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The Application of Tooth Contact Analysis in the Shaper Modification for Face-gear

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Abstract

To get ideal position of contact area for face-gear drives, we researched beginningly the rack-cutter modification, setted up equation of tooth surface of parabolic rack-cutter. According to the machining coordinate systems of shaper and the gear geometry and applied theory. The surface equation of shaper was established by using the equation of rack-cutter tooth surface and matrix for coordinate transform; The gear teeth surface equation of face-gear was got base on machining coordinate systems and the surface equation of shaper. Comprehensively considered the meshing relation among shaper、pinion and face-gear, the coordinate systems of meshing analysis were founded; The equations of meshing contact points for face-gear drives were established; Recurring to the technology of computer simulation, the effects between the face-gear meshing contact path and shaper modification were researched through the computational examples. So, The position of contact area for face-gear drives is controlled.

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Keywords: face-gear; equation of tooth surface; parabolic rack-cutter; modification; computer simulation ;contact path

1. Introduction

Face-gear transmission is a new aviation power transmission, with the advantages of small size, light weight, high load capacity, low noise, high reliability, long life and so on [1]. It is known that face-gear tooth surface parametes were determined by the cutter tooth surface parameters from the literature [2].Therefore the changes of cutter-

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surface parameters have an important impact on meshing performance of face-gear drives, starting from the tool rack, this paper studies on the impact between the face-gear machining cutter surface changes and the face-gear tooth surface equation, meshing contact trace. And the reasonable tool surface parameters were determined. The results were provided a theoretical basis for cutter modification.

2. The basic equation of face-gear tooth surface

2.1. Face-gear cutter tooth surface equation

Face-gear cutter is machined by the tool rack, rack cutter tooth surface coordinate system $S_r(o_r, x_r, y_r, z_r)$ was shown in Figure 1 (a)[3], α is rack pressure angle, M is a point on the tool rack surface. Q_r is the perpendicular foot that is marked a upright line to rack tool-surface through the origin o_r. u_r is the rack tool-surface parameter, $u_r = |MQ_r|$, a_r is the parabolic rack-surface coefficient. $l_r = \frac{\pi m}{4}\cos\alpha$. The tooth surface equation of the parabolic surface rack cutter is：

$$\vec{r}_r(a_r, u_r, \theta_r) = \begin{bmatrix} u_r \sin\alpha - l_r \cos\alpha + a_r u_r^2 \cos\alpha \\ u_r \cos\alpha + l_r \sin\alpha - a_r u_r^2 \sin\alpha \\ \theta_r \\ 1 \end{bmatrix} \qquad (1)$$

$$\vec{n}_r(a_r, u_r) = \frac{1}{\sqrt{1+4a_r^2 u_r^2}} \begin{bmatrix} \cos\alpha + 2a_r u_r \sin\alpha \\ -\sin\alpha + 2a_r u_r \cos\alpha \\ 0 \end{bmatrix} \qquad (2)$$

Among them, θ_r is the surface parameters on the direction z_r .if $a_r = 0$,the parabolic rack surface equation changes into becomes ordinary rack surface equation.

The coordinate system of rack cutter machining involute gear tool is shown in Figure 1 (b), the coordinate system $S_f(o_f, x_f, y_f, z_f)$ is the fixed coordinate system of involute gear cutters, the coordinate system $S_f(o_f, x_f, y_f, z_f)$ is moved coordinate system which fixed linked to the gear cutter, ϕ_s is the gear cutter corner, r_{ps} is pitch radius of gear cutting tools.

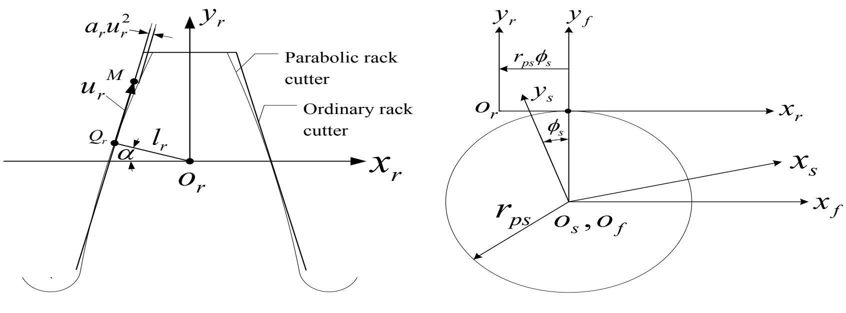

Fig.1 The machining coordinate system of gear cutter