THE CONVERSION OF DIAGRAMS AND TABLES IN THE ANALYTICAL RELATIONS FOR CALCULATING GEAR

FLOREA Ion, RIZEA Nicoleta
Petroleum-Gas University of Ploiesti, florea.ion@gmail.com

Keywords: gear diagram, pressure angle, involute calculation

Abstract: The paper establishes the analytical relations that replace some diagrams and a table used for gear calculation. They allow a simple mode for programs developing on computers. The relations refer to involute table, inva , correction factor of tensions in the tooth base Y_{Sa} , tooth form factor Y_{Fa} for the pressure angle of a=20^0 and tooth addendum factor $h_a^* = 1$ and $h_a^* = 0{,}85$.

1.THE RELATION FOR INVOLUTE

Usually, the involute is calculated with the relation

$$\mathrm{inv}\alpha = \mathrm{tg}\alpha - \alpha \qquad (1)$$

where α is the angle in radians.

The problem arises when it is known the involute value and it is necessary to be found angle value. The angle value must be looked for in a table like that from fig. 1, scanned from a book for gear calculation.

VALOXILE FUNCȚIEI $inv\ \alpha = tg\ \alpha - \alpha$

Grade / Minute	18°	19°	20°	21°	22°	23°
0	0.0107604	0.0127151	0.0149044	0.0173449	0.0200538	0.0230491
1	0.0107912	0.0127496	0.014943	0.0173878	0.0201013	0.0231015
2	0.010822	0.0127842	0.0149816	0.0174308	0.0201489	0.0231541
3	0.0108528	0.0128188	0.0150203	0.0174738	0.0201966	0.0232067
4	0.0108838	0.0128535	0.0150591	0.0175169	0.0202444	0.0232594
5	0.0109147	0.0128883	0.0150979	0.0175601	0.0202922	0.0233122
6	0.0109458	0.0129232	0.0151369	0.0176034	0.0203401	0.0233651

Fig.1. Involute values table

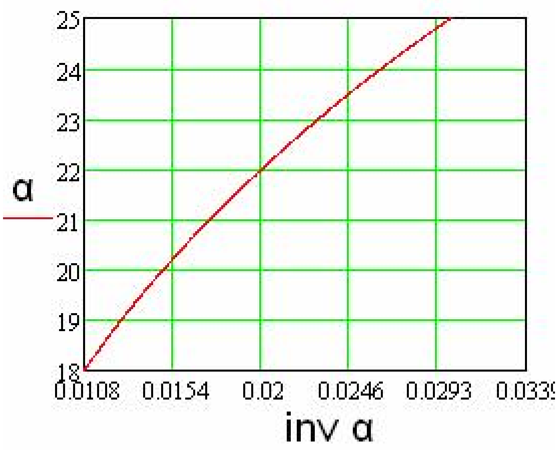


Fig.2. The variation of α depending of invα

The paper propose the function gave in relation (2) for involute calculus:

$$y = a + b\cdot x + c\cdot x\cdot \ln x + d\cdot x^{0,5}\cdot \ln x + e\cdot \ln x \qquad (2)$$

with parameters values:

a=0,011516685; b=0,9767615;
c=-0,47428021; d=-0,5647967;
e=-0,00077028407.

Example:

For $x = \mathrm{inv}\alpha = 0.02466$ results

$y = \alpha =$ 0.410152 radian=23^{0}30'

In Fig. 2 is the dependence of variation of α to invα.

2.THE RELATION FOR CORRECTION FACTOR OF TENSIONS IN THE TOOTH Y_{Sa}

The values for the correction factor of tensions in the tooth base, can be founded in diagrams as that one from Fig.3.

