International Organization of Research & Development (IORD)
ISSN: 2348-0831
Vol 04 Issue 02 | 2016

Review of Design and Optimization of Spur Gear used for Oil Mill application

GopalG.Varma[1] ,Prof.Dheeraj Verma[2], Santosh Shekokar[3]
Padm.Dr.V.B.Kolte College of Engineering, Malkapur

ABSTRACT

Gears are commonly used for transmitting power. They develop high stress concentration at the root and the point of contact. The repeated stressing on the fillets causes the fatigue failure of gear tooth. The main objective of this study is to add different radius fillets to reduce stress concentration. A finite element model of Spur gear with a segment of single teeth is to be considered for analysis and stress concentration of fillet radius of various sizes is introduced on gear teeth.

Keyword: Spur Gear, Fillet Radius Optimization.

I. INTRODUCTION

A Gear can be defined as the mechanical element used for transmitting power and rotary motion from one shaft to another by means of progressive engagement of projections called teeth. Spur Gears use no intermediate link or connector and transmit the motion by direct contact. The two bodies have either a rolling or a sliding motion along the tangent at the point of contact. No motion is possible along the common normal as that will either break the contact or one body will tend to penetrate into the other. Thus, the load application is gradual which results in low impact stresses and reduction in noise. Therefore, the spur gears are used in transmitting power with very less friction losses.

Gears

Imagine two disks are placed side by side, tangent to each other (both touching), if one disk was rotated, due to friction (caused by surface roughness) the other disk would also rotate (in the opposite direction) however, slippage would be introduced due to variation in the surface roughness. Now if we were to increase that surface roughness by cutting the disks and forming teeth on the circumference (circular outer part) then slippage would be eliminated. As a result, we would have one of the most important fundamental mechanical devices, which can manipulate speed, torque and rotational axis. Almost all machines that involve rotation have gears. Gears are found in everything from cars to clocks.

Requirement of gear:

Gears have neat characteristics which aid in the development of complex machineries: Gears can transmit power with very less friction loss. Gears can reverse the direction of rotation. It can change the speed or torque (turning force) of rotation. It can transfer rotation to a different axis or translate rotational into linear motion or vice versa.

Classification of Gears:

The basic classification of gears includes the following types; they are

- Spur gear
- Helical gear
- Worm gear etc.

Gear Materials:

Desirable properties for gear material are as follows:

- Endurance strength in bending to avoid bending failure.
- Surface endurance strength to avoid destructive pitting. (c) Low coefficient of friction to avoid scoring.
- Low and consistent thermal distortion during heat treatment.

Spur Gear

Gear having straight teeth cut on the rim, parallel to the axis of rotation. Most common & cost-effective type of gear. Designed to transmit motion & power between parallel shafts, which rotates in the opposite direction. Plastic, brass, steel, & aluminum are the materials generally used for manufacturing.

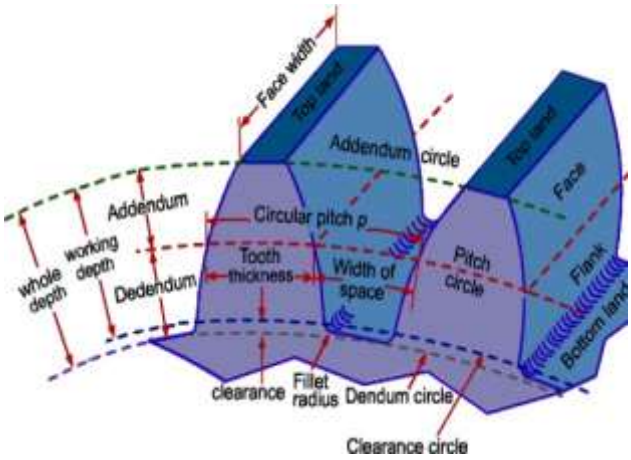

Fig. Involute Spur gear

Electric screwdrivers, oscillating sprinklers, windup alarm clocks, washing machines, clothe dryers & conveyors are just a few everyday machines where spur gears are used. Spur gears are also used in construction equipments, machine tools, marine hoists, turbine drives, multi-spindle drives, indexing equipments & roller feeds.

II. LITERATURE REVIEW

Mr. A. Gopichandet. al. [1] briefed in his Work about a software called "MATLAB" to design gear. MATLAB is extensively used for scientific & research purposes. It is accurate & also has a number of built in functions which makes it versatile. In this project SPUR GEARS are designed. The program is a user friendly one & when executed it ask the inputs and performs the necessary design calculations and gives necessary output values. It also gives the involute gear tooth profile with accurate safe dimensions. As computers are used to perform the task of gear design becomes simple, friendly & error free.

