

Special profile hobs

Hexagonal profile hobs

To determine the tooth profile of a hob that must cut a hexagonal profile, it is possible to use two different methods: the graphic method or the analytical method.

Clearly nowadays we have software which can rapidly resolve the problem of designing the required profile, but if we want to understand how this calculation is made, that is what procedure must be carried out, the computer is not of great assistance.

Let us therefore illustrate the two different methods which can be used to determine the hob tooth profile for hexagonal profile cutting.

The graphic method

We have already seen how a hob for cylindrical gears may be considered a wheel with an infinite radius in its longitudinal section, that is a rack which mates perfectly with the gear to be cut.

The same concept applies for all other non-involute profiles and especially hexagonal profiles.

The pitch circle of this pretend wheel will therefore be a line (pitch line) which will be in contact with the pitch circle or in any case with the rolling circle of the workpiece.

With reference to the figure N°1, it is clear that to mate properly one movement of the hob profile in an axial direction must correspond to each angular variation of the workpiece axis.

The value of this movement will be equal to the length of the pitch circle arc which is subtended by the workpiece rotation angle.

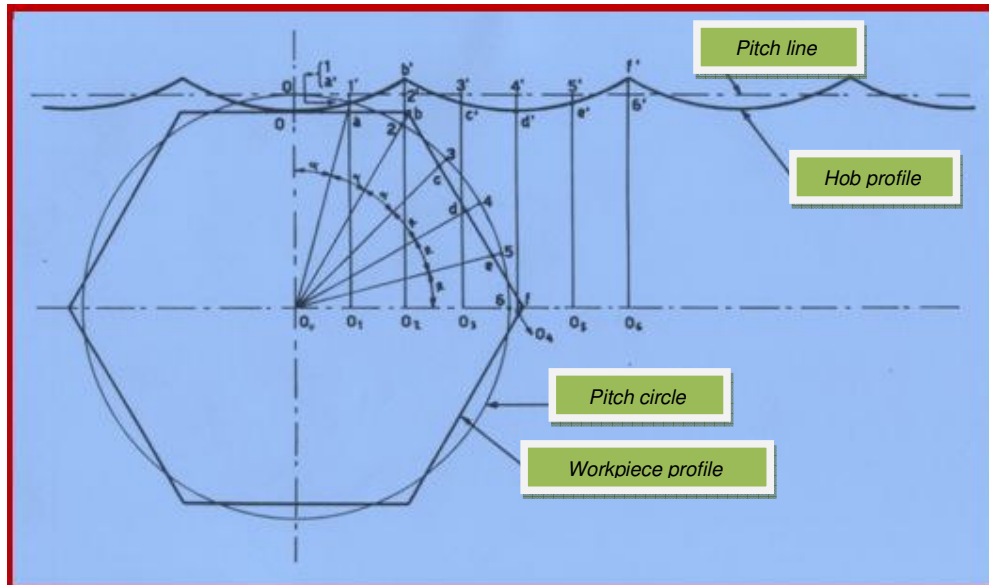


Fig. N°1

In other words the length of the arc $\widehat{O_1}$ must correspond to the segment $\overline{O_1'}$.

To simplify this concept let us suppose that instead of the hob profile, the centre of the workpiece rolling circle moves from left to right. The law of movement relativity allow us to make this supposition.

By dividing the average circumference of the profile to be generated in any number of sections (the higher this number, the more accurate the profile designed) we obtain circle arcs $\widehat{O_1} - \widehat{O_2} - \widehat{O_3} - \widehat{O_4} - \widehat{O_5} - \widehat{O_6}$ -- etc. to which the segment $\overline{O_1'}$ -- $\overline{O_2'}$ -- $\overline{O_3'}$ -- $\overline{O_4'}$ -- $\overline{O_5'}$ -- etc. on the pitch line of the hob correspond.

If we transfer the values of these segments from the centre of the circle axis (O_0), the subsequent positions that the centre of the circle will assume during the mating process at each angular movement are obtained.

More precisely after one angular movement α the centre O_0 moves to O_1 ; after an angular movement 2α the centre passes to O_2 ; etc.

Now we only have to transfer the lengths $\overline{0_0a}$ -- $\overline{0_0b}$ -- $\overline{0_0c}$ -- $\overline{0_0d}$ -- $\overline{0_0e}$ -- etc, on the respective perpendicular lines $\overline{0_1a'}$ -- $\overline{0_2b'}$ -- $\overline{0_3c'}$ -- $\overline{0_4d'}$ -- $\overline{0_5e'}$ -- etc.

