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# FLUTE PROFILE DEVELOPMENT FOR DRILLS OF HIGH HELIX

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***Abstract: In today's world of industries machining operations plays very important role in any manufacturing industry. To achieve high accuracy in machining operations it is necessary to manufacture machining tools with high accuracy. Drilling is also one of the important operations used by manufacturing industries. Drilling accounts about 22% of all the processing time spent in material removal by the many different machining operations. Accuracy of drilling operation depends of the accuracy of helical flute profile. In order to achieve highly accurate flute profile, the profile of grinding wheel must be accurate. The aim this dissertation work is to determine the wheel profile by using helical flute profile. To find wheel profile, helical flute profile must be given as sum of points with certain density. By using analytical methodology equations are derived to find the wheel shape.***
***Keywords: Helical Flute Profile, Wheel Profile, Analytical Method***

## I. INTRODUCTION

Drilling is a major and indispensable machining operation widely used in manufacturing industry [2]. In order to enhance the performance of drill it is necessary to concentrate on the accuracy of flute profile. Flute profile is of much concern to the drill performance. Flute form/shape depends on the grinding wheel profile. Hence, to accurately grind the flute form, first we must determine the accurate grinding wheel profile. Grinding wheel profile defines the accuracy of flute form. Determination of grinding wheel profile involves mathematical modeling and solving that mathematical model to get wheel profile. Simulation of flute form using that obtained wheel profile in 3D software. Many authors worked on development of flute profile by using existing wheel profile which is called as direct method [2]. Determination of wheel profile for a desired flute cross-section is called as invers method. A mathematical model is developed to determine the orthogonal flute shape but it needs to be converted into oblique flute, which is difficult [1]. To determine the abrasive wheel profile analytical methodology is used. It is

Fig.1 Helical Flutes of Drill

## II. ABBREVIATIONS

d- work-piece diameter;
Ω- helix angle of work-piece;
D- abrasive disk diameter;
$h_c$ - abrasive disk width;
α- profiled angle of the trunk conic abrasive wheels;
H- positioning distance between the abrasive disc and the work-piece axis;
β- positioning angle between the orientation plane of the abrasive trunk conic disk and the work-piece axis;
±Δ- displacement between the orientation plane of the abrasive trunk conic disk and the work-piece axis;

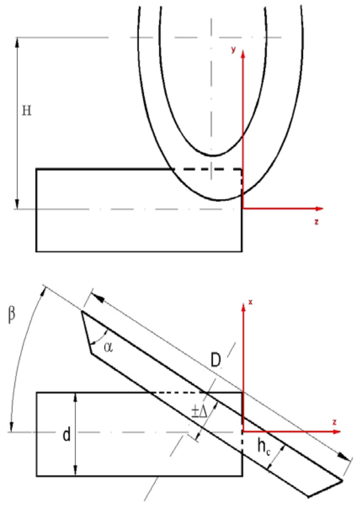


Fig.2 Wheel and Work-Piece in Manufacturing Process

## III. ANALYTICAL METHOD TO DETERMINE PROFILE OF THE ABRASIVE WHEEL

The requirement of this procedure is, the profile of the helical flute must be given as sum of points with certain density which describes the complex shape of the helical flute in the cross-section as shown in figure 2[3].

- Consider a point $P_i$ ($r_{i,}$ $\psi_i$) as shown in figure 3.
- Select a plane Q of the wheel at a distance of $x_{si}$ from the trunk cone basis and parallel to it shown in figure 4.
- Then project the points from flute profile on a helical trajectory with helix angle Ω.
- The intersection of this helical trajectory with the plane Q gives a point from the cutting area the wheel. This point is denoted as $S_i(x_{si}\ , y_{si}, z_{si})$.
- The radius at point $S_i$ is given by

$$r_{si} = \sqrt{y_{si}^2 + z_{si}^2}$$

  