AbhijitMahadevSankpalet. al. [2] worked on contact stress analysis using Photoelastic Technique**.** Contact stress refers to the localized stresses that develop as two curved surfaces come in contact and deform slightly under the imposed loads. Also due to contact stresses wear takes place at gear tooth. Wear is nothing but progressive removal of metal from the surface. Consequently tooth thins down and gets weakened. Pitting is a surface fatigue failure of the gear tooth. It occurs due to misalignment; wrong viscosity selection of the lubricant used, and contact stress exceeding the surface fatigue strength of the material. Material in the fatigue region gets removed and a pit is formed. In this work contact stresses find out by FEM method and experimental method by using the polariscope. And compare the FEM result with experimental result. As we know gear is one of the most critical components in a mechanical power transmission system, failure of one gear will affect on the whole transmission system. Therefore it is necessary to find the root cause which result into failure of gear and try to eliminate these causes. Failure analysis is an engineering approach to determining how and why equipment or a component has failed.

Dr. C. UdayaKiranet. al. [3] in this work they are optimizing the gear profile geometry by using CAD & CAE and improving the gear tooth strength. Corrective measure is taken to avoid tooth damages by introducing profile modification in root fillet using cad. In general, spur gear with less than 17 numbers of teeth had the problem of undercutting during gear manufacturing process which minimizes the strength of gear at root. In this study a novel design method, namely circular root instead standard trochoidal root fillet is introduced in spur gear and analyzed using CAE software. The strength of these modified teeth is studied in comparison with the standard design. The analysis demonstrates that the novel design exhibit higher bending strength over standard trochoidal root fillet gear. The result reveals that circular root fillet design is particularly suitable for lesser number of pinions and where as the trochoidal root fillet is more opt for higher number of teeth.

Mrs. C.M. Meenakshi et.al. [4] Studied the various stress state of spur gear. They calculated the tangential and radial forces which acts on various point upon that basis we can analyze by applying the forces. By using Ansys software bending stress and contact stress on the tooth of spur gear drive is found Gears are machine elements used to transmit power between rotating shaft by means of engagement of projection called teeth. Gears are most common means of transmitting power in the wooden mechanical world. They vary from a tiny size used in watches to larger gears used in massive speed reducers, bridge lifting mechanism and rail road

turn table drive. The gears are vital elements of main and auxiliary mechanism in many machines such as automobiles, tractors, metal cutting machine tools rolling mills hosting and transmitting and transporting machinery, massive engines etc

Vijay BhaskarSudarsiet. al. [5] deals with the finite element analysis of deformation on spur gear teeth by applying static load on teeth, the feasibility of the work is investigated and the results of the FEM analyses from ANSYS are presented. Gears are the most common means of transmitting power in mechanical engineering. With the moving wheel of science and technology the use of gears has become more common in all the upcoming industries. The application of these gears fled from tiny wrist watches to huge machinery Equipments. Gears from vital elements of mechanisms in many machines such as vehicles, metal tooling machine tools, rolling mills, hoisting and transmitting machinery, marine engines, and the like. Toothed gears are used to change the speed, power, and direction between an input and output shaft.

Gearing is one of the most critical components in a mechanical power transmission system, and in most industrial rotating machinery. It is possible that gears will predominate as the most effective means of transmitting power in future machines due to their high degree of reliability and compactness. In addition, the rapid shift in the industry from heavy industries such as shipbuilding to industries such as automobile manufacture and office automation tools will necessitate a refined application of gear technology. Parallel and co- planer shaft connected by gears are called spur gear. Spur gear have straight teeth and are parallel to the axis of the wheel. Spur gears are the most common type of gears. The advantages of spur gear is their simplicity in design, economy of manufacture and maintenance, and absence of end thrust. gear is a component with in a transmission device that transmits rotational torque by applying a force to the teeth of another gear or device. A gear is different from a pulley in that a gear is a round wheel that has linkages (teeth or cogs) that mesh with other gear teeth, allowing force to be fully transferred without slippage.

Ali Raad Hassan [6] studied effect of contact stress analysis between two spur gear teeth considered in different contact positions, representing a pair of mating gears during rotation. A programme has been developed to plot a pair of teeth in contact. This programme was run for each 3° of pinion rotation from the first location of contact to the last location of contact to produce 10 cases. Each case was represented a sequence position of contact between these two teeth. The programme gives graphic results for the profiles of these teeth in each position and location of contact during rotation. Finite element models were made for these cases and stress analysis was done. The results were presented and finite element analysis results were compared with theoretical calculations, wherever available.