Points a' , b' , c' , d' , e' are also points of the hob tooth profile in the section which is perpendicular to the helix of the thread.

The hob tooth profile is obtained by joining up these points.

Congiungendo tali punti si ottiene il profilo del dente del creatore.

The analytic method

The analytic method simply consist in calculating the length of the segments $\overline{0_0a}$ -- $\overline{0_0b}$ -- $\overline{0_0c}$ -- $\overline{0_0d}$ -- $\overline{0_0e}$ -- etc. and then in calculating the length of the arc that is subtended by the angle α on the circle with radius R_m , that is:

$$\widehat{0\hat{1}} = R_m \cdot \alpha \text{ where } \alpha \text{ is expresses in radians.}$$

Once these values are known, the hob tooth profile can be easily traced.

In the specific case of hexagonal profiles, the value of the rolling circle radius (average radius) is calculated once the radii on the inscribed and circumscribed circles of the hexagon are known, respectively R_i and R_c , with:

$$R_m = \frac{R_i + R_c}{2}$$

To simply notably these calculation, it is good idea to divide the circumference into a number of equal parts which are a multiple of 12 so as to obtain radii which pass the apexes and the median points of the sides of the hexagon.

Basically the sides of the hexagon are divided symmetrically so as to make the calculation quicker

Roller chain sprocket hobs

The tooth profile of the sprocket wheel is determined on the basis of various normatives such as: UNI 3750 -- ASA 29.1.957 -- DIN 8196 , 8197 , 8198 -- BNA 453 -- ASA B 29.2.

Alternatively special profiles may be designed to resolve specific problems.

In any case the profile use to manufacture chain sprocket is based on the UNI 3750 normative which correspond exactly to the ASA 29.1.957 normative. We will simply just examine a few of the characteristic of this type of roller chain sprocket.

In the figure N°2 a diagram which is relative to these normative is illustrated.

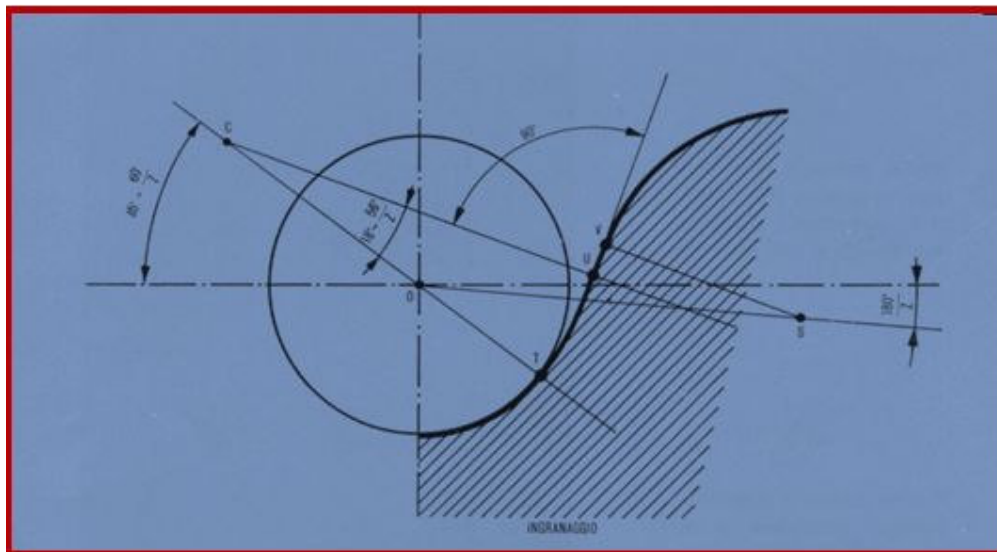


Fig. N°2

The following relations between the elements of the profile apply where:

d = roller chain diameter

p = chain pitch

Z = number of teeth of the sprocket wheel

$$D_p = \frac{p}{\sin \frac{180}{Z}} = \text{pitch diameter of the sprocket wheel}$$

$$D_i = D_p - d = \text{root diameter of the sprocket wheel}$$

$$D_e = p \cdot \left(0,6 + \text{ctg} \frac{180}{Z} \right) = \text{outside diameter of the sprocket wheel}$$

$$\overline{OT} = r_1 = \frac{1}{2} \cdot (1,005 \cdot d + 0,0762) = \text{circle radius or support curve}$$

$$\overline{CO} = 0,8 \cdot d \quad ; \quad \overline{SO} = 1,24 \cdot d \quad ; \quad \overline{SV} \text{ parallel to } \overline{CU}$$

Roller chain sprocket wheels may be classified into three different groups according to their application.

