A Review on Self-locking Lifter based on Twin Worm

[1]Indrajeet Sharma, [2]Lukesh Patil, [3]Kaustubh Patil, [4]Vikram Singh

[1,2,3,4]UG Students
Mechanical Engineering Department
G.H.Raisoni College of Engineering and Management, Chas, Ahmednagar, India

***Abstract*: In almost every material handling equipment gear drives are used. In these type of systems when the driving torque is suddenly decreased due to mechanical failure, power off or any kind of failure at the input shaft of the system, then gears will be start rotating either in the same direction driven by the system inertia, or it will start rotating in the opposite direction driven by the resistant output load due to spring load, gravity, etc. This condition is also known as back driving. But, there is solution in gear transmission that stop inertial motion or back driving using self-locking gears without any extra device. Self-locking is the potential of gear system which constitute a drive which gives the input gear the independence to rotate the output gear in any directions but the output gear locks with input when an outside torque try to rotate the output in any direction. Worm gear pair is self-locking gear pair but it have very low efficiency nearly 40%, when made self-locking. Self-locking feature is obtained by using worm pair which is in mesh with each other. The efficiency nearly 90% can be obtained as compared to 40% of conventional worm gear system.**

***Keywords*: efficiency, self-locking, worm, torque**

1. INTRODUCTION

Load lifting devices are used to lift the goods form one place to another place within a company or at site. In most of load lifting devices worm gear drive is used to lift and carry the loads from one place to other place, it has worm and gear pair. A powerful motor is used to give the required input rotary motion to the worm in turn transfers this rotary motion to the gear. The load drum is provided to the gear shaft which rotates due to rotary motion of gear and in turn the load gets lifted. The higher speed reduction is done with the help of this worm gear system, but there are some losses in this system due to the friction between the worm and gear. This worm gear system have an ability of self-locking due to which the input member can rotate the output member in any directions but when the driving force on input member is suddenly removed or it is reduced then it doesn't allow the output member to rotate the input member. This property of self-locking ensures the safe operation of any material carrying system. It also keeps the motor safe in order not to get damaged due to its opposite rotation. This advantages of worm gear like self-locking ability and simplicity in construction but it also has some disadvantages like poor efficiency. It hardly provides the efficiency around 40% because of friction between worm and gear. So our main aim behind this review is that to find out the alternate pair of objects which also has the self-locking ability, higher efficiency as compared to conventional worm gear system and simple in construction.

2. PREVIOUS WORK ON SELF-LOCLING DEVICES

Mr. Vikrant D. Sathe et.al they studied about self-Locking lifting device by application of twin worm arrangement. He made a prototype load lifting device for lifting weight up to 10 kg. He conducted test and trial on machine for different loads and find that the use of twin worm gear is helpful for lifting load with less effort. He find that as the lifting load increases the torque required to lift that load will also increases, but the speed will reduced. He found that power required is maximum for increasing load. He also found that in his trial as the load increases to maximum the efficiency is also maximum. [1]

Prof. P.B. Kadam et.al they compared their research with the patent paper of Devid W. Pessen who give the twin worm pair have efficiency of 92%. P. B. Kadam in his research of using two worm gears found the efficiency of 89.30%, which it gives to nearer to theoretical efficiency. They also stated that using of twin worm gear in self-locking gear box reduce the whole gear box lifting mechanism size, which reduces cost and size of the load lifting device. So they said that using of twin worm gears in self-locking gear box is very useful in lifting devices and in industrial application. [2]

Ajit Ramdas Gurav et.al he selected proper and different pitch angle for designing the two pair of worm gears. If both worm had same pitch angle reversible drive would result similar to helical gears this is why he selected different pitch angles for both worm gears. Because of the different pitch angle meshing of gear in parallel is not possible so he give slightly angle between both shafts so both gears can mesh properly. He modelled a Right hand worm and Left hand worm from theoretical calculation and the 3D drafting is done through Unigraphix Nx 08. He finds the ultimate tensile strength and yield strength of the worm gear. The both gears are analysed through ANSYS so that he can calculate torsional sheer failure of the worm. After calculating the torsional sheer failure of the worm. It is found that maximum stress by theoretical and analytical methods are well below the allowable limit. Also deformation is negligible. Hence the RH Worm gear and LH Worm gears are safe under the rated torque. [3]

R. D. Ankush et.al in their research they designed and did a analysis on a worm pair used in self-locking system.
But in case of self-locking systems the occasion can arise where it becomes desirable to quickly release the load. So they introduced a clutch between the pulley and worm for quick release of load. They did experiments on conventional worm gear system and mating worm pair system by applying different loads on the both system. They have calculated the value and found that the mating worm pair system also exhibits a self-locking ability as that of conventional worm gear system. Also the efficiency of the mating

worm pair system is also greater than that of conventional worm gear system. So with having some further modifications related to dimensions of worms such as its helix angle, lead angle and other parameters we can replace this conventional worm gear system with new worm pair self-locking system. [4]

Prof. Abhay M. Kalje for his study of compact self-locking lifter with zero slip he constructed all the required part like lifter drum, bearing housing, left hand internal worm gear, spur gear, right hand external thread shaft for his device. Then he did theoretical design and analysis of parts is discussed. In that with the help of Lewis strength equation he finds the dimension and module for gear and pinion. He also find the stresses and torsional failure for all the parts after getting all the values he stated that all designed parts for compact self-locking lifter is safe from torsional failure. [5]

