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A PRODUCTION INTERFERENCE OF INTERNAL GEARS – INTERFERENCE AT ROOT FILLET OF SHAPER CUTTER

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1. INTRODUCTION

Production interference can be described when during the machining of the involute internal gear the tool during itscutting movement harms the normal geometry of the tooth profile (overcut or allowance created) [1], [2], [6]-[9].

Instead of the general approximation found in the literature [3]-[6], we examine in details the effects of the cutting tool geometry on the dimensions of the internal gear. We define the conditions of the interference occurrence, and we provide condition on the parameters to avoid it.

2. DEFINING THE LIMIT VALUE TO AVOID THE INTERFERNCE AT ROOT FILLET OF SHAPER CUTTER

The interference during the machining of the involute internal gear, the tool harms the normal geometry of the tooth profile during itscutting movement.It is called interference at root fillet of shaper cutter.

According to Fig. 1 the interference can be avoided if the distance between the last involute point of the internal gear profile M and the centre of the internal gear is bigger, than the distance between the last involute point of the cutting tool profile H and the centre of the internal gear.

It can be formulated, that the interference can be avoided, if

$$\varrho_{M3} \geq \varrho_{H3}, \tag{1}$$

where $\varrho_{M3}$is the working limit curvature radius,

$\varrho_{H3}$is the production limit curvature radius on shaper cutter.

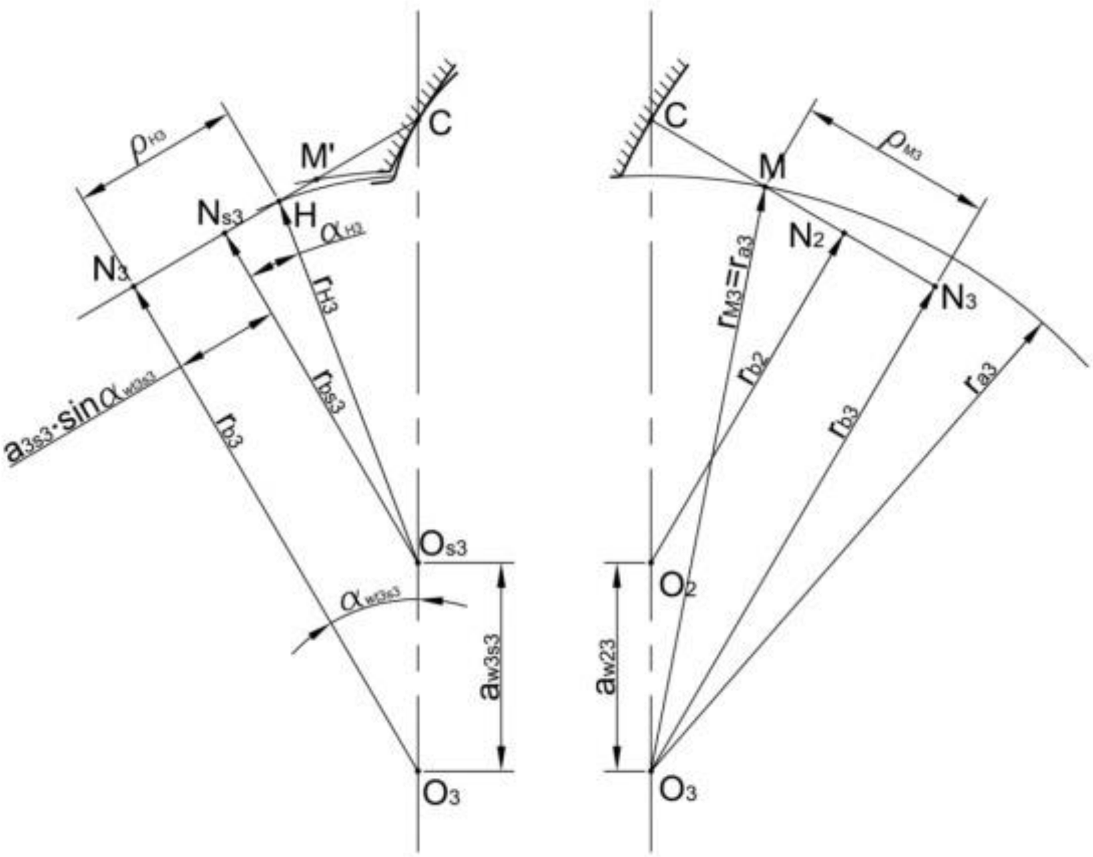

Figure. 1.