Type N¹ : Wheels for low speed transmissions which do not need to be particularly silent. Since wheels of this type may have an inexact profile, it is possible to manufacture all wheels that have given pitch and same roller diameter with just one hob, independently of the number of teeth.

This clear simplifies manufacturing significantly since less hob are required.

Type N² : Wheels for medium speed transmissions which must be silent. One hob is not sufficient since it would generate intolerable errors on some wheels and they would be too noisy. It is therefore necessary to classify the wheels that have the same pitch and the same roller diameter into various groups according to the number of teeth.

Each hob will be designed specifically to cut the wheels that belong to a specific group. The following groups may be considered.

N° of the hob	1	2	3	4	5	6
N° of teeth of the wheel	6	7 - 8	9 - 11	12 - 17	18 - 34	More than 35

Type N³ : Wheels for high speed transmission and which must be extremely silent. In this case the above subdivision is no longer applicable and it is necessary to use a hob for each specific number of teeth of the sprocket wheels.

Fixed position hobs

With a normal hob it is possible to generate any profile that is regularly repeated along a circumference as long as the profile itself does not have any re-entering sections or grooves with sharp edges at the root.

In this case the profiles are called non generable profiles and they cannot be machined with normal hobs. To cut these special profiles it is necessary to use a particular kind of hob known as the fixed position hob with which it is not possible to perform shifting.

The positioning of the hob in relation to the workpiece is limited and it must be performed by following specific rules so that some of the hob teeth are able to finish the non generable section of the profile.

Since this hobbing method does not allow for real mating with the generated profile, manufacturing performance is not very good especially since the hob does not perform shifting. In any case this type of hob is certainly more advantageous than milling with milling cutter and index plate when a large number of workpiece is to be cut.

To make positioning easier, the distance that must be allowed between the face of the hob and the workpiece axis is always etched on the face of the hob itself. (see figure N°3).

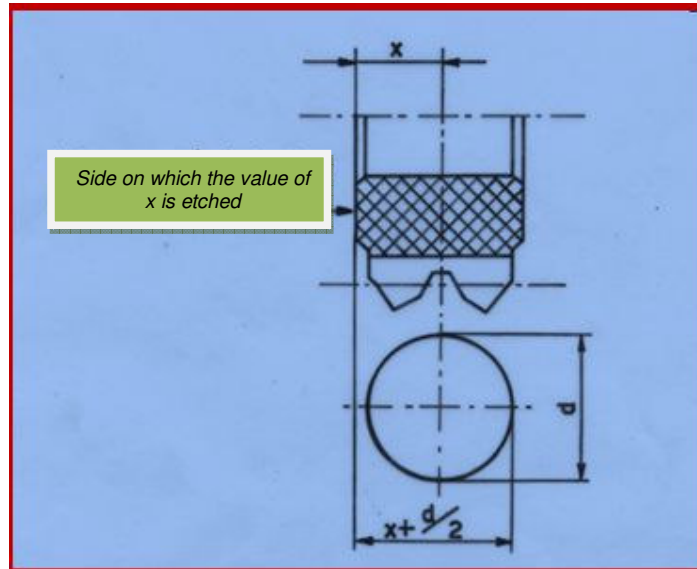


Fig. N°3

The hob must be mounted with the spindle inclined by the helix angle of the thread of the hob. In figure N°4 a diagram of a fixed hob with a single row of teeth for creating chamfering tapers is shown.

