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A REVIEW PAPER ON TRACTOR TRANSMISSION PROCESS

Vijay K. Patel
Lecturer in mechanical engineering
R. C. Technical Institute, Sola, Ahmedabad

Abstract— This project aims to modify a tractor's drive gearbox drive system. A spur planetary drive system is developed, which provides a number of advantages over the typical cylindrical spur gear drive system. It has a high torque capacity, is smaller, more efficient, and weighs less. One gear failure can have a significant effect on the entire drive system because gears are one of the most crucial design components. Gear failure can be brought on by stress, contact pressures, or temperature. In order to meet safety standards including tooth root strength, pitting resistance, and scuff resistance, spur planetary drive gears are built. These gears are much safer than cylindrical spur gear drives.

Keywords— Transmission system, Tractor, Planetary, Solidworks

1.INTRODUCTION

An off-road vehicle's gearbox system uses gears to transmit engine power to the rear wheels. Using a variety of gear drives, it reduces the vehicle's speed while raising its torque. The transmission mechanism is made up of the gearbox, intermediate housing, and main transmission housing, with the back wheel receiving the final drive via portals. The speed drops significantly inside the portals. The power train's final drive is a gear reduction system that sits between differentials and the drive wheels. Final drive then transmits the power to the rear axle and wheels. The tractor's back wheels are not mechanically coupled to the half shafts directly; rather, the drive is conveyed through gears.

2. PROBLEM IDENTIFICATION

In order to overcome the drawbacks of the current final drive cylindrical spur gear pair mechanism, which uses a ring and pinion configuration, the project's objective is to build a final drive system employing a spur planetary gear arrangement.

It was determined from all the data that planetary design saves weight over cylindrical spur gear pair after a number of approaches were employed to optimize housing weight, gearbox system efficiency, and gear pair design [1].

3.EXISTING MECHANISM AND ITS DRAWBACKS

The spur gear is a cylindrical shaped gear in which teeth are parallel to the axis. Each half shaft terminates in a small gear which meshes with a large gear called gear wheel. The gear wheel is mounted on a shaft, carrying the tractor rear wheel. The device for final speed reduction, suitable for tractor rear wheels is known as final drive mechanism. Reduction gear ratio of the final drive is determined by number of teeth on the ring gear divided by number of teeth on the pinion gear.

Housing and casting of gear wheel (bull gear) and pinion is big that‘s why space requirement is more in cylindrical spur gear pair mechanism of final drive transmission. Weight of gear wheel is more in cylindrical spur gear pair due to larger size of gear wheel. Velocity reduction is lower in cylindrical spur gear pair final drive mechanism. Lubrication oil used to lubricate the gear wheel and pinion is more in cylindrical gear pair due to more space requirement of housing and casting of gear wheel and pinion. Contact ratio is less in ring and pinion type final drive mechanism. Initial cost of final drive system is more.

Permissible tooth root stress is more in case of cylindrical spur gear pair and safety for tooth root stress is not as per the required safety. Therefore the gear is not safe. In the condition of tooth root strength transmittable power of cylindrical spur gear pair is lower. Pitting is the major cause of gear failure, occurs during transmission of torque or due to compressive fatigue on the gear tooth surface. When safety considered against pitting (tooth flank) safety for surface pressure at operating pitch circle is lower than the required safety. Therefore transmittable power is lower in cylindrical spur gear pair. In cylindrical spur gear pair brakes takes extra space for brake housing therefore larger space occupied and having more weight when compared to the spur planetary final drive as in this mechanism brakes are attached in the

samehousing of final reduction.

