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DESIGN AND ANALYSIS OF AN EPICYCLIC GEAR TRAIN USING CORRECTED GEARS

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Abstract: Very huge speed reduction is carried using epicycle gear train with corrected gears Predetermined Centre distance is attained. In this set-up, four external spur gears are used. Load carrying capacity and sliding conditions could also be improved by using addendum-modified gears without altering the dimensions in a major way. High speed reduction ratio of 3600:1 is achieved. Further after design, the gear train is analyses for its efficiency and effective simulation is shown

1. Introduction

It is possible to obtain very high transmission ratios hydraulically. [1]Man has always tried to improve on his finding from time immemorial. This project has been taken up to obtain high transmission ratios mechanically using non-standard gears. [2]The set up consists of four gears having teeth of 59/60, 61/60. The gears are held in position using an arm which rotates with the input shaft .Using this setup it is possible to obtain speed ratio of the order of 3600:1.

2. Reasons For Using Corrected Gear

Naturally a question will arise in the mind of gear designer, gear manufacture or gear user as to what is the need for addendum- modified gears. [3]There are many situations where addendum – modified gears are necessary. Some of them are given below.

(a) To obtain a given gear ratio maintaining the same Centre distance, addendum – modified gears are used. This may arise when a new gear ratio is to be obtained for a pair of gears in an old gear box where Centre distances cannot be altered.

(b) In a given set-up, due to other constraints the number of teeth of the pinion may be less than the minimum number to avoid undercutting. [4]Then the pinion can be produced with addendum modification to avoid undercutting.

(c) It is possible to design gears to suit given loads in a given drive.

(d) Load capacity and sliding conditions can be improved by using addendum- modified gears without altering dimensions in a major way.

3. Non – Standard Spur Gears

In this set-up we use non-standard gears because with standard gears [5]it is possible to obtain speed ratio of the order of 1:4 to 1:9 only. Gear 'A' and 'D' are corrected to avoid under cutting and to obtain predetermined center distance. Based on correction aspect gearing can be classified into two broad categories,

(1) S_0 gearing
(2) S gearing

4. Profile Correction of Gears

Apart from the fact that interference hampers conjugate action when the involute portion of a teeth meets with the non-involute portion of the other tooth. There is every likelihood that the meshing gears will not rotate at all. [6]Rather the gear causing the interference will have a tendency to jam on the flank of the pinion, unless, of course the pinion tooth-root has already been undercut making room to provide free movement of the gear teeth. Besides, due to interference and in the absence of an undercut, the mating gear will try to scoop out metal from the interfering portion. [7]But since the mating gear is not a cutting tool, in the process the teeth become damaged and it will have an overall detrimental effect on the gear system.

If the situation warrants a pinion might have to be designed with number of teeth less than minimum number stipulated to avoid under cutting. [8]In such cases, the practice which is not universally adopted in what is known as the "profile correction" gear tooth. In gear technology profile correction is also termed "Addendum modification".

"S_0"Gearing:

In S_0 gearing the two components of mating pair of gears receive numerically equal correction factors but these factors are algebraically of opposite sign, normally the pinion is provided with positive correction and the gear with negative correction. In other words

$$x_1 + x_2 = 0 \text{ (or) } [x_2 = -x_1]$$

(I.e. pass through the normal pitch point pin the case .it is shifted away by an amount equal to the numerical value of xm (mm).

In case of the pinion , [9]which normally receives the positive correction ,the cutter is moved away from the gear blank centre by an amount of xm (mm) while cutting so that an enlarged pinion with its tip diameter increased by an amount 2xm(mm) is produce.[33-34]

In case of the gear, the cutter is moved toward the gear centre by the same amount so that its diameter is smaller by an amount of 2 xm (mm)[10] than in the case of uncorrected gear. Since topping is not necessary for so gearing , the gear blanks are simply made bigger or smaller , as the case may be ,by the amount indicated before feeding them to the gear –cutting machine.