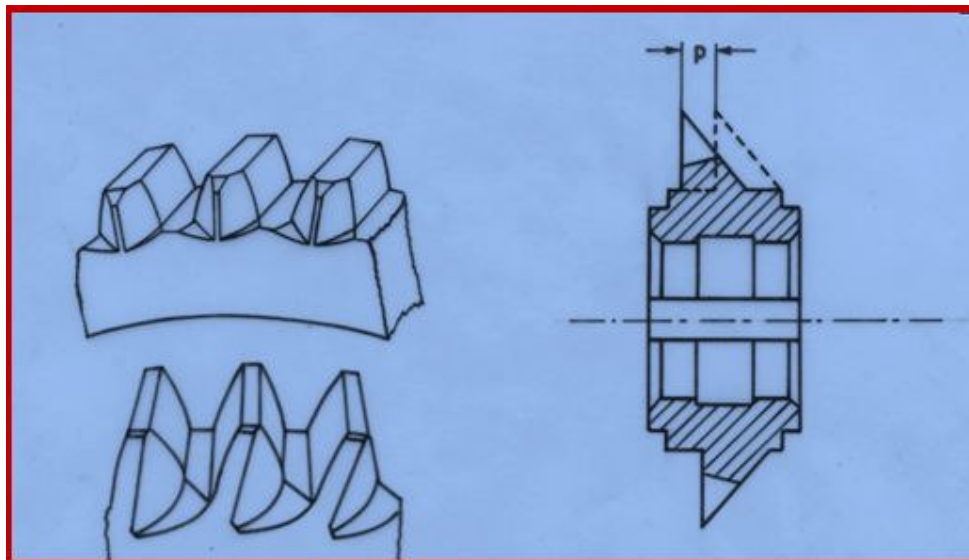


Fig. N°4

In figure N°5 a fixed position hob with a single row of teeth for face gear is shown.

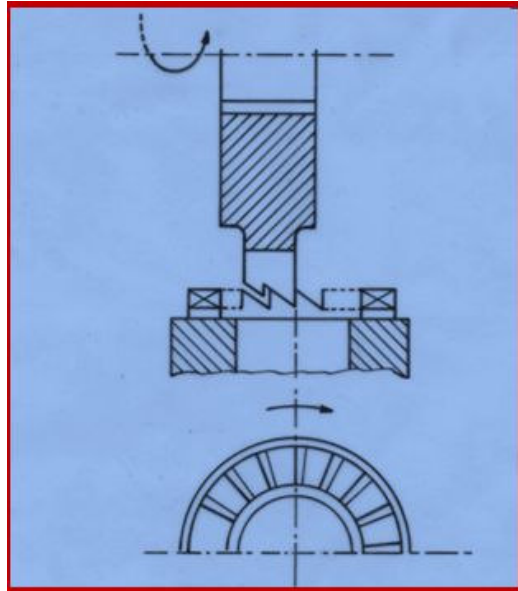


Fig. N°5

In figure N°6 a fixed position hob with a single row of teeth for ratchet gears is illustrated.

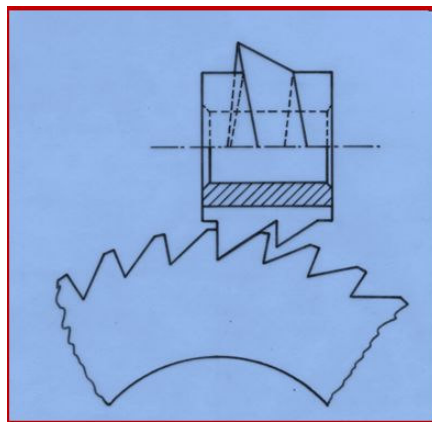


Fig. N°6

Finally in figure N°7 we can observe the teeth generated by a fixed position hob for straight sided splined shafts with a sharp-edged root.

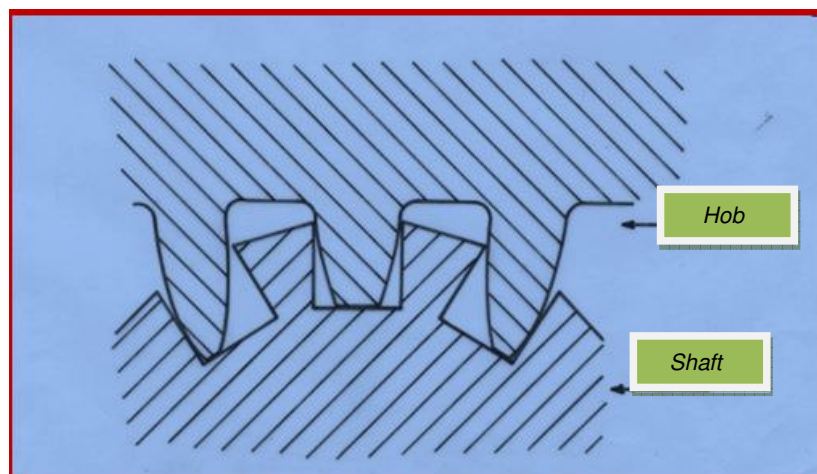


Fig. N°7