THE GENERATION OF THE CURVED SPUR GEARS TOOTHING

Bojan Ştefan, Sucală Felicia, Căzilă Aurica, Tătaru Ovidiu
Universitatea Tehnică din Cluj-Napoca

Abstract: *Starting from the described surfaces by the toothing tools, the curved surfaces of the teeth flanks will be determined.*
Key Words: *spur gear, curved toothing, head holder, imaginary generating rack-bar.*

1. INTRODUCTION

The processing procedure of the spur wheels curved teeth flanks, is based on the unique generating rack-bar for the both wheels of a gearing.

The tools head holder exerts a rotation motion, and the toothed wheel rolls on the imaginary generating rack-bar.

Through the introduction of the generating rack-bar between the tools head holder and the toothed wheel, the study of the winded (processed) surfaces can be made in two stages:
- the study of the tools head holder meshing with the rack-bar, that is the rack-bar flanks generation (proccessing). The tools head holder exert a rotation motion, and the rack-bar a translation one;
- the study of the rack-bar meshing with the spur toothed wheel, that is the generating (processing) of the wheel tooth flanks. The rack-bar exert o translation motion and the wheel a rotation one

2. THOOTHING TOOL

The toothing tool for cutting the cylindrical wheel with curve teeth is a cutters frontal head the same one with used in cyclopaloidale system of the conical toothing (fig. 1).

The toothing could be done with cutter holder head with more beginning (cutters group) by continuous dividing. It is thought a cutter holder head with two cutter placed at 180^o. If the toothing wheel is rotated with one pitch than the cutter holder head have to rotates complete ones so that a cutter to cut a flank, and before that the another one cutter to cut the opposite flank which is find at p/2 distance.

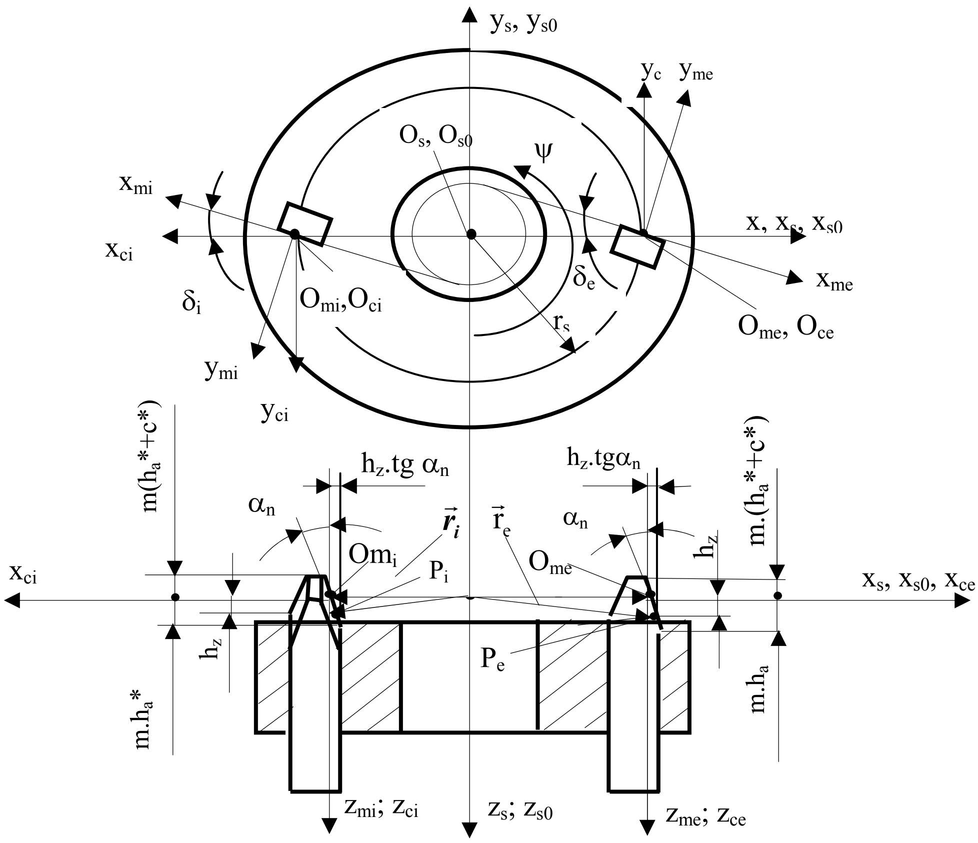

Fig. 1. *The tools head holder*

If the fly circles radiuses of the cutters are equals the convex and concave flank result with the same curvature and localization of the contact spot could be realized by modifying the radius of curvature.

