Investigation In To The Polymer Gear Tooth Thermal By Using Ansys

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ABSTRACT

Polymer composite gears are replacing metallic gears in many applications due to their high extraordinary properties and low weight. In gear studies temperature generation between the two teeth is the main problem so to replace the metallic gear with polymer Temperature sensitive polymeric material necessitates occurs new gear design procedures so an attempt in this work a polymeric symmetric and asymmetric gear was designed by using ANSYS and studied the Temperature effects and displacement and contact line deviation...

Keywords - **Gear, Asymmetric, Symmetric, Thermal expansion, Contact line deviation**

I. INTRODUCTION

Weight reduction becomes major objective in most of the part design, particularly in the automobile industries. In recent years, focus has been shifted to the transmission elements, where there is a more scope for weight reduction. Weight reduction of a gear can be achieved by two major means, one is through the change in basic design and other is through the utilization of light weight materials for gear manufacturing. In present days with the advent of computer engineering analysis is getting more dependent on computer. In a product design process involving engineering analysis, design alternative has been developed in the geometric modelling process. Gear is a toothed wheel that engages another toothed mechanism in order to change the speed or direction of transmitted motion. It is used to transmit motion and power between rotating shafts by means of progressive engagement of projections called teeth. Gear teeth geometry and analysis is one of the complex one. Many researchers developed a finite element model to analyse the behaviour of a different gear [1],[2],[3],[4].

In recent years, polymer composite gears are replacing metallic gears in many applications due to its low costs, low weight and quiet performance compared with the metal gears. Temperature sensitive polymeric material necessitates new gear design procedures.

The symmetry and asymmetric of geometry is one of the main criteria to study and analyse. An additional alteration that is very rarely used is to make the gears asymmetric with different pressure angles for each side of the tooth. The study of symmetric and asymmetric geometry of the gear teeth by using ansys and other modelling were done by various scientists.[5],[6]. Pedersen [7] shown that significant improvements in the bending stress for gears can be found by the use of asymmetric gears. The largest reduction in the bending stress can be found with drive side pressure angle greater than coast side pressure angle. Park [8] developed a time dependent thermal model to predict local and maximum surface temperature with time. Mao [9] proposed a new design method for polymer composite gear based on the correlation between polymer gear wear rate and its surface temperature. Youqiang et al. [10] developed a numerical method for the transient thermo hydrodynamic lubrication problem of an involute spur gear by using multigrid method. Seireg [11] investigated the effect of thermal shock and thermal stress cycling on pitting, micro pitting and wear for different gear geometries, materials, operating conditions, machining processes and surface treatments.

In the present work, a new polymer composite gear is generated of 20-20 symmetric gear and 20-34 asymmetric gears were modelled by commercial finite element software, ANSYS which are then subjected to thermal load. Change in gear tooth profile at involute and non involute region of gear tooth was estimated. And study of the Contact line deviation of the gear teeth...

II. MATERIALS AND METHODS

2.1 **Spur gear:** Spur gears are the most common type used. Tooth contact is primarily rolling, with sliding occurring during engagement and disengagement. Some noise is normal, but it may become objectionable at high speeds. The spur gear is shown in figure 1

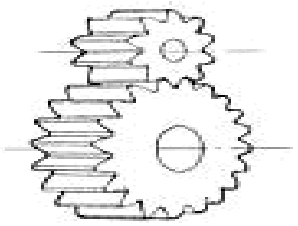


Fig 1**.** spur gear

2.2 **Procedure to find the contact line deviation**

Contact line Deviation is observed by importing the gear tooth profile co-ordinates from ANSYS to AUTOCAD and the contact points of the mating teeth is pointed out by rotating those mating teeth to different angles like 5°, 10°,15° with respect to their base centers. Line joining the contact points forms the contact line. Comparison study is done between the contact lines at room temperature to the lines at different elevated temperatures for both symmetric and Asymmetric gears.

