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EFFECT OF PRESSURE ANGLE ON CONTACT RATIO OF ASYMMETRIC INVOLUTE SPUR GEAR TEETH

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Abstract — *The main objective of this paper is to show effect of pressure angle on contact ratio of asymmetric spur gear teeth. Analytic calculation has been done with illustration and conclusion made on it. A programme has been developed in SciLab software to obtain contact ratio of Asymmetric Spur Gear tooth. Step by step producer has been describing to obtain contact ratio of Asymmetric Spur Gear tooth.*

Keywords- *Asymmetric Spur Gear, contact ratio*

I. INTRODUCTION

Asymmetric Spur Gear tooth means both side of gear profile are with different pressure angle as shown in fig.1.

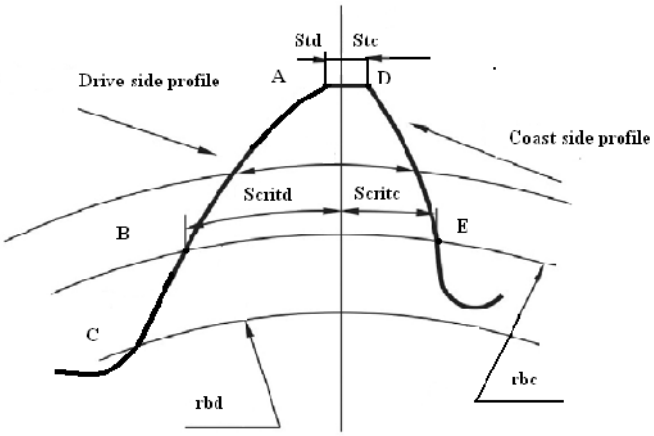

Fig. 1 asymmetric involute spur gear tooth.

Pressure angle on Drive side involute profile is higher or lower than coast side involute profile as requirement shown in fig.1. As per definition of involute function it depend on pressure angle and mathematical description are given below [3].

$$inv\alpha = \tan\alpha - \alpha \quad (1)$$

Where, α = pressure angle

Generally pressure angle on coast side profile kept constant and it is 200 while pressure angle on drive side profile increases, higher pressure angle on drive side reduce bending stress at critical section of gear tooth [1,2] which is beneficial. But contact ratio is also depending on pressure angle as per equation 2. So, study of how different pressure angle affect on contact ratio is necessary which is done in this paper with illustration.

II. CONTACT RATIO

Contact ratio is a measure of the average number of teeth in contact during the period in which a tooth comes and goes out of contact with the mating gear [5]. Contact Ratio is the ratio of the arc of action to the circular pitch [5].

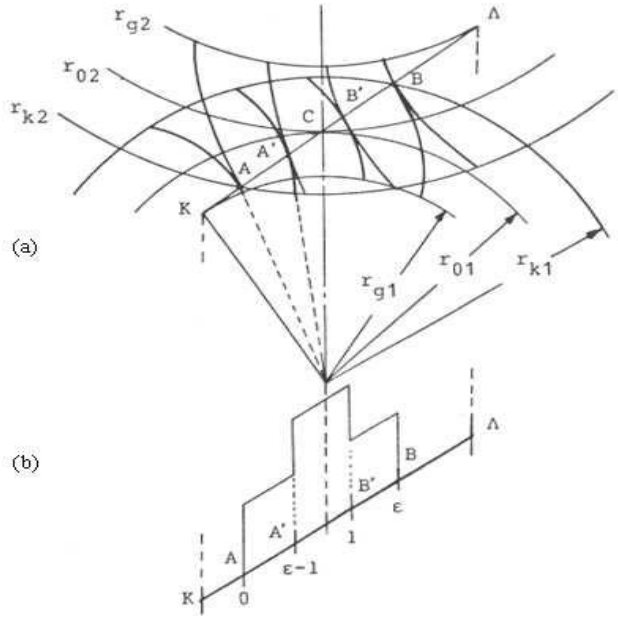

Fig. 2 Positions of tooth contact

Fig.1 show contact position of tooth of gear and pinion. From point A engagement of gear and pinion has start and at point B disengagement occurs. Contact duration AA' and B'B show two tooth are in contact while A'B' show only single tooth contact in pair. Contact duration AA',B'B and A'B' depend on contact ratio.

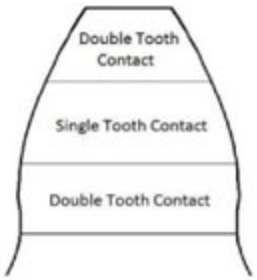

Fig. 3 tooth contact position

Fig .1 show higher contact ratio double tooth contact duration AA' and B'B is larger as compare to single tooth contact duration A'B' and vice versa. Means contact ratio decreases single tooth contact duration A'B' increase and double tooth contact duration AA' and B'B is decreases.fig. 2 show tooth contact position.

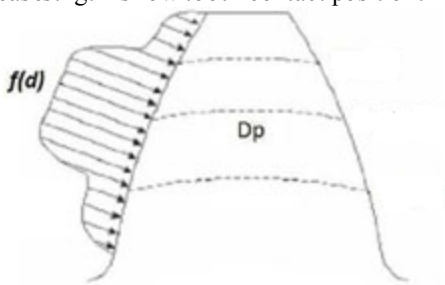

Fig.4 load on tooth as per tooth contact position

Fig. 3 show load on tooth as per tooth contact and load intensity is higher when single tooth is in contact.