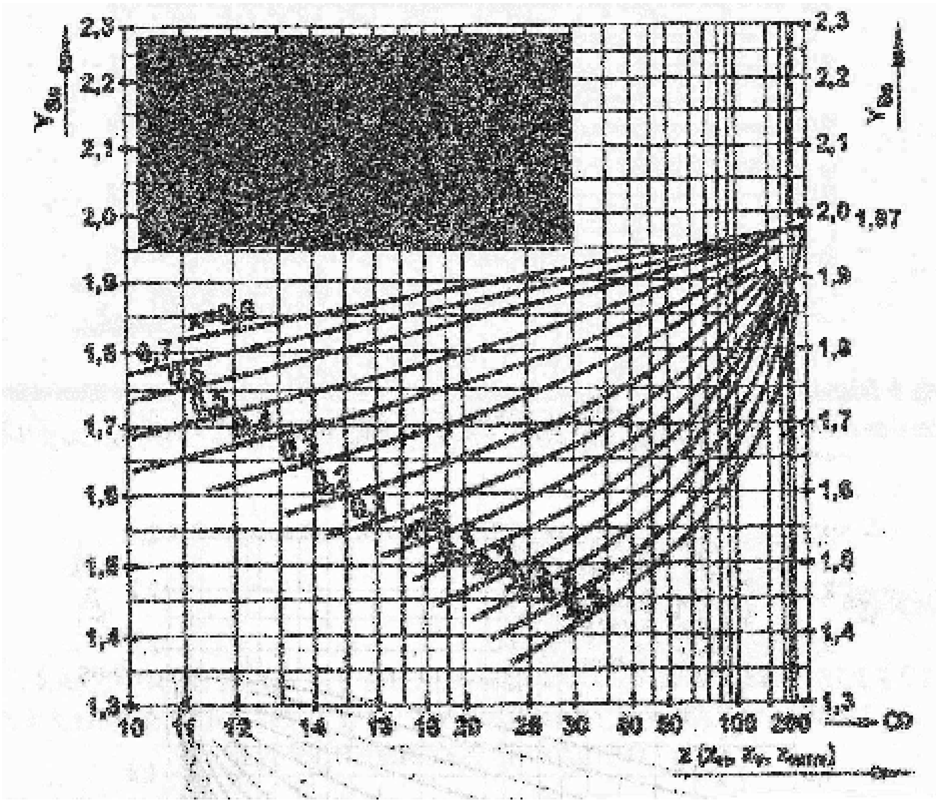


Fig.3. Diagram for** Y_{Sa} **(from specialised literature)

The diagram from Fig.3. can be replaced with the relation (3).

$$f(x,y) = a + b\cdot\left[0{,}5 + \frac{\operatorname{arctg}\left[\frac{x-c}{d}\right]}{\pi}\right] + e\cdot\left[0{,}5 + \frac{\operatorname{arctg}\left[\frac{y-f}{g}\right]}{\pi}\right] + \qquad (3)$$

$$+ h\cdot\left[0{,}5 + \frac{\operatorname{arctg}\left[\frac{x-c}{d}\right]}{\pi}\right]\cdot\left[0{,}5 + \frac{\operatorname{arctg}\left[\frac{y-f}{g}\right]}{\pi}\right]$$

The parameters from (3) are:

a= - 6,0274138; b=9,594915; c= - 0,038801869; d=0,91409863; (4)

e=7,9755724; f= - 38,206289; g=28,597828; h= - 9,4873016.

In (3) f is correction factor of tensions in the tooth base

$f = Y_{Sa}$; (tooth addendum factor is $h_a^* = 1$).

x- correcting factor

x= correcting factor, $x \in (-0.5...0.8)$

y-number of teeth of the gear

y=z ($z \in (10, \infty)$)

The dependence of correction factor of tensions in the tooth base $f = Y_{Sa}$ is presented in Fig. 4.