2.3 **Terminology**

The first step of learning gear design is to know the basic terminology of the gear the basic terminology shown in figure 2. Since spur gears are the most common form of gearing, it will be used to illustrate the nomenclature of gear teeth. The following figure is presented by Shigley et al. [12] and displays the nomenclature of spur gear teeth. Gear tooth parameters used in this work are given in table 1 and the material specifications are given in table 2.

The symmetric and asymmetric shapes of the gear tooth profile which is developed in ANSYS is given in the figure and the meshed figures are given

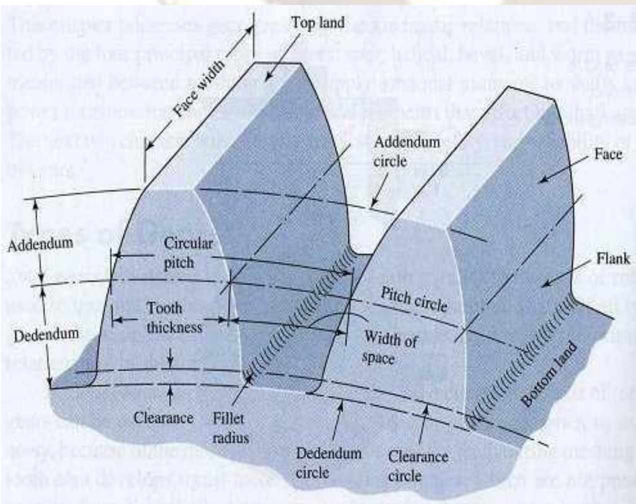


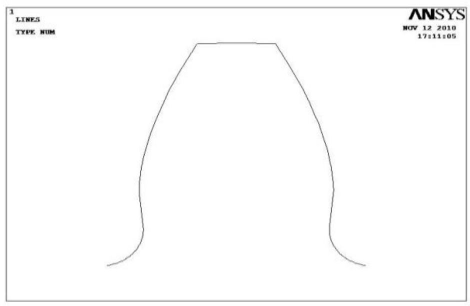
Fig.2 Nomenclature of spur gear teeth

Table 1 Gear tooth parameters used

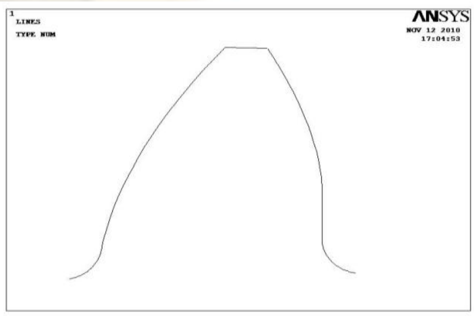
Parameter	Value	
Pressure angle (°)	20	34
Module (mm)	3	
Number of teeth	18	
Pitch circle diameter (mm)	54	
Tip circle diameter (mm)	60	
Root circle diameter (mm)	46.50	
Base circle diameter (mm)	50.74	
Face width (mm)	8	
Root fillet radius (mm)	1.14	

Table 2 Properties of material used in analysis

Material	Poly propylene
Modulus of elasticity(MPa)	900
Poisson's ratio	0.42
Density (Kg/m^3)	893
Thermal Expansion secant coefficient (/ ^{0}C)	3.3E-5
Thermal Conductivity(W/m-^{0}C)	0.3

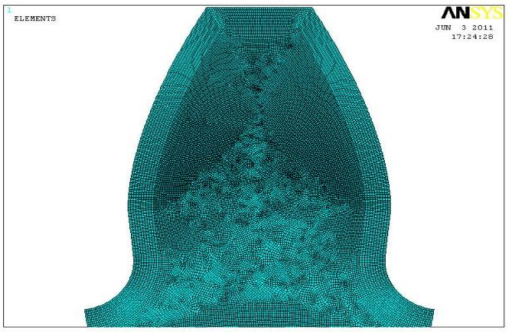


(a)



(b)