III. ANALYTIC METHODS TO OBTAIN CONTACT RATIO AT DIFFERENT PRESSURE ANGLE OF ASYMMETRIC INVOLUTE PROFILE SPUR GEAR TOOTH

To obtain contact ratio at different pressure angle an involute profile of asymmetric spur gear tooth parameters are used. Gears are used to transmit a power of 18KW at 1600 rpm.

TABLE I
Gear tooth parameter

Sr. No.	Description	Value
1	Pressure angle, Coast side	20^0 fixed
2	Pressure angle, Drive side	$20^0 - 52^0$ increment by 2^0
3	Number of teeth	25
4	Module	4 mm

ε is indicating Contact ratio and it is the average number of pairs of teeth in contact. Its derivation and mathematical description are given below [8].

$$\varepsilon = \frac{\sqrt{r_{tip1}^2 - r_{base1}^2} + \sqrt{r_{tip2}^2 - r_{base2}^2} - C.\sin\alpha}{p.\cos\alpha} \quad (2)$$

IV. PROGRAMME USING SCILAB SOFTWARE OBTAIN CONTACT RATIO

Programme has been developed with help of above equations to calculate contact ratio on asymmetric spur gear tooth.

function:

```
function [contact]=CR(m,ng.np,degrees)
rpg= (m*ng)/2
rtg=rpg+4
radians = degrees*(%pi/180)
rbg=rpg*(cos(radians))
p1=((rtg^2-rbg^2)^0.5)
rpp= (m*np)/2
rtp=rpp+4
rbp=rpp*(cos(radians))
p2=((rtp^2-rbp^2)^0.5)
p3=( ( rpg*(cos(radians)))+( rpp*(cos(radians)))
p4=(3.14*m*cos(radians))
contact=( (p1+p2-p3)/ (p4))
endfunction
```

Programme in Scilab:

```
-->   disp(CR(4,25,47,20));
-->end
```

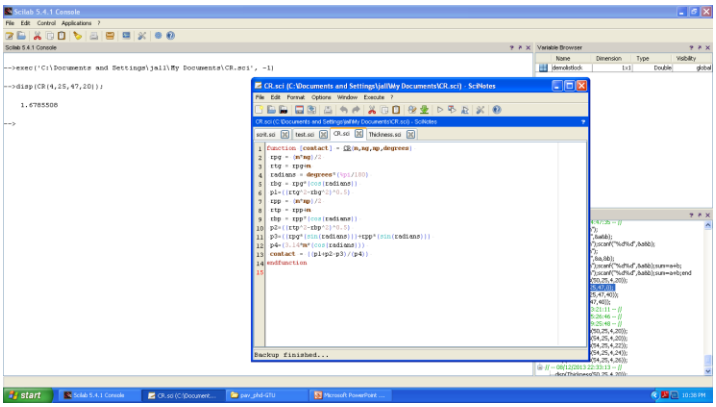

Fig. 5contact ratio of asymmetric spur gear teeth for different Pressure angle using SciLab software

Contact ratio for different pressure angle on drive side profile of asymmetric gear tooth was achieved by above developed programme.

Sr. No.	Pressure angle	Contact ratio
1	20	2.353172698
2	22	2.187420980
3	24	2.032378068
4	26	1.886437329
5	28	1.748135497
6	30	1.616141522
7	32	1.489242839
8	34	1.366330239
9	36	1.246382037
10	38	1.128447872
11	40	1.011632196
12	42	0.895077246
13	44	0.777945107
14	46	0.659398232
15	48	0.538577534
16	50	0.414576804
17	52	0.286411744

Table-2: contact ratio of asymmetric spur gear teeth for different Pressure angle on drive side profile.

V. RESULTS AND DISCUSSIONS

From above result graph between pressure angles on drive side profile of asymmetric spur gear vs. contact ratio has been created which is shown bellow.

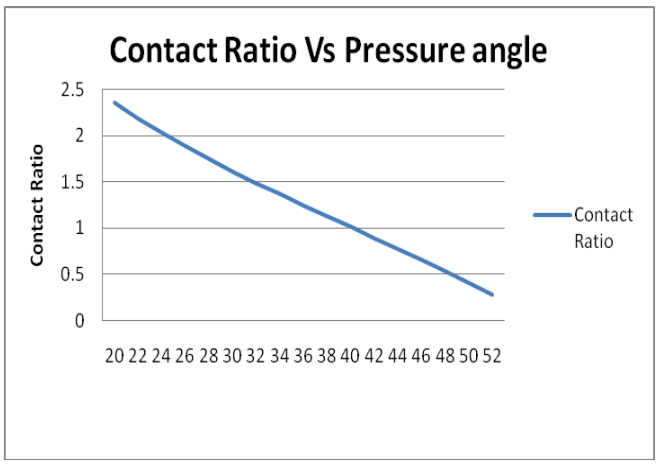

Fig. 6 pressure angle on drive side profile of asymmetric spur gear vs. contact ratio

As per the graph pressure angle on drive side profile of asymmetric spur gear increases, contact ratio decreases.

VI. CONCLUSION

From the analysis it was found that as pressure angle on drive side profile of asymmetric spur gear increases, contact ratio decreases. Lower contact ratio means higher single tooth loading contact period compare to double tooth loading contact period. So, contact ratio decreases, single tooth loading contact period increases. The loading period of a single gear tooth pair significantly increases when contact ratio decreases, which is undesirable under cyclic loading conditions. So, Gear standard procedures such as IS, recommended that the contact ratio should be greater than equal to 1.1.

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