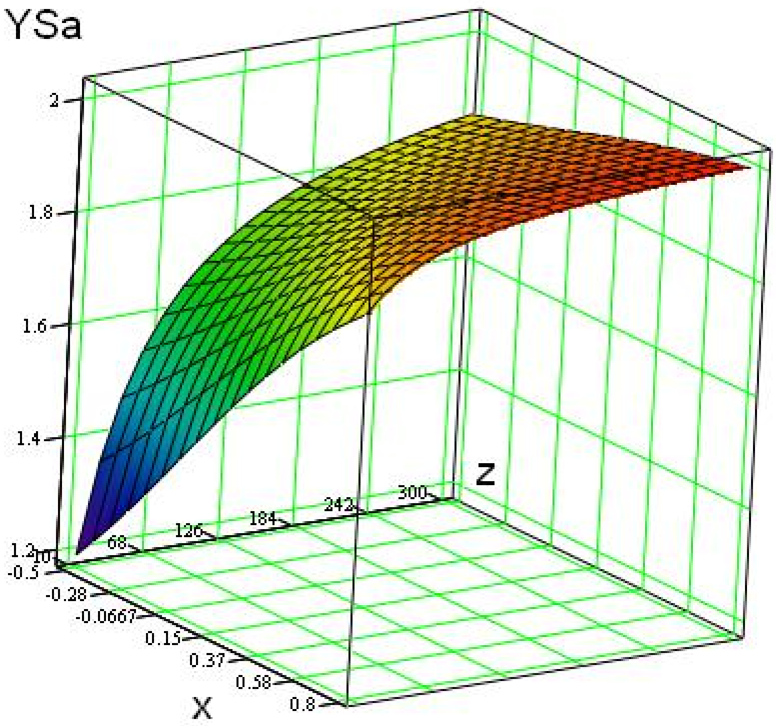
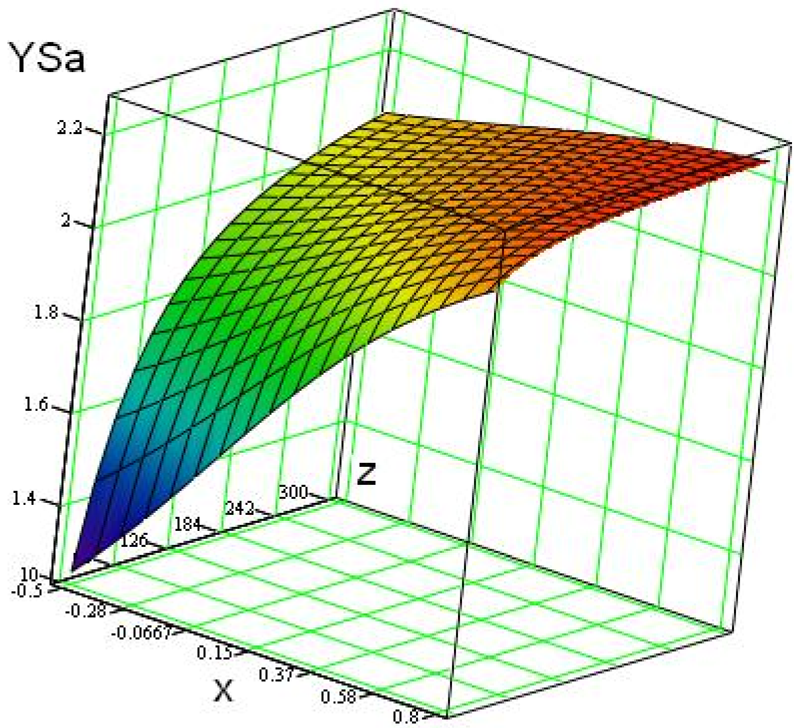


Fig.4.The variation of correction factor of tensions in the tooth base($h_a^* = 1$ ***)***

For tooth addendum factor $h_a^* = 0{,}85$ can be used the same relation as (3) with the next parameters:



a= - 7,8758942
b=12,296626
c= - 0,065367117
d=0,79473565
e=10,0975222
f= - 42,996997
g=30,258976
h= - 12,241702

Fig.5.The variation of correction factor of tensions in the tooth base($h_a^* = 0{,}85$ ***)***

3. THE RELATION FOR TOOTH FORM FACTOR Y_{Fa}

The values for the form factor can be founded in diagrams as that one from Fig.6.