The tool from figure 1 has one inner cutter and one external cutter, which finishing the convex flank respectively the concave flank of the curve tooth.

The cutters cutting edges is defined in own system $\Sigma_{mie}(O_{mie}x_{mie}y_{mie}z_{mie})$ with column matrix:

$$M_{mie} = \begin{vmatrix} x_{mie} \\ y_{mie} \\ z_{mie} \\ t \end{vmatrix} = \begin{vmatrix} htg\ \alpha_n \\ 0 \\ h \\ 1 \end{vmatrix} \qquad (1)$$

where α_n - is the angler between the cutting edge with positive direction of the axes $O_{mie}Z_{mie}$;

h – a parameters of the cutting edge representing the distance from a certain point P_{ie} of the cutting edge to the plane $O_{mie}x_{mie}y_{mie}$

The parameter t represents the unit of time.

The surfaces S_{ie} describe by points P_{ie} belong the cutting edges of the cutter holder head rotation arround axe $O_s z_s$ are given by the relations, that if $\delta_{ie} \neq 0$ represent the rotation hyperboloide and if $\delta_{ie}=0$ are conical surfaces:

$$M_{s_{ie}} = \begin{vmatrix} x_{s_{ie}} \\ y_{s_{ie}} \\ z_{s_{ie}} \\ 1 \end{vmatrix} = \begin{vmatrix} \mp r_s \cos\psi_{ie} + h\,tg\alpha_n \cos(\psi_{ie} - \delta_{ie}) \\ \mp r_s \sin\psi_{ie} + h\,tg\alpha_n \sin(\psi_{ie} - \delta_{ie}) \\ h \\ 1 \end{vmatrix}. \qquad (2)$$

3. THE DETERMINATION OF THE IMAGINARY RACK-BAR SURFACES

It is considered the tools head holder (fig. 2) on which the coordinate systems, previously presented, are fixed and which exert a rotation motion with the angular speed $\overline{\omega}_s$ oriented in the

