Analysis & Optimization of Gearbox Efficiency- A Review

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Abstract

The less efficiency of gear box of a machine tool is a serious problem as it increases maintenance cost and also affects the reputation of a firm. Hence its life has to be increased and should be made more reliable. The work to be done here is to find and rectify the causes of failure thereby improving the life of it. Also bearing failure should be reduced which is a cause of system failure. The alternative for the above problem is to design and optimization of a worm and worm gear box which reduced maintenance and improved reliability, lack of lubrication requirements, precise peak torque transmission, inherent overload protection, physically isolated input and output shafts, misalignment tolerance, and low acoustic noise and vibration etc. The parameters considered in the research are Lead Angle, Backlash and Bearing failure.

Keywords: Worm and Worm Gearbox, Double Disc Surface Grinding Machine, Efficiency, Backlash, Lead Angle, Bearing, Finite Element Analysis, Optimization..

I. INTRODUCTION

A worm drive is a gear arrangement in which a worm (which is a gear in the form of a screw) meshes with a worm gear (which is similar in appearance to a spur gear, and is also called a worm wheel). Like other gear arrangements, a worm drive can reduce rotational speed or allow higher torque to be transmitted. A worm is an example of a screw, one of the six simple machines. A gearbox designed using a worm and worm-wheel will be considerably smaller than one made from plain spur gears and has its drive axes at 90° to each other. Worm gear configurations in which the gear cannot drive the worm are said to be self-locking. Whether a worm and gear will be self-locking depends on the lead angle, the pressure angle, and the coefficient of friction; however, it is approximately correct to say that a worm and gear will be self-locking if the tangent of the lead angle is less than the coefficient of friction.

There are three different types of gears that can be used in a worm drive.

(1) Non-throated worm gears
(2) Enveloping (hourglass) worm gears
(3) Double-enveloping worm gears

Fig.1: Worm and Worm Gear

The worm and worm gear drive is never 100% efficient as there is always some power loss due to the friction (rubbing action) between the worm and worm gear. The factors have an impact on the friction and therefore, the efficiency of a drive includes

Backlash, Lubrication, Speed of worm, Material of worm and gear, Load, Finish of surface on worm thread, Accuracy of cutting worm and gear and Lead angle of worm.

Application of Worm and Worm Gearbox:

- Double Disc Surface Grinding Machine
- Presses
- Rolling mills
- Conveying engineering
- Mining industry machines

II. LITERATURE REVIEW ON WORM AND WORM GEARBOX EFFICIENCY AND LIFE

(1) Study and Investigate Effect of Input Parameters on Temperature and Noise in Gearbox Using DOE, Rushil H. Sevak, Saurin Sheth, © 2014 IJEDR | Volume 2, Issue 2 | ISSN: 2321-9939.

In this research paper, Researcher suggest that before making gearbox, verification of its work, performance, efficiency, which effects gearbox performance is necessary. He used DOE techniques to achieve desired design of gearbox for control the temperature and noise levels in gearbox. He reached to the conclusion that it seems that the input speed, back lash, axial play of pinion and output shaft, oil viscosity are very crucial for the gearbox noise and temperature of oil. By optimizing input parameter, life of the gearbox will be increase.

(2) *The Research and Analysis of the New Modification Theory of Toroidal Worm gearing*, Wen qingming, Xu hua, Tang weixiang (2010), International Conference on System Science, Engineering Design and Manufacturing Informatization

In this research paper, Researcher discovers the shortage of the traditional "modification" theory, and then a research method of new modification principle is brought forward. Accordingly, the principle of curvature modification is established and the effect of the curvature modification theory is also analyzed. During the research and analysis, he find that the curvature modification principle solves the long time unsolved problem in the modification of toroidal worm-gearing is get in theory and practice. The new toroidal worm gearing modified on the principle of curvature modification have higher carrying capacity and transmission efficiency than the traditional toroidal worm-gearing. Experiment also proves that compared with the traditional modification, it can bring higher bearing ability and transmission efficiency. Including as a technological measure to improve transmission stability, the modification principle of toroidal worm is a theory and technology to study the basic structure of toroidal worm.

(3) *An Experimental Investigation of Power Losses in Gear box at different operating condition*, Prakash D Patel, J.M.Patel Proceedings of TFMS 2012, National Conference on Thermal, Fluid and Manufacturing Science, January 20 – 21, 2012, Surat, Gujarat, India.

In this study, Researcher studies the influence of a variety of operating conditions on the power losses and efficiency of an automotive manual transmission was investigated experimentally. An experimental methodology was developed to measure power losses of a manual transmission under both loaded and unloaded conditions while all operation parameters were controlled tightly. A set of fixtures and instrumentation were designed and implemented to apply the experimental methodology to a five-speed, manual transmission from a front-wheel-drive passenger vehicle. Experimental parametric studies were performed to quantify the influence of operating conditions including load, oil viscosity and oil volume on load-dependent (mechanical) and load-independent (spin) power losses of the transmission. Analysis of the power loss data revealed that all three of these parameters influenced the components of the transmission power loss significantly, and specific conclusions were drawn in order to aid attempts to increase overall transmission efficiency.

(4) *The study and analysis of a new Anti-backlash worm gear*, Deng Xingqiao, Wang Jinge, Wang Qiang, Liu Qin-qin,Zhang Junfu, Paper Ref: S0601_P0216, 3rd International Conference on Integrity, Reliability and Failure, Porto/Portugal, 20-24 July 2009.

In this research paper, Researcher suggested a new kind of anti-backlash worm gearing has been proposed to eliminate the backlash in worm gearing and the structure work principle has been introduced. According to the theories of gear meshing, the author analyzes the contact line, the lubrication angle, and Induced normal curvature. The analyze results shows the proposed anti-backlash worm has three major advantages. First it can eliminate the backlash of worm gearing through the interleaving roller. Second as the roller have changed the glide friction into the roll friction, the transmission efficiency and load capacity of the anti-backlash double-roller enveloping hourglass worm gearing is higher than that of an normal worm and finally third the roller can be changed easily when it corrupt.

(5) *Influence Factor on Gearbox Power Loss*, Bernd-Robert Höhn, Klaus Michaelis and Michael Hinterstoißer 978-1-4244-7739-5/10/$26.00 ©2010 IEEE.

In this research paper, Researcher studied different methods are discussed for power loss reduction. No load losses can be reduced, especially at low temperatures and part load conditions when using low viscosity oils with a high viscosity index and low oil immersion depth of the components. This in turn influences the cooling properties in the gear and bearing meshes. All in all a reduction of the gearbox losses in average of 50 % is technically feasible. There is a comparison of the no load losses of different bearing Types for same load capacity C = 20 kN. Lowest no load losses of radial bearings are expected for cylindrical roller bearings. They also low values of taper roller bearings are valid for unloaded bearing arrangements. Dependent on the

application and the operating regimes a power loss reduction potential in a gearbox of some 50% was proven to be possible. In some applications only the simple change to a highly efficient lubricant can save some 20% power loss.

III. CONCLUSION

As per review of research papers, we can see that no one has focus on effect of improving the output torque for improving gearbox efficiency and life. After study of many research papers and market survey, it should be prove that torque improvement, lead angle improvement, reducing backlash and proper bearing and lubricant selection influences the gearbox life and efficiency. In this project work, I want to try to improve the life and efficiency of gearbox by concept of torque improvement, lead angle improvement, reducing backlash, proper bearing and lubricant selection, reducing noise and vibration.

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