Fig.3 (a,b) shows the ANSYS developed symmetric and asymmetric gear teeth



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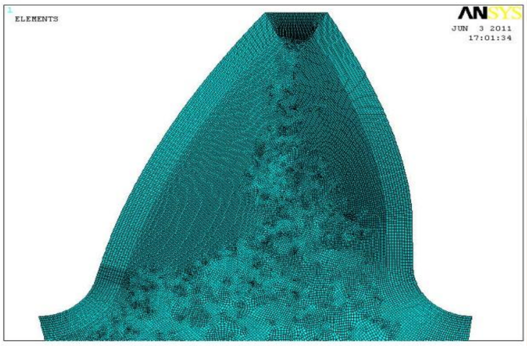
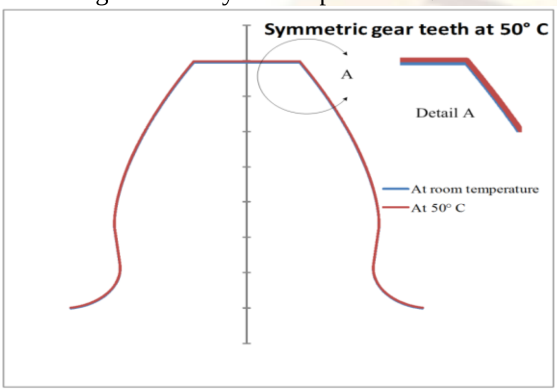


(b)

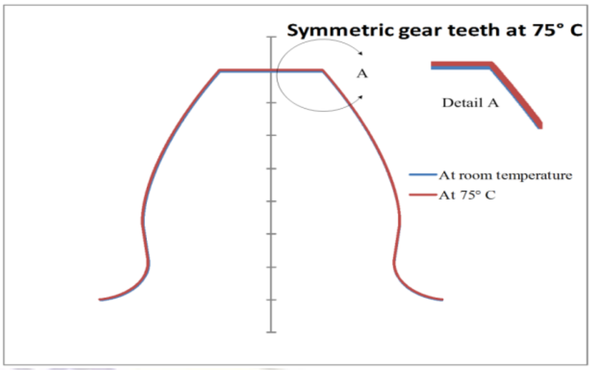
Fig.4 (a,b) shows the ANSYS developed symmetric and asymmetric gear teeth after meshed.

III. Results and Discussion

From figures 5 (a-d) represent the displacement of teeth profile at different elevated temperatures like 50°C, 75°C, 100°C, 125°C. As the temperature increases, the amount of expansion in the profile area increases. The enlarged view of the excel plots are shown for the understanding clear picture of thermal expansion at different temperatures. In the enlarged view, the displacement is clearly visible at highest temperature where as for other temperatures it is almost seems to be coinciding due to very less displacement.



(a)



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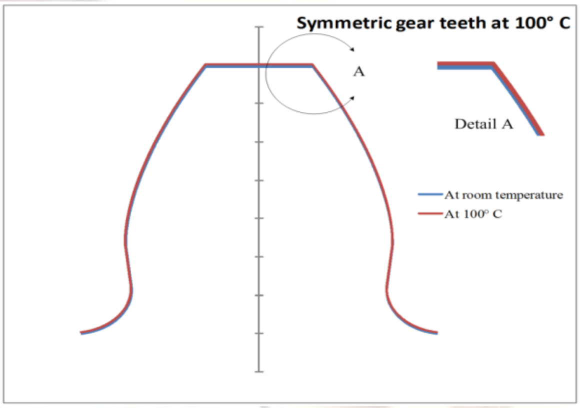