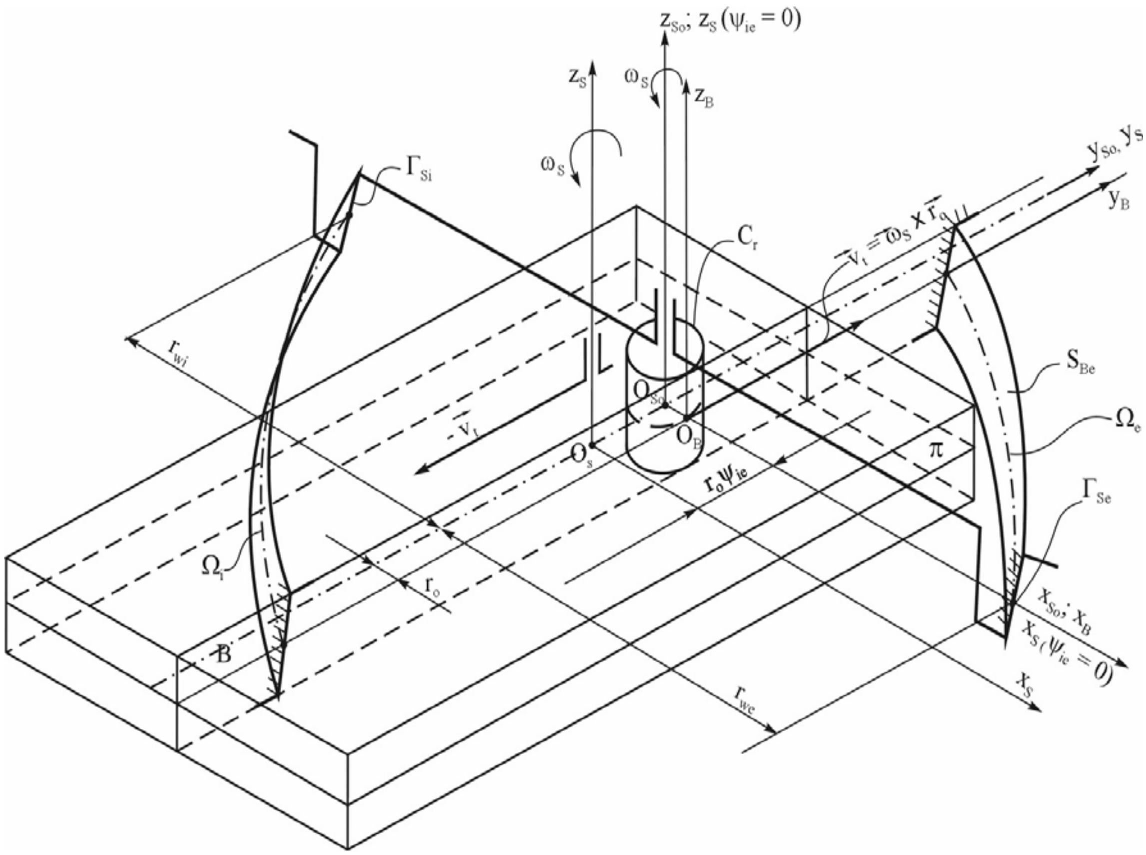

Fig. 2. *The generation of the imaginary rack-bar teeth flan*ks

positive sense of the axis $O_s z_s$, and the opposite mobile body, which represents a toothed wheel with an infinite teeth number and which exert a translation motion with the velocity $\overline{v}_t$, so that no sliding speed to exist in the plane B, belonging to the opposite mobile body and the cylinder C_r of radius r_0 connected to the tools head holder. Therefore: $\overline{v}_t = \overline{\omega}_s \times \overline{r}_o$.

One has to solve the problem of the surfaces S_{Bie} determination, which are processed by the tools cutting edges in the opposite mobile body. In these conditions, the plane B becomes a fixed centroide (basis), the cylinder C_r mobile centroide (rolling) and C_r generator, tangent to the plane B, instantaneous rotation axis.

One has to remark that if the points P_{ie} move along the afferent cutting edges Γ_{sie} and the instantaneous rotation centers have a corresponding motion, on the instantaneous rotation axis, it results resembling curves on the surfaces S_{Bie}.

Therefore the surfaces S_{Bie} are made of the resembling curves described by the points P_{sie}, which displaces along the afferent cutting edges, in parallel planes with $O_s x_s y_s$, which contain them, the tools head holder effecting a rotation motion around the axis $O_s z_s$ and a translation one parallel to $O_s y_s$ (fig. 3).

