reduced by approx. 15% at a power ratio of 55-65% (the ratio of work power to maximum PTO output), approx. 25-30% at a power ratio of 35-40% and approx. 35-45% at a power ratio of 20% with full throttle. Fuel consumption was also reduced by approx. 10% at a power ratio of 25-30% and approx. 10-25% at a power ratio of 10-15% with 50% throttle. Attaching it to a 24 kW riding tractor, they confirmed that the device issued appropriate notifications by conducting indoor and field tests. Also, the fuel consumption reduction in tests when the device notified changes in operating

conditions to reduce fuel consumption were approx. 15% at a power ratio of 55-65%, 25-30% at a power ratio of 35-40% and 35-45% at a power ratio of approx. 20% while the operations were underway with full throttle, approx. 10 and 30-40% at power ratios of approx. 35 and 10-20% with approx. 75% throttle, and approx. 10 and 10-25% at power ratios of approx. 25-30% and 10-15% with approx. 50% throttle.

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B.S Dangil et al (2013) [3] has been done research work thoroughly by selecting adequate technology and scientific calculations in all the assemblies and critical parts e.g. pivots, mounting bearing are analyzed through readymade CAD software as very firmness and strength is desirable. Maximum spare parts have been preferred IS standard (ready stock found vigorously). Right from selecting end support bearing of reel-the foremost unit, Pitmanless tumble and knife link of cutter unit, dowel pin of cross auger (the screw to roll&push the cut crop), and bevel gear&pinion of PTO unit, Indian standards are followed thoroughly. Finally, this device connected to PTO fabricated by a small enterprise, as scientific knowhow is available with the authors. It has been predicted to save final labour, being minimized in the field. Maximum spares parts (more than 70%) can be found as ready stock in the market for running a medium or small scale enterprise. PTO connectivity through Tractor is possible like conventional models .

S. K. Sümer¹ et al (2010) [4] showed that fuel consumption values needed for the machine to operate (machine activity) and for the tractor to be able to move (tractor mobility) in field conditions in agricultural activities were determined for some PTO driven agricultural machine operations (turbo atomizer and disc fertilizer spreader). Besides, the effects of 540 and 540E PTO options on fuel consumption distribution were evaluated. Besides, the effects of 540 and 540E PTO options on fuel consumption distribution were evaluated. Three different tractors (John Deere 5625, Massey Ferguson 3085 and New Holland TD85) were used for this purpose. In field experiments, tractor fuel consumption, PTO torque and power parameters were measured. These measurements were repeated under static conditions in the laboratory without changing the functions of the machines. In these experiments, the torque and power requirements were found to be higher for the turbo atomizer for both of the PTO operations (540 and 540E). Data analysis showed that fuel consumptions performed in the laboratory condition with the 540 PTO in turbo atomizer and disc fertilizer spreader operations for all tractors were 77.08 and 74.29%, respectively in average of overall average fuel consumption values performed in field conditions. Fuel consumptions for 540E PTO operation were determined to be 65.97 and 64.74% in average, respectively. According to the variance analysis, for all test tractors, PTO options and experiment conditions were statistically significant on fuel consumption for each PTO driven machines. Since the PTO speed was the same for both of the PTO operations (540 rpm), the torque and power values did not show significant changes with respect to the PTO operations for the two agricultural machines. The higher torque and power requirement is the natural cause of higher fuel requirement.

Reno Antonio Rodeghieros et al (2007)[5] invented a PTO transmission transmits power from an engine-driven shaft to a PTO shaft. The transmission includes a Variable displacement hydraulic pump driven by the engine-driven shaft. A planetary transmission unit includes 'a ring' gear driven by the engine-driven shaft, a planet carrier drivingly coupled to the PTO shaft, planet gears rotatably mounted on the planet carrier and in meshing engagement With the ring gear, and a sun gear in meshing engagement With the planet gears and drivingly connected to a fixed displacement Variable speed hydraulic motor hydraulically driven by the pump. A one-way clutch is coupled to the sun gear. The clutch allows the sun gear to rotate in only one direction so that at rated engine speed all power is transmitted

mechanically. The present invention relates to a mechanism for transmitting power from an engine shaft to a power take-Off (PTO) shaft.