***Application of S_0 gearing*:**

The so gearing is normally meant where the reduction ratio is large. [11]Thicker pinion teeth are ensured and the gear teeth also do not become significantly weak. However, S_0 gearing is not recommended for small reduction ratios as it tends to weaken the teeth of the gear. The S_0 gearing is also sometimes recommended where for certain specific reasons the normal tooth-thickness of the gear pair or the specific sliding velocity between the meshing teeth flanks are to be change. Besides, since normally the pinion teeth are weaker than gear teeth [12-16]when both are made of the same material, they are more vulnerable to breakage and wear, The S_0 system tends to equalise the tooth strength and thereby reduces the susceptibility to such damage.

Types of corrected gearing:

(a) Normal gearing x, = $x2$ = 0
Pressure angle a = 20'
(b) So-Gearing x, = - $x2$ = 0.5
Working pressure angle
(c) S-Gearing x, =$x2$ = 0.5
Working pressure angle
a, = 25.1 5', a = 20"

Design of gear:

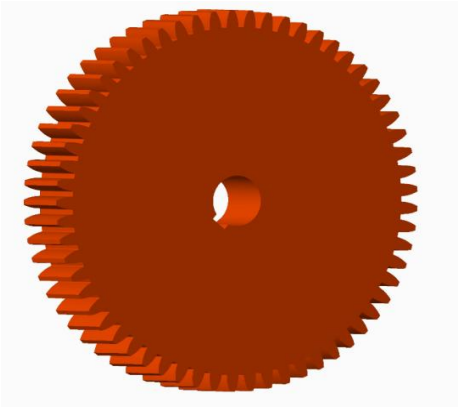


Figure 1. gear A

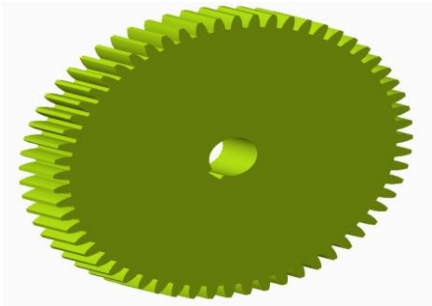


Figure 2. gear B

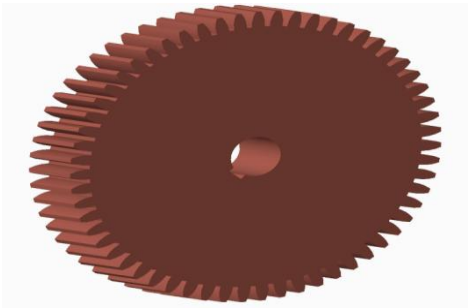


Figure 3. gear C

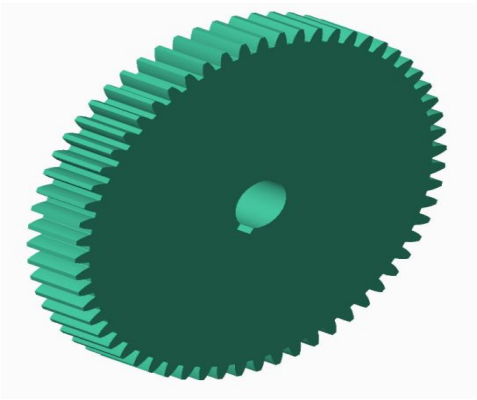