The value of working limit curvature radius, according to Fig. 1:

$$\varrho_{M3} = r_{b3} tg \alpha_{a3} \tag{2}$$

and

$$\alpha_{a3} = arc\cos\frac{r_{b3}}{r_{a3}}, \tag{3}$$

where r_{b3} - is the radius of the base circle,

r_{a3}- is the radius of the tip circle,

α_{a3} - is the pressure angle at the tip circle of the internal gear.

The value of the radius r_{H3} what represents the last involute point of the cutting tool profile next to the fillet radius of it. It can be determined according to Fig. 2.

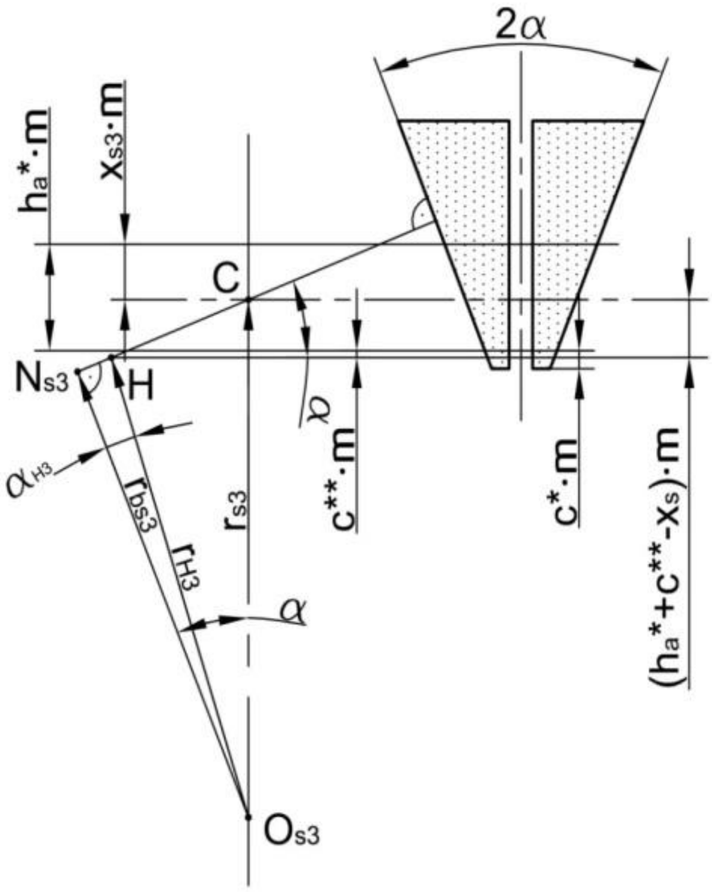

Figure. 2

$$r_{H3} cos\alpha_{H3} = r_{s3} cos\alpha, \tag{4}$$

where α_{H3}- is the pressure angle of the tool profile at last involute point,

α - is the pressure angle,

r_{s3} – is the radius or the pitch circle of the tool.

The equations as follow can be determined according to Fig. 2

$$r_{H3} sin\alpha_{H3} = r_{s3} sin\alpha - \frac{(h_a^* + c^{**} - x_{s3})m}{sin\alpha}, \tag{5}$$

where h_a^* - is the addendum of basic rack,

c^{**} - is the bottom clearance according to the fillet radius of the grinding tool ,

x_{s3}– is the profile sift coefficient of the cutting tool of internal gear,

m -is the module of the gear.

From equations (5) and (4), we obtain that :

$$tg\alpha_{H3} = tg\alpha - \frac{(h_a^*+c^{**}-x_{s3})m}{r_{s3}sin\alpha cos\alpha}. \tag{6}$$

Substituting the equations (2), (3) and (6) into equation (1), we get the inequality

$$r_{b3}tan\left(arccos\frac{r_{b3}}{r_{a3}}\right) \geq a_{w3s3}sin\alpha_{wt3s3} + r_{bs3}tan\alpha - \frac{r_{bs3}}{r_{s3}}\frac{(h_a^*+c^{**}-x_{s3})m}{sin\alpha cos\alpha}. \tag{7}$$

According to equation (7), the minimum value of $r_{a3}$to avoid the interference is:

$$r_{a3min} = \sqrt{r_{b3}^2 + (a_{w3s3}\ sin\alpha_{wt3s3} + r_{bs3}tg\alpha_{H3})^2}. \tag{8}$$

Consequently, it can be written, that the condition to avoid interference is:

$$r_{a3} \geq r_{a3min}. \tag{9}$$

3. CONCLUSIONS

1. The limit values for the radius of the tip circle of the internal gear for the interferenceoccurrence can be determined by using detailed data analyses of cutting tool and the internal gear.

2. After defining the limit values of different kind of interferences the interference free geometry zone can be determined.

5. REFFERENCES

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