P.YUVANARASIMMANI et al (2014) [6] observed that nowadays developments occur in mechanical as well as agricultural industry in country for competing worldwide market. Automotive industry is the leading sector in India which can be utilized in directly or indirectly to the various country development fields. In this scenario technical developments are needed for the agricultural fields in India. All the leading manufacturers of automotive industry, needs technological improvement and implementation for their development and customer satisfaction for the survival in the global market. This project attempts to identify one of the failures which really affect the performance of the agricultural equipment industry. A detailed study of the failure is made, and analysis will be carried out based on the design and development techniques. Corrective action and introducing new methodology or mechanism will be developed through the Techniques. A detailed literature survey was completed to study about the Tractor, Implements and the Power Take Off system. Analyzing was been carried out using ANSYS software by applying load on the shaft and the power distribution among the shaft with different load conditions. From the first method by changing the no of splines, results shows that the reduction in no of splines will increase the capacity to withstand the produced stress. And second method was seen that change in material can cause the stress and strain values changed, hence resulting in slight increase in life of the PTO shaft. Further improvement can be brought by changing the dimensions of the shaft with respect to ultimate shear stress, wear and tear.

TOPAKCI et al (2008) [7] designed Rotary tiller which is one of the tillage tools which gets own motion from tractor power take off (PTO) and it had been designed for blend to soil. Soil traffic is decreased to great extent with this tool by blending the soil. Using of rotary tiller is increasing nowadays in our country because of its many benefits. Rotary tiller construction has a gear box that changes motion direction with 90 degrees from tractor PTO, transmission gears for rotation velocity and a rotor shaft which placed as horizontal to soil for blending. There are cutter blades on rotor shaft for breaking into pieces and blend to soil. Especially, on cutter blade and transmission gears, deformations occur because of high vibration, pointless high power, impact effect of soil parts, design-manufacturing error and wrong using conditions. Especially for construction and transmission parts, stress distributions should be determined well for understand failure reasons. In this study, transmission gear train of a rotary tiller which was designed and manufactured by a local manufacturer was modeled as three-dimensional in a parametric design software and structural stress distributions on transmission gears were simulated using a finite element method software according to its operating condition. After evaluating of simulation results, stress distributions on gears show that gears working without failure according to yield stress of gear's materials. Additionally, working safety coefficient of gears calculated by reference simulation results.

Krzysztof KUKIELKA et al (2014) [8] the aim of this work is to develop a numerical application to strength and fatigue numerical analysis of jointed-telescopic Power Take-Off shaft. Exemplary results for equivalent of stress in whole shaft and in a part of stress concentration are shown. Presented chart of changing of the number of the correct cycles operation of the PTO shaft depending on the Torsional angle allows to predict a shaft life. From numerical analyses of process it follows that the numerically tested system can withstand the load associated with the vibration phenomena and is properly designed. Furthermore, it was found that the shaft at the maximum rotational operating speeds, is working at frequencies under resonance.

On the basis of numerical analysis and experimental research the following conclusions can be drawn:

1. Improper operation of jointed-telescopic shaft (eg. No turning off on the headland) leads to their premature fatigue wear.
2. Developed applications in the system ANSYS enables complex strength, modal, fatigue and harmonic analysis of jointed-telescopic power take-off shaft.
3. Conducted analysis let for determination of stress concentration. For the analyzed case demonstrates that the greatest equivalent stresses are in the same place, where occurring defects in fact.
4. Developed the fatigue wear curve, on based which we can predict the durability of the shaft, depending on the load moment and angle deviation for driving and driven shafts.
5. From numerical analysis of process it follows that the numerically tested system can withstand the load associated with the vibration phenomena and is a properly designed. Furthermore, it was found that the shaft at the maximum rotational operating speeds, is working at frequencies under resonance.
6. The developed application can be used also in the process of designing new jointed-telescopic shaft, in order to make complex analysis. At the first step it is possible to perform calculations of strength, fatigue, modal and harmonics. On the other hand, in the second stage, before production of designed shafts, is perform optimization (optimization of topological and parametric optimization [6, 11, 12]).