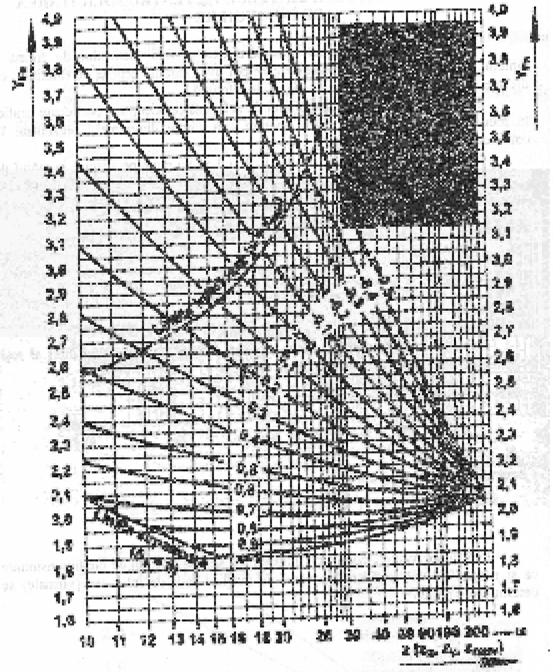


Fig.6. Diagram for Y_{Fa}

(from specialised literature)

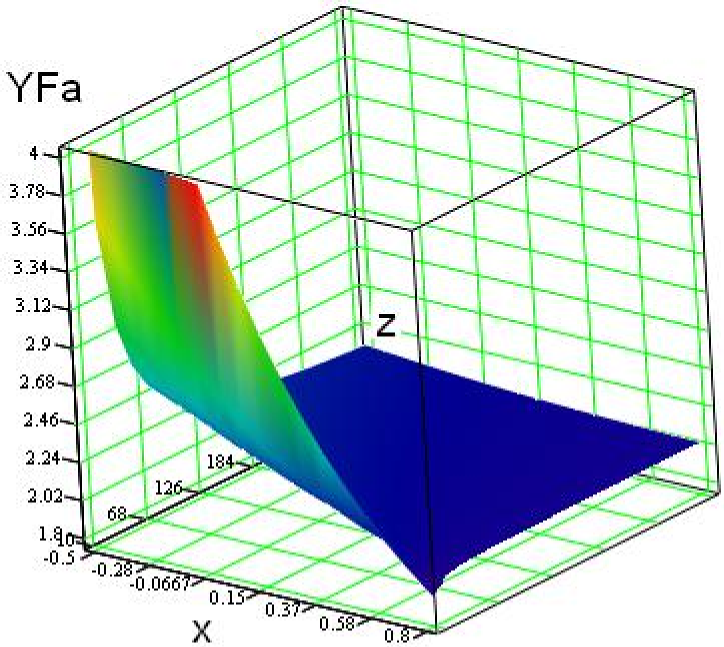


Fig.7.The variation of form factor( )

For the form factor Y_{Fa}, $h_a^* = 1$ can be used the same relation as (3) with the next parameters:

a=2,0434578; b= - 0,028222506; c= - 0,4502154; d= - 0,61790694;
e= - 9,110626; f=4,0743503; g= - 4,709691; h=58,616343.

For the form factor Y_{Fa}, $h_a^* = 0{,}85$ can be used the same relation as (3) with the next parameters:

a=1,8523819; b=0,036963476; c= - 0,49171175; d= - 0,54018914;
e= - 8,0791657; f=4,0998684; g= - 4,1448342; h=54,158597.

4.CONCLUSIONS

The relations established to replace the table and the diagrams give good precision for their using in calculating gear. It is a good thing the fact as for all cases presented is necessary only a kind of relation, but with different parameters. These relations can be easy implemented on computers.

BIBLIOGRAPHY

4.CREITARU, A, MINOIU, St – Proiectarea sistemelor de transmisii mecanice, Ed. Universitatii Petrol-Gaze Ploiesti, 2007.

1.JULA, A. , s.a. – Proiectarea angrenajelor evolventice. Ed. Scrisul Românesc, Craiova, 1989.

2.Mott, R - Machine elements in mechanical design, 4th Edition, Prentice Hall, 2004.

3.SAUER,s.a.-Angrenaje.Proiectare.Materiale. Ed. Tehnica, Bucuresti, 1970.

5.Table curve 2D and 3D, soft