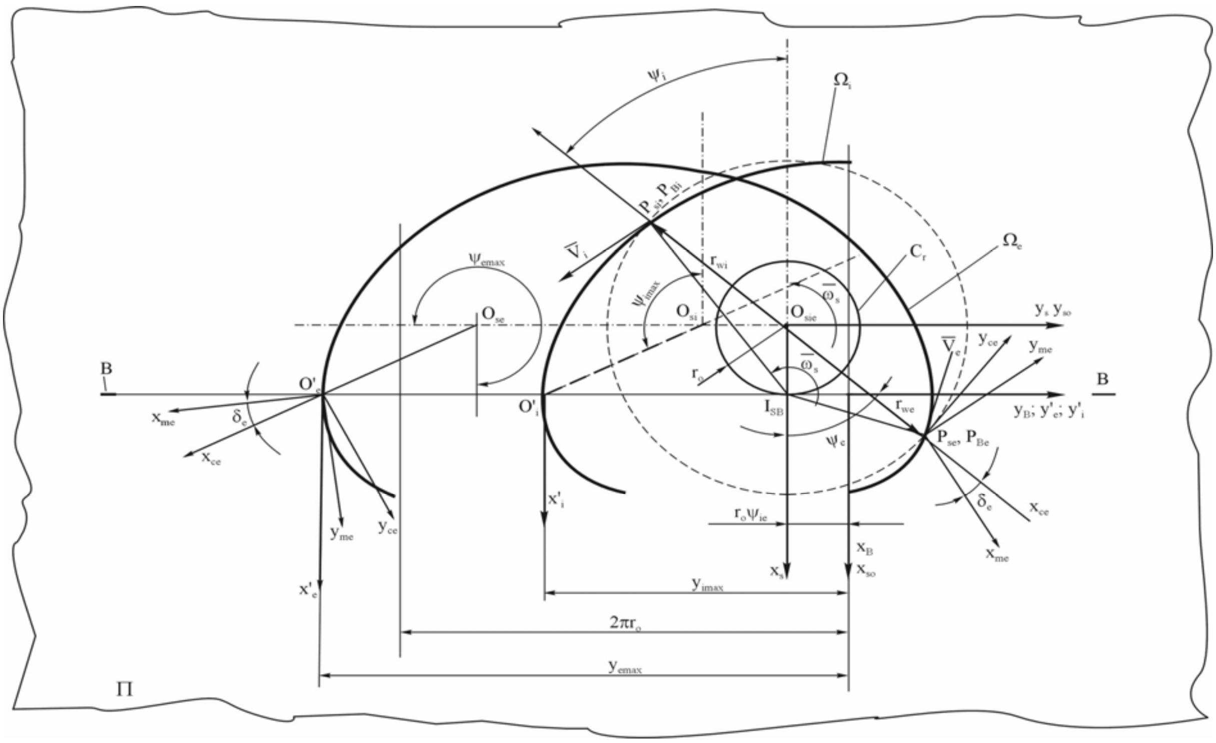

Fig. 3. *Directrix curves of the teeth flanks in the rolling plane*

The coordinates of a certain point belonging to the surfaces S_{Bie} are given by matrix:

$$\left\| \begin{matrix} x_{Bie} \\ y_{Bie} \\ z_{Bie} \\ t \end{matrix} \right\| = \left\| \begin{matrix} \mp r_{wie} \cos\psi_{ie} + h_z tg\alpha_n \cos(\psi_{ie} - \delta_{ie}) - r_o \\ \mp r_{wie} \sin\psi_{ie} + h_z tg\alpha_n \sin(\psi_{ie} - \delta_{ie}) - r_o \psi_{ie} \\ h_z \\ 1 \end{matrix} \right\| \quad (3)$$

where: ψ_{ie} and h_z are the surfaces parameters.

Graphical, the surfaces S_{Bie} are presented in figure 4, by means of the calculus programme.

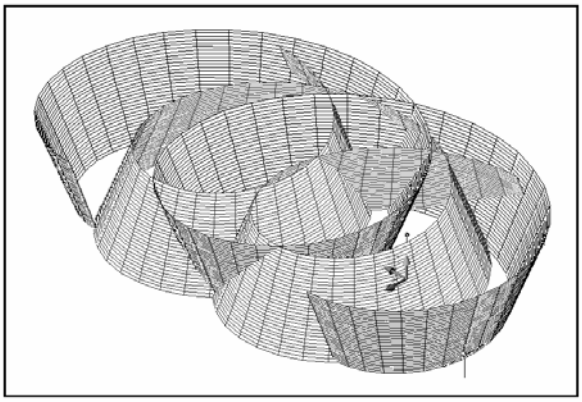

Fig. 4. *The graphical representation of the rack-bar teeth flanks surface***s**

For determine the surface equations covered by surface S_{Bie} of the generatrix flank rack in bodies C_1 and C_2, it is take account two reference system jointly with rack $O_{ie}x_{ie}y_{ie}z_{ie}$ (fig. 5).With parallel axes of system $O_Bx_By_Bz_B$ but with origin points moved at y_{iemax} given the O_B on y_B axe. The wheel 1 and 2 are jointed the fix systems $O_{10}x_{10}y_{10}z_{10}$ respectively $O_2x_2y_2z_2$ with the axes parallels with system $O_{ie}x_{ie}y_{ie}z_{ie}$ but with the origin points moved with - r_1 along the axe z_{ie} for wheel 1 and + r_2 for wheel 2. Also the wheels are more jointed with the system $O_1x_1y_1z_1$ respectively $O_2x_2y_2z_2$ connected with these.

The coordinates of a generatrix points P_{Bie} in system $O_{ie}x_{ie}y_{ie}z_{ie}$ are given by matrix:

$$M'_{ie} = \begin{Vmatrix} x'_{ie} \\ y'_{ie} \\ z'_{ie} \\ t \end{Vmatrix} = \begin{Vmatrix} \mp r_{wie} \cos\psi_{ie} + h_z \,tg\alpha_n \cos(\psi_{ie} - \delta_{ie}) - r_o \\ \mp r_{wie} \sin\psi_{ie} + h_z \,tg\alpha_n \sin(\psi_{ie} - \delta_{ie}) - r_o\psi_{ie} + y_{ie\max} \\ h_z \\ 1 \end{Vmatrix}, \qquad (4)$$

the size y_{iemax} representing the maximum value of the ordinate curve described in plane (π) related to the system $O_Bx_By_Bz_B$.

The coordinates of points P_{Bie} overlapping through the points P_{12ie} in system $O_1x_1y_1z_1$ respectively $O_2x_2y_2z_2$ will constitute the coordinates of points belonging to the teeth flanks.