Yogesh C. Hamand [7] ex- amines the various stresses and deflection developed in sun gear tooth of planetary gearbox which is used in Grabbing Crane. Also includes checking sun gear wear stresses and bending stresses using IS 4460 equa- tions. Also calculate various forces acting on gear tooth. In this study, perform the calculation for sun gear tooth to calculate bending, shear, wear & deflection using theoretical method. 3D model is created of circular root fillet &trochoidal root fillet of gear tooth for simulation using ProE Wildfire 3. In Pro-E, the geometry is saved as a file and then it is transferred from Pro-E to ANSYS 10 in IGES format. The results of the 3 D analyses from ANSYS are compared with the theoretical values. Comparison of ANSYS results in circular root fillet &trochoidal root fillet also carry out.

III. OBJECTIVES AND SCOPE OF THE PRESENT INVESTIGATIONS/STUDY:-

The objectives and scope of this investigation given as following

- Design of Spur Gear
- 3D model of Gear using CATIA
- Finite Element Analysis of Gear profile using ANSYS Software
- Stress analysis on Gear – Material, Loading, Profile aspect.
- Optimization of Gear profile for best results.

Research Methodology/ Requirements of the Research Work:-
Steps of Research Problem:-

- Study of Gear Design and its manufacturing process.
- Design of Gear for said application
- Modeling and Analysis of Gear
- New Suggestion in designs for optimization
- Optimization of Gear Profile

Methods Used:

- Analytical Method

- Finite Element Method
- Experimental Method

IV. DESIGN CALCULATIONS FOR GEAR USED

In this work gear used in special purpose machine is consider. Regular failure of gear occurs due to the bending stresses which occur on gear tooth profile during working condition. So we carried out the work to find out value of face width and root radius of gear which produces minimum bending stress during working condition and life of gear get increases.Gear having following specification, Material of the gear steel having modulus of elasticity E = 210000Mpa
Poisson ratio = 0.3.
In this work gear box transmitting 5 KW power at 290 rpm.

Table: Design Parameters

Contents	**Formulae**	**Value**
Number of teeth (Z)	Given	21
Module (m)	Given	8 mm
Pressure angle (ϕ)	Given	20^0
Normal Pressure Between Teeth	Given	25 N / mm of width
Pitch Circle Diameter (D)	m x Z	168 mm
Circular pitch	n m	25.12 mm
Addendum circle diameter	0.8 *m*	174.4 mm
Thickness of tooth	1.5708 *m*	12.57 mm
Face width (b)	9.5 *m* to 12.5 *m*	84 mm (From Calculations)
Working depth	1.60 *m*	12.8 mm

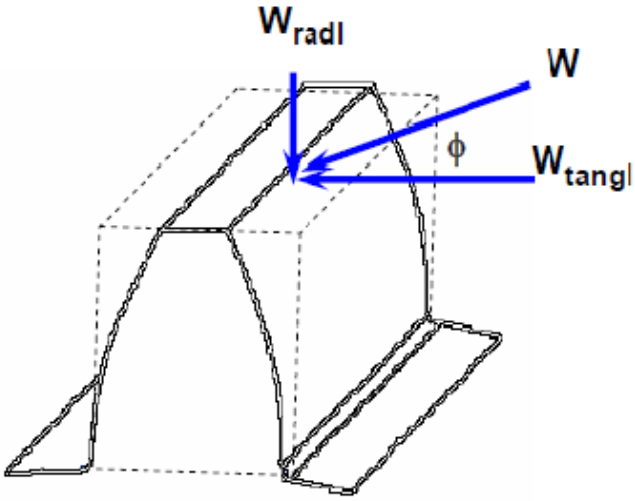

Fig. Load acting on gear tooth profile Necessary width of the pinion

We know that the torque acting on the pinion,

$$T = \frac{P \times 60}{2\pi N}$$

$$= \frac{5 \times 10^3 \times 60}{2\pi \times 290}$$

= 164.643 N-m

Tangential load, $W_T = \frac{T}{D/2}$
…….. (D is taken in meters)

= 1960.036, N

and normal load on the tooth,

$$W_N = \frac{W_T}{\cos \phi}$$

$$= \frac{1960.036}{\cos 20}$$

= 2085.826 N

Since the normal pressure between teeth is 25 N per mm of width, therefore necessary width of the pinion,

$$b = \frac{2085.826}{\text{Width}}$$
$$\frac{}{25}$$
= 83.43 mm ….Selecting 84 mm as Face

V. GEOMETRIC MODELING

In this work parametric geometric modeling of spur gear is done by using the software Catia.Parmetric modeling is nothing but modeling of each feature in such way that if we change dimension value of any one feature then according to that dimension of other get changed as per define relations. First, open a new part file and create the basic gear parameters these are module, no of the teeth, pressure angle using Tools Parameters. These basic parameters determine the all other parameters that define gear tooth profile. The other gear parameters are defined in terms of relationship of basic parameters using Tool relation. By selecting the appropriate datum and commands like extrude, cut etc. The 3D geometric model of gear is created. Fig. 3-D modeling in Catia After creating the 3D geometric model of involutes spur gear saved this model in IGES file so that it can be import to Ansys work bench for analysis