Figure 4. gear D

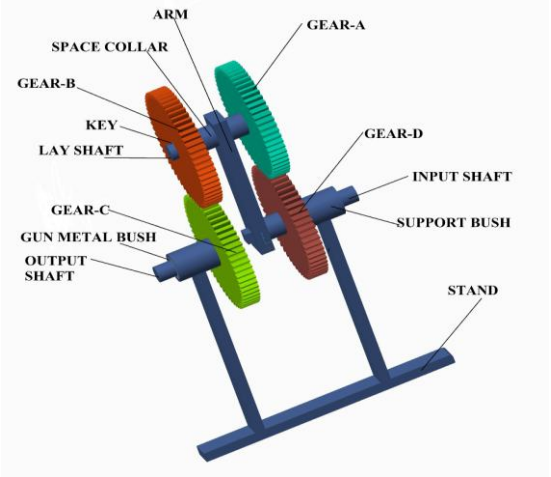


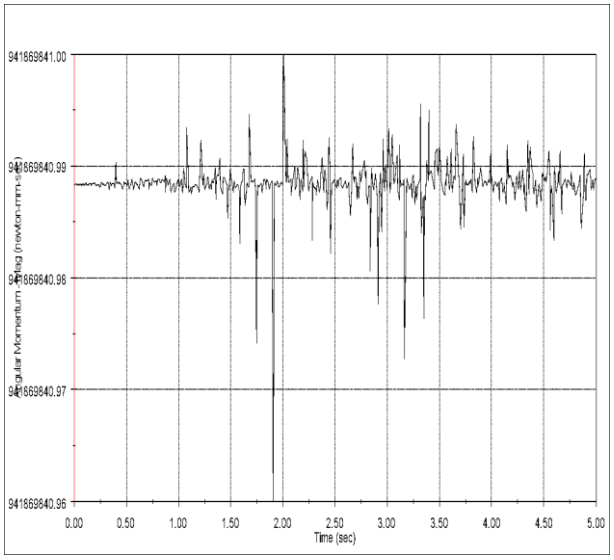
Figure 5. Profile of assemble epicyclic gear train

5. Simulation and Analysis

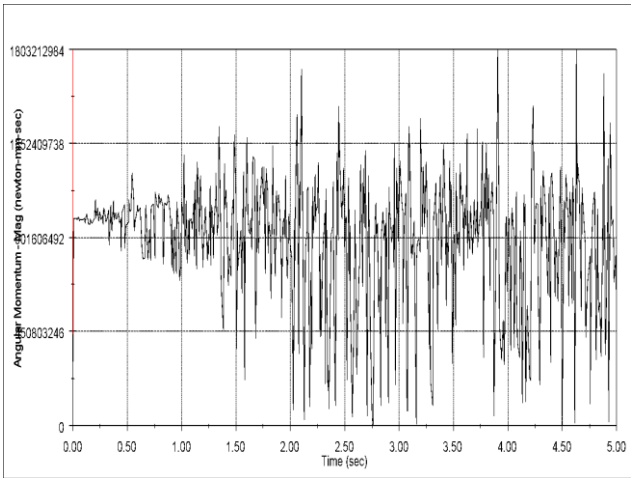
[17]We have used multibody dynamics software depending upon the movement of the bodies (hears) .the arm is fixed and the speed of 3600rpm is transferred to all other gears. The angular momentum is calculated based on the numerical method. [18-20]Only magnitude is considered i.e. time magnitude of angular momentum.

From the graph we can came across the sinusoidal curve.it vary as per the rotation.at one point we have noticed that in gear pair. The clearance given is more due which slip of occur and when this is reduced we can maintain the angular momentum or angular Velocity. [20-26]Constraint over a period of time, or else as we see after one point it is seen to decrease and one point it increase.

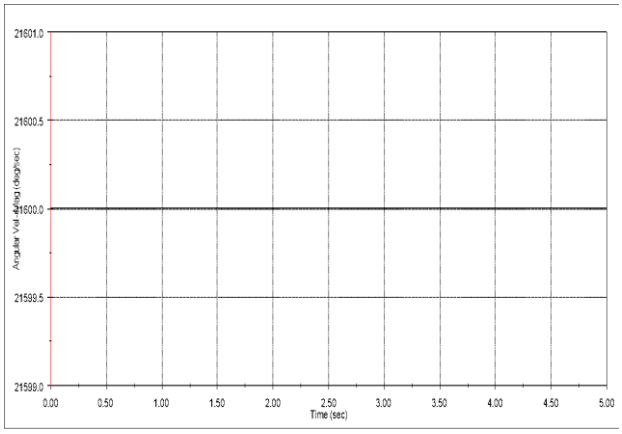
From this we are able [27]to do the prediction. We have found that since all the gear are in simulated condition , [28-30]there is no much variation in the angular displacement of we go in for simple point condition e can find the result actually.