4. CONCLUSIONS

The surfaces which bounding the teeth of the gear wheel have been determinate like rolling surface of the generatrix tooth flank of rack bar in it translation, the teeth wheel made the pure rotation around wheels axes.

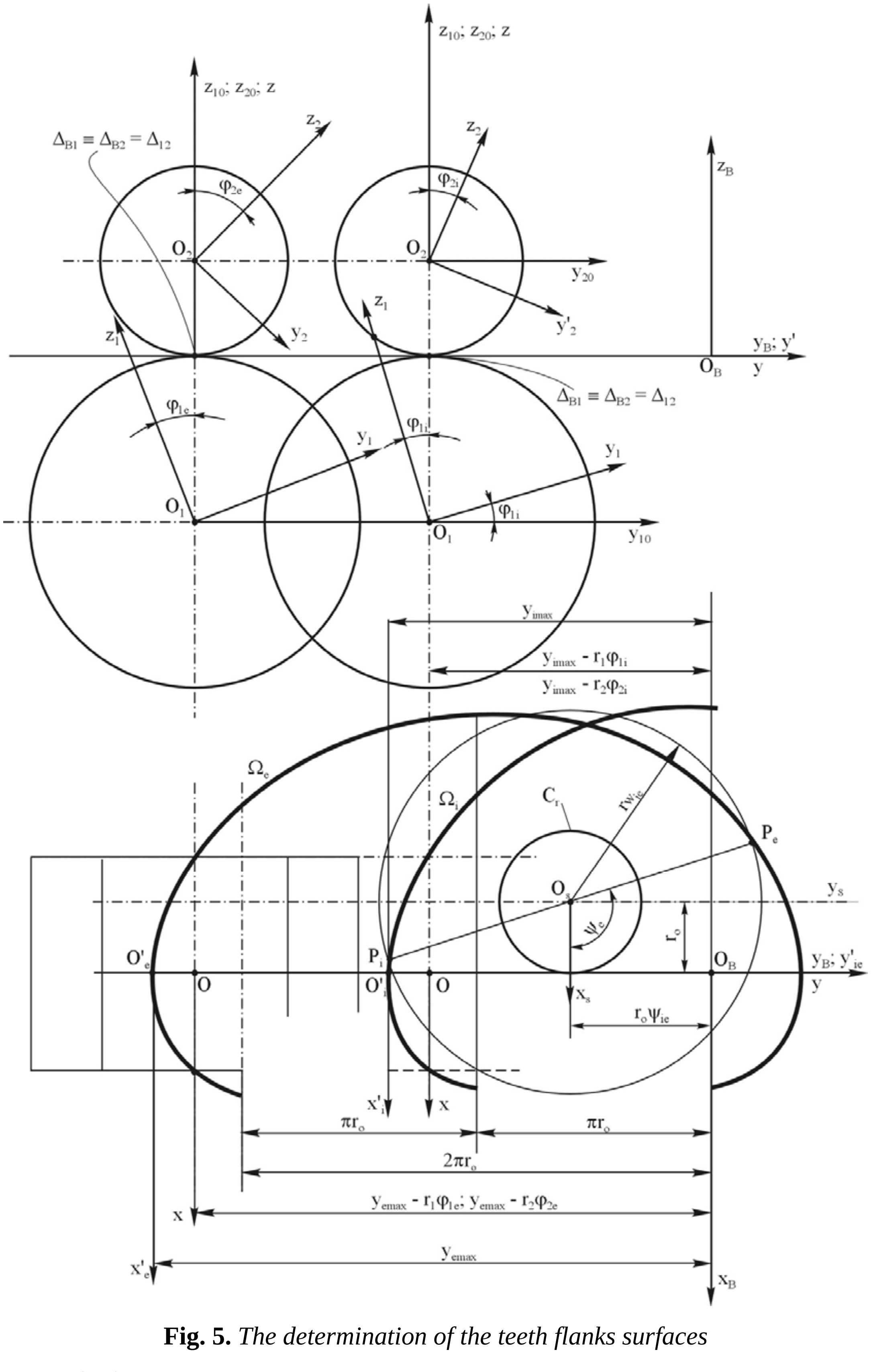

Fig. 5. *The determination of the teeth flanks surfaces*

REFERENCES

1. Bojan, St. Contribuții la realizarea angrenajelor cilindrice cu dantură curbă, Teză de doctorat, Universitatea Tehnică Cluj-Napoca, 2002.