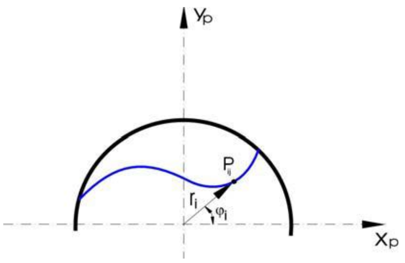

Fig.3 The profile of the drill helical flute

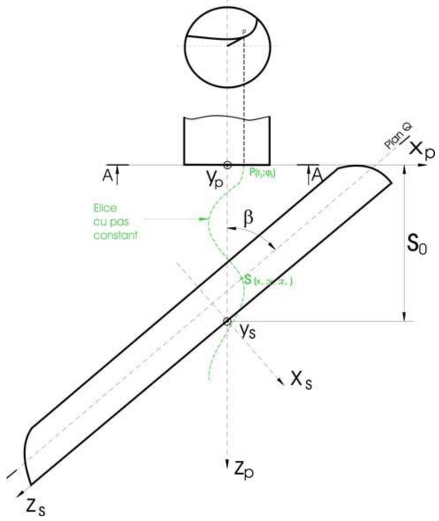

Fig.4 The trajectory of the points from the drill helical flute

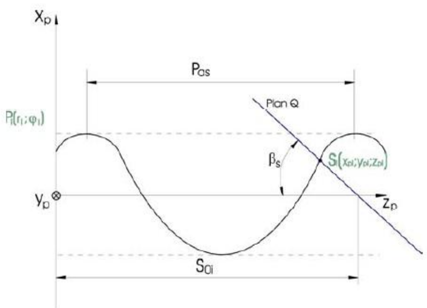

Fig.5 Helix projection in plane $O_p\, x_p\, z_p$

$O_px_py_pz_p$ Is the work-piece co-ordinate system.
$O_sx_sy_sz_s$ Is the wheel co-ordinate system.
$S_o$- Distance between the wheel and work –piece.
$S_o = R_{so}.\cos\beta$
As shown in the figure 5, the point $P_i$ follows a helical trajectory of pitch "Pas", which is given by
Pas = π. d / tan Ω.
From figure coordinates of $P_i$ point around the axis $O_pz_p$ can be given as

$$x_p(z_p) = r_i.\cos\ (\psi + z_p\, .\frac{2\pi}{Pas})$$

$$y_p(z_p) = r_i.\sin(\psi + z_p\, .\frac{2\pi}{Pas})$$

The distance between the plane $O_px_py_p$ to the intersection of the axis Q with $O_pz_p$ is calculated as

$$S_{oi} = S_o - \frac{x_{si}}{\cos\beta}$$

The equation of plane Q in $\mathbf{O_px_py_pz_p}$ co-ordinate system can be written as

$$(z_p - z_o) = m.(x_p - x_o)$$

From figure it can be determine that,

- $z_o = S_{oi}$ ;
- $x_o = 0$ ;
- $m = \tan(\pi - \beta)$;

Then equation of plane Q becomes

$$z_p = x_p.\tan(\pi - \beta) + S_{oi}$$

Substituting values of $z_p$ , $S_{oi}$ and "Pas" in equation of $x_p$ and $y_p$ we get,

$$x_p(z_p) = r_i\cos(\psi_i + 2.\frac{x_p.\tan(\pi-\beta) + S_o - \frac{x_{si}}{\cos\beta}}{d.\tan\Omega})$$

$$y_p(z_p) = r_i.\sin(\psi_i + 2.\frac{x_p.\tan(\pi-\beta) + S_o - \frac{x_{si}}{\cos\beta}}{d.\tan\Omega})$$

Solving above equations using numerical methods such as "Bisection method" or "Regula-Falsi method" to calculate the value of $x_p$ and $y_p$. The value of $x_p$ ranges from $-r_i$ to $r_i$.
Now shift the points $x_p, y_p, z_p$ to $O_sx_sy_sz_s$ co-ordinate system. This can be done by using figure

- $x_{si}$ = known;
- $y_{si} = y_p - H$;
- $z_{si} = z_p.\cos\beta - x_p.\sin\beta - S_o.\cos\beta$;

As the values of $y_{si}$ and $z_{si}$ are known we can find the value of $r_{si}$,

$$r_{si} = \sqrt{y_{si}^2 + z_{si}^2}$$

Passing through the area $x_s \in [0, h_c]$ with a proposed precision Pas(x), we will find the profile of the abrasive wheel which will manufacture the helical flute of the drill we need.
Fig 6 shows the wheel profile obtained by joining the points having minimum radius in each section. Fig 7 shows the flute profile of helical flute which is obtained by using the wheel profile shown in fig 6.

## IV. CONCLUSION

This paper represents an analytical method to determine the shape of grinding wheel by using points on the flute profile. As the method is analytical, equations can be solved in any mathematical software to determine the points on wheel profile.

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Fig 6 Wheel profile Obtained

Fig 7 flute profile Obtained

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