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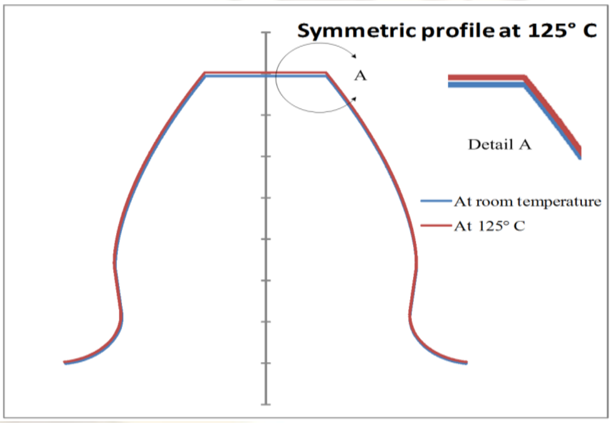
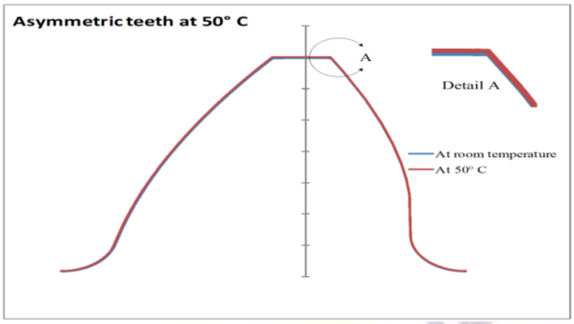
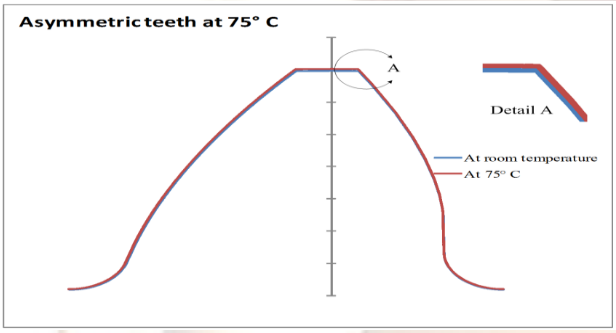


Fig.5 (a-d) shows the displacement symmetric of teeth profile at different elevated temperatures like 50°C, 75°C, 100°C, 125°C

From figures 6 (a-d) represent the displacement of asymmetric teeth profile at different elevated temperatures like 50°C, 75°C, 100°C, 125°C. As the temperature increases, the amount of expansion in the profile area increases. The enlarged view of the excel plots are shown for the understanding clear picture of thermal expansion at different temperatures. In the enlarged view, the displacement is clearly visible at highest temperature where as for other temperatures it is almost seems to be coinciding due to very less displacement.



(a)



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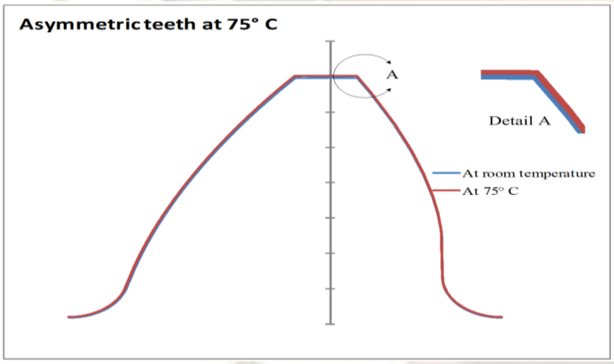

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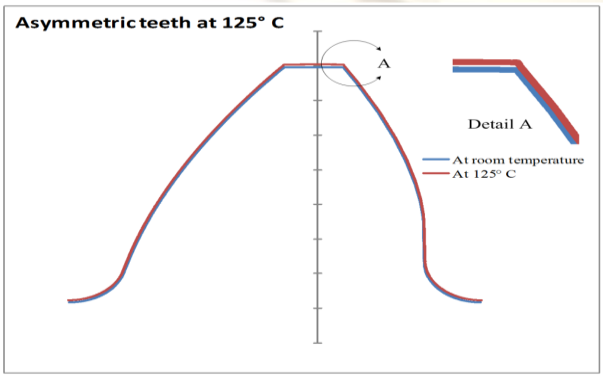

(d)

Fig 6 (a-d) shows the displacement asymmetric of teeth profile at different elevated temperatures like 50°C, 75°C, 100°C, 125°C

