Computer Calculation of the Profile of the Chamfer Miller

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Abstract

In order to improve productivity and product quality and reduce cost, over the past many years, producers made great efforts to find the new method of chamfering. One of the methods is the chamfer milling cutter, on the milling machine tool. This method is suited for medium and small batch production. The tool life is long, the machining quality is stable. In this paper, the principle of meshing between gears and rake is applied. The design principle and calculation method of the chamfer milling cutter is put forward. This paper also made some computer simulation

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Keywords: Rack gear, Chamfering amount, Basic Worm

1. Introduction (Heading 1)

In order to improve productivity and product quality, reduce product cost, over the years, many factories producing gear are bevel gears for a new method, which is using gear chamfering hob, hobbing on ordinary chamfer. This method is suited for medium and small batch production, tool life is long, stable machining quality. Process, the hob to do continuous cutting movement, no air travel, but also in the hob at the same time to participate in multi-tooth cutting blade, processing efficiency. In this thesis, the principle of meshing gears and the rack, put forward chamfer hob design principle and calculation method, the basic worm on the hob and the chamfer chamfering hob blade shape analysis of the research, design the two inverted Corner hob, which one is the smaller half of the amount of gear chamfering chamfering hob, the other to a large amount of shift gear chamfering chamfering hob.

2. The theory of the chamfer miller

The profile of chamfered gear is formed by a basic rake. The chamfered surface is the conjugate surface of the tapered rake.
In the above figure, the distance from the axis to the transverse surface:

\[ V = R_{au} \cos \delta_3 \]  

(1)

3. The distance from the axis to the tangent of reference circle:

\[ E = R_{au} \sin \delta_3 - h_a \]  

(2)

The radius of the pitch circle of the base gear \( R_{ju} \):

\[ R_{ju} = \sqrt{V^2 + E^2} \]  

(3)

The maximum radius of the dedendum of the milling cutter:

\[ R_{iu,\text{max}} = \sqrt{V^2 + (E - h_l)^2} \]  

(4)
In order to calculate the axial section profile of the milling tool, two static coordinate systems are needed:

The relationship between these two systems:

\[ X_u = x_o + E, \quad Y_u = y_o + V, \quad Z_u = z_o \]  \hspace{1cm} (5)

Since that the basic profile of the gear is choosing on the plane of \( x_o, y_o, z_o \), so that for the basic profile, in the equation (5) we let

\[ y_o = 0, \quad \text{or:} \quad X_u = x_o + E, \quad Y_u = V, \quad Z_u = z_o \]  \hspace{1cm} (6)

In the basic profile, lets choose any point \( (x_o, y_o, z_o) \), the equation of which:

\[ z_o = \pm \left( \frac{B}{2} - x_o \cdot \tan \alpha_f \right) \]  \hspace{1cm} (7)

Put equation (5) into equation (6), we can get the equation of the basic gear on the system \( Q_u = x_u, y_u, z_u \):

\[ X_u = x_o + E, \quad Y_u = V, \quad Z_u = \pm \left( \frac{B}{2} - x_o \cdot \tan \alpha_f \right) \]  \hspace{1cm} (8)

Let the profile line rotate about the axis of chamfer milling cutter, with the \( \theta \) being the rotate parameter, we can fine the basic profile of the chamfer milling cutter.

\[ X'_u = X_u \cdot \cos \theta + Y_u \cdot \sin \theta \]
\[ = (x_o + E) \cdot \cos \theta + V \cdot \sin \theta \]
\[ Y'_u = Y_u \cdot \cos \theta - X_u \cdot \sin \theta \]
\[ = V \cdot \cos \theta - (x_o + E) \cdot \sin \theta \]
\[ Z'_u = Z_u = \pm \left( \frac{B}{2} - x_o \cdot \tan \alpha_f \right) \]  \hspace{1cm} (9)

In order to find the section line of the basic profile on the axial plane \( X_u Q_u Z_u \), in the equation(9) let \( Y'_u = 0 \), we can get:

\[ \tan \theta = \frac{V}{(x_o + E)} \]  \hspace{1cm} (10)

So that, in the axial section plane \( X_u Q_u Z_u \), the equation of the basic profile:

\[ X'_u = (x_o + E) \cdot \cos \theta + V \cdot \sin \theta = \frac{V}{\sin \theta} \]
\[ Z'_u = \pm \left( \frac{B}{2} - x_o \cdot \tan \alpha_f \right) \]  \hspace{1cm} (11)