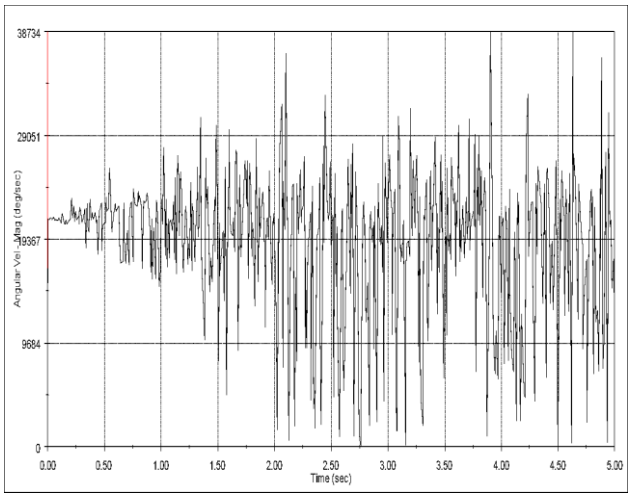
Angular momentum of gear C



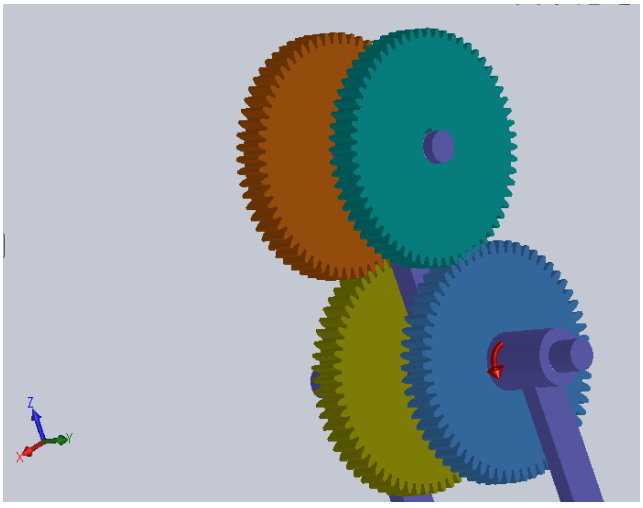
Angular momentum of gear B



Angular velocity of gear C



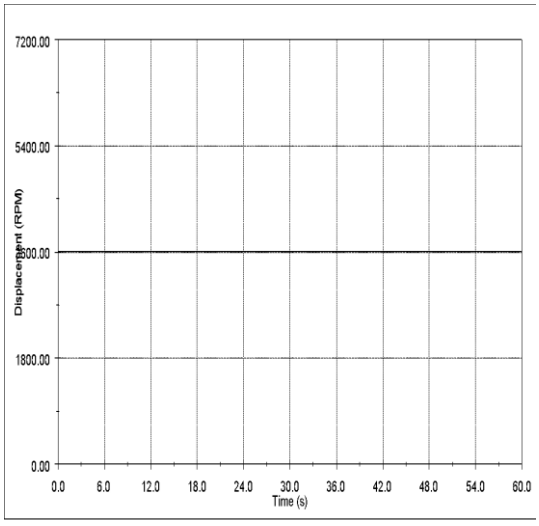
Angular velocity of gear B



3600 RPM Is Given To Gear D

Result Of Simulation Analysis:

The results of stress analysis are as given below:



No of rotation of gear D

Advantages: High density power transmission. Light weight, smaller size. Load carrying capacity is high. Low noise and vibration. Using corrected gear, undercutting and the problem of interference is avoided. Life can be increased.

6. Conclusion

By using the C-program the involute profile such as warm compaction or high velocity compaction tensile strength, impact energy

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