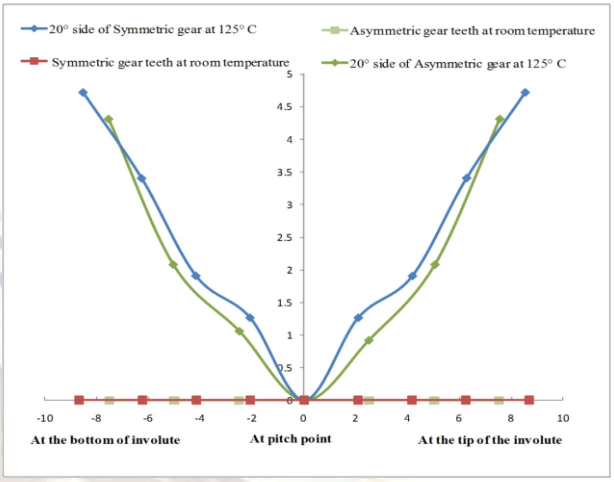

Fig 7 Comparison curve of contact lines between 200 profiles of asymmetric and symmetric gear teeth profiles from tip to bottom of the involute.

Comparison curve for contact lines is drawn between Symmetric and Asymmetric with 200 side gear tooth involute portions. The contact line deviation due to temperature rise is observed to be higher in Symmetric gear teeth profile when compared with Asymmetric gear teeth of 20° side (As seen in Fig 7). The contact line mates exactly at the pitch point and deviates the most at the top and bottom positions which is analogous to the tip and base circle position of the gear teeth.

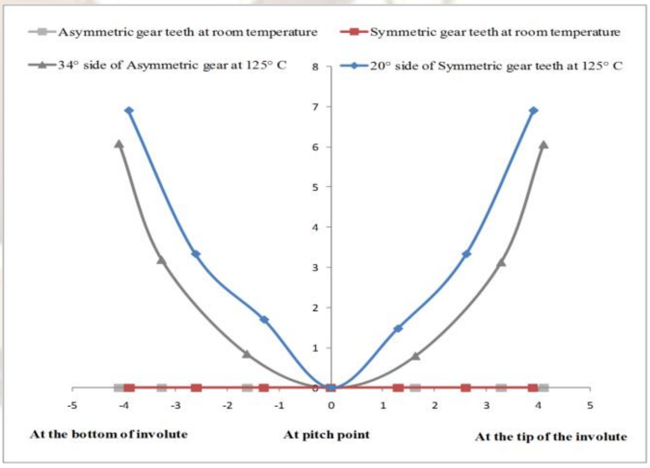

Fig 8 Comparison curve of contact lines between 340 profile of Asymmetric gear teeth and Symmetric gear teeth from tip to bottom of the involute.

Comparison curve for contact lines is drawn between Symmetric and Asymmetric with 340 side gear tooth involute portions. It is found that contact line deviation due to elevated temperature is more in Symmetric gear teeth when compared with Asymmetric gear teeth profile of 34° side(As seen in Fig 8). The contact line mates exactly at the pitch point and deviate most at the top and bottom of the involute positions. As the surface area of the Asymmetric gear teeth is more than the Symmetric, the temperature distribution is higher and hence less thermal expansion resulting in low contact line deviation

IV. CONCLUSION

Based on this study of the following conclusions can be drawn:

1. Finite element analysis was carried out on symmetric and asymmetric gear teeth to understand the profile change at involute and non involute region of gear tooth. With modified tooth profile, contact line deviation was also estimated graphically.
2. In the symmetric as well as asymmetric gear, the change in gear tooth profile was found to be larger in tip region than that of root region. However when both the mating gear profile are assumed to be affected by temperature, contact line deviation is found to be maximum at the beginning and at the end of engagement; while at the pitch point no deviation is observed.
3. Profile deviation exhibited by the involute region of asymmetric gear tooth found to be lesser than that of symmetric gear tooth due to the more available area for thermal expansion. However due to the larger base circle, steepness in the curvature of the fillet portion at asymmetric gear is higher than that of symmetric gear fillet region. This steepness in the fillet region contributes to the larger profile deviation at asymmetric gear than that of symmetric gear.

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