4. PROPOSED MECHANISM

Planetary gear sets are used in many applications, ranging from gas turbines to automotive power trains. They provide a large set of different transmission ratios. Improved efficiency relative to fixed axes transmission systems is one of the most important advantages of planetary gear sets [2]. Spur are often used because they are the simplest to design and manufacture, and are the most efficient, as well. Spur gears have straight teeth that are situated parallel to the gear axis. They are most commonly used in power tools and robotics applications. As the spur gear gives maximum operating efficiency therefore in the new design of final drive spur gears are used for planetary final drive. Planetary gear has advantages of compact structure, large transmission torque, stable transmission and high efficiency. It is widely used in various mechanical settings. Li et al., 2013 [3]

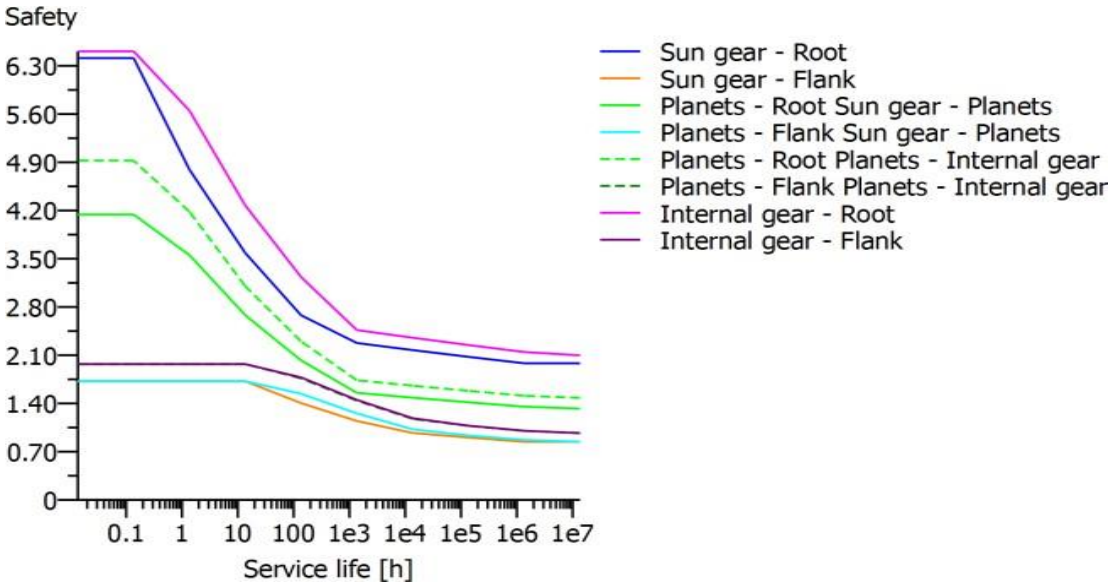
The terminology 'planetary transmission' comes from the gear arrangement similar to that of planets in solar system. A sun gear is located at the centre of mechanism and is in mesh with several planets which orbit around it. The planets are mounted on carrier which can either be fixed or rotating. Fig shows a schematic representation of planetary gear set comprising planet gears, a sun gear, a ring (internal) gear and a planet carrier (a relatively rigid structure that supports the planets).

5. COMPARISON

Optimization of final reduction mechanism from cylindrical spur gear pair mechanism to spur planetary gear mechanism is done using KISSsys software that permits to layout automatically a complete final reduction mechanism and theirparameters. It is necessary to choose a quicker way of evolution for the performance of gear teeth, regardless of the material of construction and manufacturing process adopted.

The performance parameter like tooth bending, surface distress and tooth deflection are the basic modes of fatigue failure of any toothed gearing Carl C Osgood, 1970 [4**]**. The case hardened material is used in the final reduction mechanism arrangement. Case hardened materials commonlyused in highly loaded gears. The gear wheel is a machine element that has puzzled many engineers, as numerous technological problems arise in a complete mesh cycle. The designer has to make the most durable design that will allow for good economy and performance for the end user the result of course depends on the segment to which the end user belongs.

Factor of safety is used to provide a design margin over the theoretical design capacity to allow for uncertainty in the design process. Factor of safety to be used in this design is essentially a compromise the benefit of increased safety and reliability. The table describes the safety factor for tooth root stress on the gears of final reduction mechanism and comparing spur planetary gear final reduction mechanism and cylindrical spur gear pair mechanism



Safety factor curves

Due to high service load, harsh operating conditions or fatigue, faults may develop in gears [5]. Gear faults are responsible for approximately 60% of gearbox failures. Most of these come from damage on the gear teeth such as pitting, cracking, and spalling [6]. Through observations at Syncrude Canada Ltd, fatigue crack and tooth pitting were the two commonest failure modes [7].