4. The structure of the chamfer milling cutter
Fig.2 The structure of the chamfer milling cutter

The programming of the profile of the chamfer miller

Private Sub Picture1_Click()
    Picture1.Scale (-300, 300)-(300, -300)
    Picture1.Cls
    Picture1.ForeColor = &H0
    Picture1.ForeColor = &H0
    c3 = 2.924
    d3 = 26.033
    b = 6.841
    ha = 6.674
    hi = 3
    v = 44.927
    e = 15.271
    rfu = 47.451
    riumax = 46.846
    p = 0
    namf = 1.8115
    x0 = rfu
    y0 = 0
    For thi = 0 To 360 Step 1
        x = rfu * Cos(thi * 3.14 / 180)
        y = rfu * Sin(thi * 3.14 / 180)
        x0 = x
        y0 = y
    Next thi
    x0 = riumax
    y0 = 0
For \( t = 0 \) To 360 Step 1
\[
x = r i u m a x \times \cos(t \times 3.14 / 180)
\]
\[
y = r i u m a x \times \sin(t \times 3.14 / 180)
\]
\[
x_0 = x
\]
\[
y_0 = y
\]
Next \( t \)
\[
x_0 = -ha
\]
\[
\theta = \arctan(v / (x_0 + e))
\]
\[
xu_0 = (x_0 + e) \times \cos(\theta) + v \times \sin(\theta)
\]
\[
z_0 = \left(b / 2 - x_0 \times \tan(20 \times 3.14 / 180)\right) + p \times \theta
\]
For \( x = -hi \) To \( ha \) Step 0.2
\[
\theta = \arctan(v / (x + e))
\]
\[
xu_1 = (x + e) \times \cos(\theta) + v \times \sin(\theta)
\]
\[
z_1 = \left(b / 2 - x \times \tan(20 \times 3.14 / 180)\right) + p \times \theta
\]
\[
xu_0 = xu_1
\]
\[
z_0 = zu_1
\]
Next \( x \)
\[
x_0 = -hi
\]
\[
\theta = \arctan(v / (x_0 + e))
\]
\[
xu_0 = (x_0 + e) \times \cos(\theta) + v \times \sin(\theta)
\]
\[
z_0 = -(b / 2 - x_0 \times \tan(20 \times 3.14 / 180)) + p \times \theta
\]
For \( x = -hi \) To \( ha \) Step 0.2
\[
\theta = \arctan(v / (x + e))
\]
\[
xu_1 = (x + e) \times \cos(\theta) + v \times \sin(\theta)
\]
\[
z_1 = -(b / 2 - x \times \tan(20 \times 3.14 / 180)) + p \times \theta
\]
Print \( xu_1, zu_1 \)
\[
xu_0 = xu_1
\]
\[
z_0 = zu_1
\]
Next \( x \)
End Sub
The results of calculate data:
The programming of another side:

Private Sub Picture1_Click()
    Picture1.Scale (-300, 300)-(300, -300)
    Picture1.Cls
    Picture1.ForeColor = &H0
    Picture1.ForeColor = &H0
    c3 = 2.924
    d3 = 26.033
    b = 6.841
    ha = 6.674
    hi = 3
    v = 44.927
    e = 15.271
    rfu = 47.451
    riumax = 46.846
    p = 0
    namf = 1.8115
    Print c3, d3
x0 = rfu
y0 = 0
For thi = 0 To 360 Step 1
x = rfu * Cos(thi * 3.14 / 180)
y = rfu * Sin(thi * 3.14 / 180)
x0 = x
y0 = y
Next thi
x0 = riumax
y0 = 0
For thi = 0 To 360 Step 1
x = riumax * Cos(thi * 3.14 / 180)
y = riumax * Sin(thi * 3.14 / 180)
x0 = x
y0 = y
Next thi
x0 = -hi
thi = Atn(v / (x0 + e))
xu0 = (x0 + e) * Cos(thi) + v * Sin(thi)
zu0 = (b / 2 - x0 * Tan(20 * 3.14 / 180)) + p * thi
For x = -hi To ha Step 0.2
thi = Atn(v / (x + e))
xu1 = (x + e) * Cos(thi) + v * Sin(thi)
zu1 = (b / 2 - x * Tan(20 * 3.14 / 180)) + p * thi
Print xu1, zu1
xu0 = xu1
zu0 = zu1
Next x
x0 = -hi
thi = Atn(v / (x0 + e))
xu0 = (x0 + e) * Cos(thi) + v * Sin(thi)
zu0 = -(b / 2 - x0 * Tan(20 * 3.14 / 180)) + p * thi
For x = -hi To ha Step 0.1
thi = Atn(v / (x + e))
xu1 = (x + e) * Cos(thi) + v * Sin(thi)
zu1 = -(b / 2 - x * Tan(20 * 3.14 / 180)) + p * thi
xu0 = xu1
zu0 = zu1
Next x
End Sub
The calculate data of another side:
5. The computer aided drawing of the profile of the chamfer milling cutter
Fig. 3 The computer aided drawing of the profile of the chamfer milling cutter

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References