Study of Gearbox Efficiency

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***Abstract*:** There are many ways by which we can improve efficiency of gear. Many papers are published on efficiency of gear and gearbox. But these papers focuses on two or more parameters on which efficiency is depends such as noise, structure of gear, material used, lubrication, surface roughness, hardness etc. And methodology used for study of gearbox efficiency are FZG gear test rig, surface analysis, ANSYS etc. An effective method which focus on one parameter is required. Hence optimization of gearbox efficiency can be possible.

Keywords: Parameters, Optimization.

1. Introduction

An automobile requires high torque when climbing hills and when starting, even though they are performed at low speeds. On other hand, when running at high speeds on level roads, high torque is not required because of momentum. So requirement of a device is occur, which can change the vehicle's torque and its speed according to road condition or when the driver need. This device is known as transmission box. The transmission box which is also known as the gear box is the second element of the power train in an automobile. It is used to change the speed and torque of vehicle according to variety of road and load condition.

Transmission box change the engine speed into torque when climbing hills and when the vehicle required. Sometimes it is known as torque converter. Gears always produce a change in torque, creating a mechanical advantage, through their gear ratio and thus may be considered a simple machine. The teeth on the two meshing gears have the same shapes. Two or more meshing gears toothed part called a rack thereby reducing translation instead of rotation. Comparing efficiencies of different gear types across various reduction ratios will help us to make right gearbox selection for our applications.

2.1 Literature Survey of gearbox efficiency

Xinmin Li, et, al [1] in this study a recirculating power back-to-back FZG test rig was used to investigate the efficiency of spur gears made of powder metallurgy (PM) material using two different surface manufacturing methods (ground and super-finished). The Young's modulus for PM material is lower than for conventional gear steel. Results showed that the influence of gear tooth bending on PM gear transmission efficiency can be ignored in the FZG gear geometry.

AnandParey, et, al [2] studied failure analysis of gearbox which was failed in three months after its installation. And recommendations were given to enhance the fatigue life of gears. The gearbox under investigation was used for driving the axial fan for an air cooled condenser of power plant.Profiles and pitch errors were measured on the SmartGear CNC gear metrology machine. Micro-hardness analysis of the new gear was done and Microstructure examination was done using the Optical Microscope. The gears should be case hardened instead of through hardened and the surface finish of the gear should be improved.

Jing LI, et, al [3] in this paper a test system is set up for gearbox's measurement. By checking the mechanical structure of system and analysing the experiment data, there are some interference factors in this test system. A new calculation method is used to eliminate the interference factors from the mathematical calculation.

Ashwani Kumar, et, al [4] studied the effect of mechanical properties of materials on natural frequency and mode shapes of heavy vehicle gearbox transmission casing. Grey cast iron grade FG 260, structural steel, Al alloy and Mg alloy materials were analysed on the design and vibration index. Solid edge and Pro-E was used for CAD designing of transmission gearbox casing. FEA based ANSYS 14.5 is used for modal analysis. The simulation results were compared with experiment results available in literature.

Farag K. Omar, et, al [5] proposed a novel wavelet-based technique for detecting and localizing gear tooth defects in a noisy environment. A1:1 gearbox is used to collect the gearbox vibration data. The technique has shown accurate results in detecting and localising gear tooth fracture with different damage severity.

FarisElasha, et, al [6] presented a life assessment methodology for tidal turbine gearboxes which was developed with synthetic data generated using a blade element momentum theory (BEMT) model The prognostic model developed was validated using experimental data. Furthermore it was noted that the high speed pinion has the highest damage index.

S.Sjoberg, et, al [7] in this paper an FZG gear test rig was used to investigate how two running-in loads affects the gear mesh efficiency for two different temperatures. The gear surface roughness was investigated in parallel with testing. Higher efficiency was observed for tests using a high running-in load, and for low lubricant temperatures. The high running-in load also yielded higher gear mesh efficiency and had a larger imact on surface parameters.

Giorgio Bonori, et, al [8] presented genetic algorithm which is based on binary encoding of eight parameters, which identify the set of profile modifications on both pinion and gear profiles. He developed genetic algorithms in order to optimize spur gears towards vibration.

Weli, et, al [9] analysed three dimensional analysis of unsteady state temperature field and temperature sensitivity analysis of gear transmission for which frictional heat caused surface temperature rise which reduced their bearing capacity.

Philippe R. Spalart, et, al [10] studied an methods such as future of noise prediction and Some day oriented design. The four weel landing gear truck had level of complexity ,which reduces complexity by detached eddy simulations and Fowcs-wiliamscalulaton.

Marcello Faggioni, et, al [11] analysed on optimization method which is focused on gear vibration reduction by means of profile modifications, the approach shows good performances for the computational efficiency and reliability of results.

J.Astool, et, al [12] presents new methods and tools to understand gear meshing also this method has the objective to reduce gears quasi-static transmission error. The process approached is based on optimization process including loaded meshing simulations.

Meherwan P. Boyce [13] studied on recent advances in turbomachinery technology, especially in turbines, compressor, couplings and bearing have required gearing to withstand high external forces.

Ron Hodkinson, et, al [14] examines the optimization of gear based on most efficient exploitation of the special features of electric and hybrid drive vehicle. He considered structural and performance efficiencies of gear in his study.

M Saimurugan [15] studied that gearbox is an essential device in industries to vary

speed and load condition according to requirement.

Huimin Dong, et, al [16] studied that wind turbine usually consists of gearbox and some configuration of gearbox are used in wind turbine. Planetary gear train (PGT) is widely used configuration of gearboxes in wind turbine.