SAFETY AGAINST PITTING

Pitting takes place due to large contact pressure occurring between the tooth surfaces. Fatigue cracks set up due to the repeated contact stress and the cracks get developed into pits resulting in ultimate failure of the teeth. Maximum pitting occurs on the tooth face because tooth loading is cyclic. Pitting is a surface fatigue failure that occurs when the endurance limit of the material is excluded this failure nature depends on surface contact stress and number of stress cycles. Initial pitting is usually caused by gear tooth surface not fitting together properly and not properly conforming to each other. The criterion for surface durability is based on the Hertz pressure on the operating pitch point.

6. DESIGN AND MODELING

In the study, Gears of spur planetary final drive are modeled in KISSsoft by using gear ratio of existing final drive mechanism. Gears are generated by taking some criteria for spur planetary final drive system. Generated gears for final drive are one ring gear, one sun gear, and three planet gears.

After the assembly of gears for spur planetary final drive system full assembly is done by attaching carrier, bearing and other components. The spur planetary final drive system is mounted on the rear axle housing with the bolts. The rear axle housing is attached to the wheel shaft. The rear axle housing has to be in a horizontal position so that bolts of ring gear of final drive system could be mounted on the rear axle housing.

The transmission left-hand (LH) and right-hand (RH) outputs are connected via toothed, sliding couplings to the sun gears of the LH and RH final drives, respectively. As the ring gears of the two final drives are fixed, and they provide the reaction torque. The output power from the LH and RH final drives is taken from the planet carriers, which are connected to the LH and RH sprockets driving the tracks.

The rear axle housing in fig. is the optimized housing and the parameters are altered according to the original rear axle housing in Solidworks.

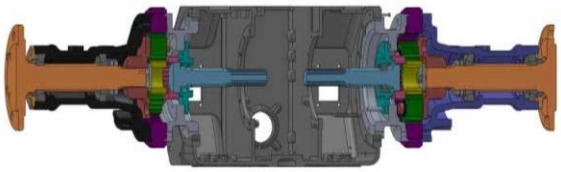


Fig. – Sectional view of rear axle housing

MOTION CONVENTION PLANETARY DRIVE:

For the combined rotation and revolution of planet gear two steps taken into account. The first step is to lock the whole assembly and rotate the whole assembly even the ring which is fixed, in one turn CCW.

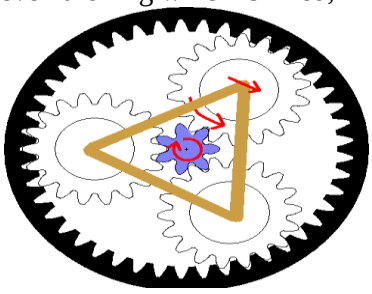


Figure: Motion of planetary drive

The motions are entered into the table using theconvention: CCW = PositiveCW = Negative

	Sun	Planet	Ring	Carrier
Rotate whole assembly CCW	-1	+1	+1	fixed

7. CONCLUSIONS

Primary objective of this research work is to reduce weight of final drive transmission and to generate safer gears for final drive. This objective is achieved with the help of experimental investigations. Weight of spur planetary final drive is lower than existing system by33.031 kg. Space due to the tooth geometry and gear geometry for new arrangement of final drive is lesser than existing making spur planetary final drive compact in size. Gears of spur planetary final drive are safer in case of tooth root strength, pitting and scuffing than cylindrical spur gear pair final drive and therefore life of gears is more as compare to existing system. Hence present analysis shows that spur planetary final drive is more efficient than cylindrical spur gear pair final drive mechanism in 65 HP HMT make tractors. The comparisons show that the gears in spur planetary gear final reduction mechanism are much safe than the gears of cylindrical spur gear pair mechanism as the value of safety for tooth root stress and pitting is less than required safety. Therefore spur planetary gear final reduction mechanism is more efficient than spur cylindrical spur gear pair mechanism.

Table above shows the transmittable power in spur planetary gear and cylindrical spur gear. The differences conclude that spur planetary gear final reduction mechanism is the more efficient than cylindrical spur gear pair as the maximum power transmit in spur gear final reduction mechanism is more than cylindrical spur gear pair at tooth root strength and pitting.

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