Mr. Naeem B. Tamboli he designed and studied about dual worm self-locking system for improved transmission efficiency & deceleration locking property. In this he compared the conventional system and mating worm gear. He said that the efficiency of worm gear depends on the coefficient of friction and the lead angle. In order to obtain a worm gear with high efficiency it is recommended to use the lead angle in the range between 15° and 30°. In his study he also concluded that mating worm pair system also exhibits a self-locking ability as that of conventional worm gear system. Also the efficiency of the mating worm pair system is also greater than that of conventional worm gear system if they use in mesh fashion. If we can modify the warm gear for helix angle, lead angle and other parameters. The replacement of conventional system i.e. existing system is possible with proposed system i.e. worm pair with self-locking system also we can achieve maximum efficiency and less frictional losses. [6]

Werner Sigmund et.ai they evaluate load-carrying capacity as well as overall efficiency of large sized worm gears are carried out on the large-sized worm gear test rig developed by FZG. In order to apply a particular load on the test worm wheel, they have used a hydrostatic torque motor which is connected to the reverse transfer gearbox. Via a summation gearbox, the bracing cycle is closed. Consequently, only occurring overall power losses have to be fed in by a direct current motor. There main aim for the project is to analyse large-sized worm gears with centre distance a=315mm with regard to their wear and pitting behaviour and overall efficiency at diff erent operating as well as with various lubrication conditions. They have continuously measured and analysed the overall efficiency of worm gear test rig with centre distance 315mm. They find overall efficiencies of up to Ƞ=96% are measured at present operating conditions. Although an increasing pitting damage occurs up to Ƞ=45%, no significant influence on efficiency is recorded. With the use of lubricants with low viscosity (ISO VG 220) slightly lower efficiencies are reached when compared to lubrication with an oil of viscosity ISO VG 460. A mineral oil with comparable viscosity even leads to significantly lower values. [7]

A. A. Pandharabale et.at in year 2015 he designed dual worm system for optimal load lifting capacity is done with, optimal factor of safety & optimal efficiency for reduced power consumption. He finds the value of deflection and vibration analysis by using ANSYS, he also find the mechanical design validation by using ANSYS. The experimental validation part of the lifting force developed by the dual worm system is validated using test rig. He plotted various characteristics value by using different chart and graph. He stated that the torque increases with the decrease in the output speed indicating that the device will slow down slightly if the load is increased. He concluded that the load lifting capacity can be increases by increasing the output power. [8]

3. CONCLUSION

Firstly we have studied about the conventional load lifting devices at present and found that there is some drawbacks in conventional load lifting device like no safety for the machine if the motor is failed or in over load condition and power loss due to friction. We have also seen that the convention load lifting device have only efficiency of 40%. So if we use worm and worm gear it will be safer for lifting load even if the motor get failed during lifting the load. Using two worm gear pair increases the efficiency up to 90%. Using twin worm is safer as the output worm cannot rotate the input worm in any condition but input worm can rotate the output worm. The cost of manufacturing and space requirement for dual worm is also less than conventional load lifting devices

REFERENCES

[1] Mr. Vikrant D. Sathe, “Testing of Compact Self-Locking Lifting Device by Application of Twin Worm Arrangement” International Research Journal of Engineering and Technology Volume: 04 Issue: 10 | Oct -2017.
[2] Prof. P.B. Kadam, “Improvement in the Design & Manufacturing of Twin Worm Self Locking Technique and applications” IOSR Journal of Engineering May. 2012, Vol. 2(5) pp: 1224-1233.
[3] Ajit Ramdas Gaurav, “Design and Analysis of Dual Worm Self Locking System” International Journal for Scientific Research & Development| Vol. 3, Issue 05, 2015 | ISSN (online): 2321-0613
[4] R. D. Ankush, “Design and analysis of worm pair used in self-locking system with development of manual clutch” International Journal of Research in Engineering and Technology eISSN: 2319-1163 | pISSN: 2321-7308.
[5] Prof. Abhay M Kalje, “Design of Compact Self-Locking Lifting Device by Application of Twin Worm Arrangement” International Journal of Innovative and Emerging Research in Engineering Volume 4, Issue 9, 2017
[6] Mr. Naeem B. Tamboli, “Modeling, Design, Development, Testing & Analysis of Dual Worm Self Locking System for Improved Transmission Efficiency & Deceleration Locking Property” International Journal of Innovations in Engineering Research and Technology ISSN: 2394-3696 Volume 2, Issue 12, DEC.-2015

[7] Werner Sigmund, "Efficiency of worm gearboxes" Proc IMechE Part C: J Mechanical Engineering Science 0(0) 1–5 IMechE 2015, Reprints and permissions: sagepub.co.uk/journalspermissions.nav, DOI: 10.1177/0954406215602286.
[8] Pandharabale, "Design Development Analysis of Compact Self-Locking Lifting Device by Application of Twin Worm Arrangement" International Engineering Research Journal (IERJ) Special Issue 2 Page 4027-4033, 2015, ISSN 2395-1621.
[9] R.S. Khurmi, J.K. Gupta, S. Chand, Textbook of "Machine Design" (publication) (2005), page 640, graph 17.5.