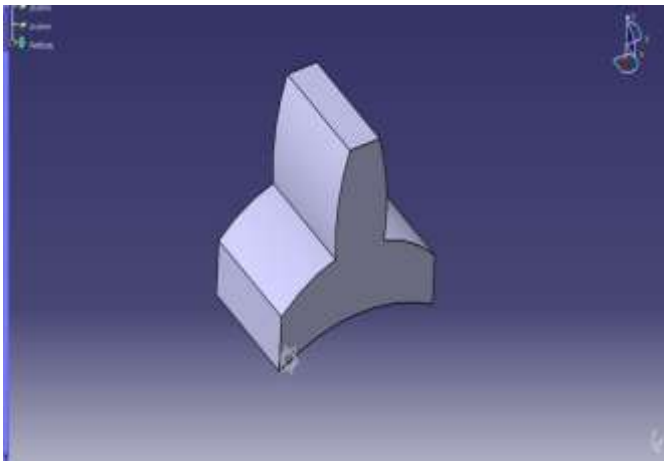

Fig. Tooth Profile without Root Fillet

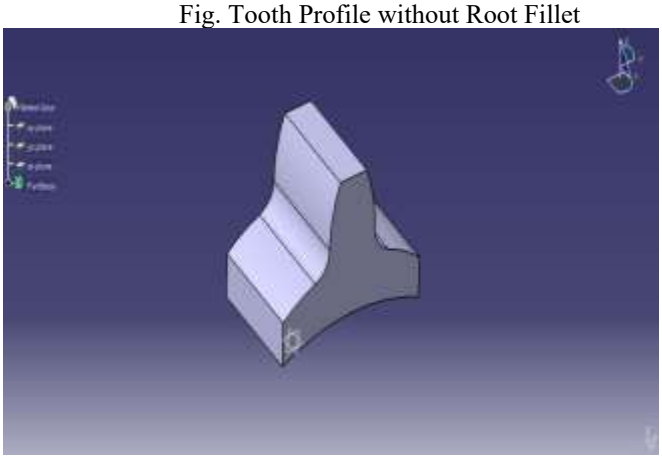

Fig. Tooth Profile with Root Fillet

VI. CONCLUSION

Its gives the clear idea about the gear geometry, design parameters, material required, design calculation related to spur gear. From the literature its clear that Profile variation will lead into reduction in stresses of gear.

VII. FUTURE WORK

Optimization of the tooth profile is to be done using Analysis and best profile is to be selected for final manufacturing. (ANSYS Software can be used)

REFERENCES

[1]. "Design of Spur Gear and its Tooth profile" by Mr. A. Gopichand M.TECH(Ph.D);, Prof. A.V.N.L. Sharma, K. Pavan Kumar, K. Sainath, I. Aravind at International Journal of Engineering Research and Applications (IJERA) ISSN: 2248-9622, Vol. 2, Issue 2, Mar-Apr 2012, pp.820-827

[2]. "Contact Stress Analysis of Spur Gear by Photoelastic Technique and Finite Element Analysis" by

AbhijitMahadevSankpal, M. M. Mirzaat International Journal on Theoretical and Applied Research in Mechanical Engineering (IJTARME), ISSN (Print): 2319-3182, Volume -3, Issue-2, 2014

[3]. "Profile Modification for Increasing the Tooth Strength in Spur Gear using CAD & CAE " by A.Parthiban, P.RavikanthRaju, V. sreenivasulu, P.Divakara Rao, Dr.C.UdayaKiran at International Journal of Innovations in Engineering and Technology (IJIET), Vol. 2 Issue 1 February 2013 ISSN: 2319 – 1058

[4]. "Analysis of Spur Gear Using Finite Element Analysis" by Emmanuel Mrs. C.M. Meenakshi, Akash Kumar, ApoorvaPriyadarshi, Digant Kumar Dash and Hare Krishna at Middle-East Journal of Scientific Research ISSN 1990-9233, 12 (12): 1672-1674, 2012

[5]. "The Finite Element Analysis of Deformation on Spur Gear Teeth " by Vijay BhaskarSudarsi and T.B.S.RaoInternational eJournal of Mathematics and Engineering ISSN 0976 – 1411, 208 (2013) 2037 – 2055

[6]. **"** Contact Stress Analysis of Spur Gear Teeth Pair" by Ali Raad Hassan at International Scholarly and Scientific Research & Innovation 3(10) 2009 World Academy of Science, Engineering and Technology Vol:3 2009-10-20

[7]. "Analysis of Stresses and Deflection of Sun Gear by Theoretical and ANSYS Method" by Yogesh C. Hamand, Vilas Kalamkar at Modern Mechanical Engineering, 2011,1,56-68 doi:10.4236/mme.2011.12008 Published Online November 2011.