V. Pădureanu¹ et al (2013) [9] said that nowadays tractor manufacturers tend to reduce the specific weight of those. For that purpose, this work aims to improve traction performances of universal wheeled tractors by using a supplementary driven axle actuated by power timed plugs of tractor. Lately, on a global level within the tractors industry it is observed a more and more accentuated tendency to reduce the constructive weight of tractors. This tendency has been generated on one side, by the necessity of cutting the tractor's price and on the other side, by the necessity of improving the traction and economic indexes of the tractor when it is exploited under different circumstances. The traction and economic qualities of the tractor (tractive efficiency, productivity, fuel consumption etc.) depend on a large scale on the correlation of two parameters: tractor's weight at exploitation and the nominal power of the engine. For the consumed power used for the tractor's motion to be minimal, the weight of tractor needs to be the smallest possible. On the other side, this weight needs to suffice in order to ensure a good adherence of the system of rolling up the soil. As tractors are exploited in a large range of velocities, they should have a variable exploitation weight: small for the transportation works with high velocities – when the drawbar load is reduced and great in the case of exploitation with low velocities – when the drawbar load is great. But most of the times it is difficult to modify the exploitation weight of the tractor, its traction qualities for the inferior velocity stages are not limited to the power of the engine. This way, for low working velocities the tractor's engine is not used rationally

An effective solution for improving the utilization degree of the engine and, at the same time, for improving the traction and economic efficiency of the tractor regarding varied agricultural works, is using a supplementary driven axle-PTO shaft. In order to underline the efficiency of these systems, as follows, there is drawn up a comparative study of the traction qualities of the tractor 4x4, with and without supplementary driven axle. The basic scheme of the system formed by the tractor combined with the supplementary driven axle mechanically activated by means of the tractor PTO (power take off) is presented. They represented graphically the limits of the traction forces in which the tractor has a high efficiency are increased. Thus, the traction efficiency of the standard tractor is above 0.6 in the interval 8kN....29.3kN, and the traction efficiency of the tractor with a supplementary driven axle is above 0.6 in the interval 12.1....41.9 kN The traction force limited by the adherence increases 1.43 times more at the tractor equipped with supplementary driven axle, than at the standard tractor. Within the limits of the adopted velocities, at the tractor equipped with supplementary driven axle, the number of the stages of velocity to which the engine is used totally, increases from 2 to 4. • At the tractor equipped with supplementary driven axle the respective minimal fuel consumption is smaller and is moved to the area of the great traction forces.

III. CONCLUSION

In this review paper, all about PTO shaft, following conclusions were made:

1. The average fuel saving rates achieved by the 540E power take off operation depends on operating conditions and power ratio.
2. Engine –PTO speed of tractor also effect the fuel saving achieved by 540E operation.
3. The PTO torque value tended to increase linearly with the applied load.
4. All machines and elements efficiently possible to run by tractor PTO.
5. Stress distribution simulations increase the quality and capacity of optimum machinery and tool design in agricultural mechanization systems.
6. Reduction in no of splines will increase the capacity to withstand the produced stress, change in material, slight increase in the life of PTO shaft.
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IV. ACKNOWLEDGEMENT

The authors would like to express their appreciation to the Mrs. Jayanti Ravi, Commissioner, CTE, Gujarat, India for Granting deputation for PG. The author wish to acknowledge PG Co-ordinator, Govt. Engineering College Bhuj, India, and Technical Head of Field Marshal-Tractor unit, Rajkot, India for their interest and support of this work.

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