Xihuiliang, et, al [17] studied that gearbox is widely used in industry and military operations, due to high service load, hash operating condition and invietable fatigue, faults may developed in gear. If gear fault cant detect earlier teeth of gear will be degraded.

Kai Chain, et, al [18] examined there is significant electromechanical phenomenon in mechanical installation. It is analysed that planetary gearbox by using stator current significance analysis in PMSM based on electromechanical coupling.

I.V.Myakutina [19] studied that one pair toothing pair is used in reduction gearbox of EOS actuators. A spring load is applied on gear teeth for the elimination of backlashes. This study shows that multipair application allows to solve this and other problems.

Vladimir Rassokhel [20] examines the possibility of decreasing driver fatigue and work intensity influencing the traffic safety and road accident presentation with route of vehicle it can design automatic gearbox shifting pattern.

Carlos M. C. G. Fernandes [21] In the present study the influence of different gear oil used to increase the efficiency of gear box in turbine. He used test rig technique to check the efficiency of oil. In result the power losses is less for PAO and PAOX compare to mineral oil and efficiency is increase by 0.3% for PAO(polylhaolephin base oil with addition of ester oil) and efficiency increase by 1% for PAOX (Polyaplhaolephin Base oil with plastic deformation additives)

Jun Qui et al. [22] presented a study on the development of wind power from 2000 to 2015. The main current type of gear box of wind turbine under different rated power are summarized, and the feature types of gear box with power split transmission are presented and will be predicted in the future wind turbines with more than 5 MW. In order to obtain the new types of gear box for 6W wind turbines, a new types s

N.Saravanan, et, al [26] shows the fault diagnosis of gearbox is one of the core research areas in the field of condition monitoring of rotating machines. This work has outlined the procedure of fuzzy diagnosis technique by using the characteristic variable which represent a particular running condition of gearbox to determint the fuzzy membership function.ynthesis approach is proposed by means of the state space methods. Through the operation of the duel vectors of the internal and external meshing transmission unit according to the connection rules of series, parallel and hybrid, the state equation of different gear transmission system are derived.

Parth B. Shah [23] the less efficiency of a gearbox of a machine tool is a serious problem as it increase maintenance cost and also affect the reputation of firm hence its life has to be increased and should be made more reliable. The conclusion is to improve torque lead angle, reduced backlash and proper bearing and lubrication selection influences the gearbox life and efficiency.

Atul surface et al. [24] experimented with AISI 4140 steel, particulate composite material AA 2014/A1203/10% and glass fiber reinforced polymer spur gear pairs. The damping properties of all the three materials were compared through experimental set up. The noise level was measured for the pair of spur gear of these three different materials at various speed of rotation. The present work includes the investigation into the effect of the damping properties of gear material and noise level in spur gears for light load application in

automotive vehicles. The results indicated that glass fiber reinforced polymer spur gears are better than metal gears in light load power transmission applications due to their lesser noise and damping factor.

C.U.Dogruer,[25],study of pair of spur gear with elastic module was studied. The main goal of this paper is to control the elastic mode of a spur gear to have a gear mechanism that runs silent.

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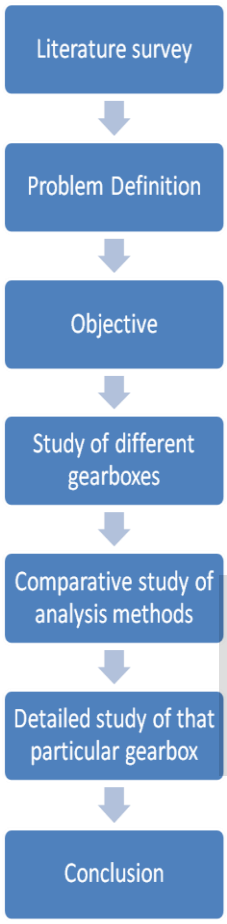
Aleksey Suslin, et, al [27] presents a study of point involute gear where they conducted test where two gear to be tested were mounted on test rim. The point involute gears have three pair of teeth in contact which make it more hard than simple spur gear. They conducted the test up to gear fail where the spur gear point involute gear tooth. But the endurance limit to bending of point involute gear does not significantly differ from that of involute spur gear. Hence point involute gear can be implemented in gas turbine. But the manufacturing of spur gear is difficult.

A Diez-lbarbia et al[28] experimented the load sharing impact of the efficiency of spur gear with modified profile was assessed in this work. The main conclusion of this work is that the tip release which makes the optimal efficiency coincides with the theoretical dynamic optimum of the transmission.

Fannia Pacheco, et al [29] studied that gearbox are crucial devices in rotating power transmission system with application of industries, gearbox faults can caused catastrophic physical consequences, long equipment downtimes and severe production cost.

R.Martins, et, al [30] in this paper the influence of multilayer composite surface coatings on gear scuffing load carrying capacity, gear friction coefficient and gearbox efficiency is discussed. Tests reported in the literature, such as Rockwell indentations, ball cratering, pi-on-disc and reciprocating wear, FZG gear scuffing tests are performed in order to evaluate the coatings anti-scuffing performance. The influence of MoS_2/Ti & C/Cr surface coatings on the friction coefficient between gear teeth is analysed Significant efficiency improvement was found with the MoS_2/Ti coating.

Methodolgy:



Conclusion:

As we can see that by many ways efficiency of gearbox can be improved. But the methods are mostly applied on two or more parameters. There is scope to check some parameter with different techniques and check their resemblance with practical effect and improvement in efficiency of gear box.

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