5th INTERNATIONAL MEETING OF THE CARPATHIAN REGION SPECIALISTS IN THE FIELD OF GEARS

CONSIDERATION ABOUT THE WEAR OF THE GEARS

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ABSTRACT: The paper presents one of methods for calculus of adhesive wear of the gears. Is presented the logical diagram of wear calculus, the mathematical model, a few graphic representations for adhesive wear of the gear and conclusions.

1. Introduction

The adhesive wear is frequently meet and is produced by welding and breaking of welding bridge between the contact micro-zones. Characteristic for this type of wear is a high friction coefficient and high wear intensity.

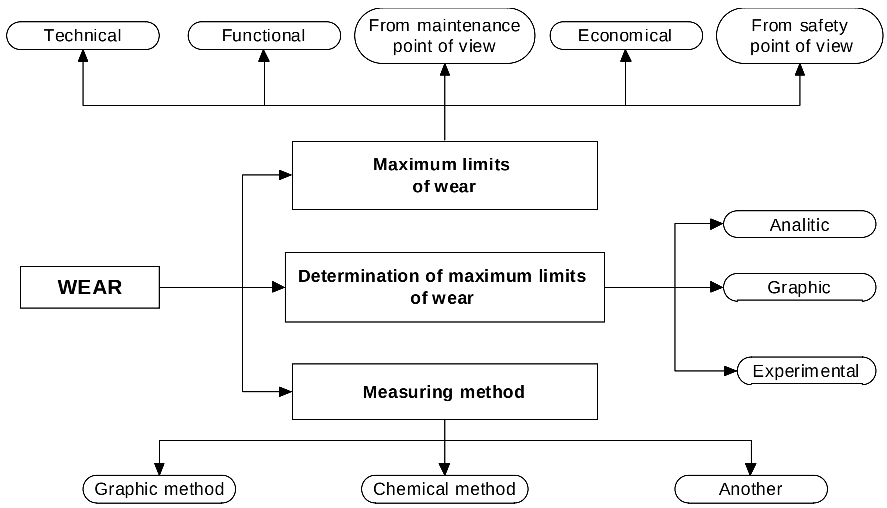

Fig. 1. Consideration about the wear

For the calculus of adhesive wear was elaborated many theories: the welding bridges theory [1][4], the atomic interaction theory [2][4], the initial contact between surfaces theory (elastic or plastic) [3], etc.

2. The calculus of adhesive wear of gears

The calculus of adhesive wear of the gears is a cumbersome process and is indicated to use the computers for numeric calculus or to elaborate one application based on a strong program (Visual Fox, Excel, MathCAD, etc.).

Based on Romanian specialty literature [5][3] the logical diagram presented on figure 2 is the starting point for mathematical model.

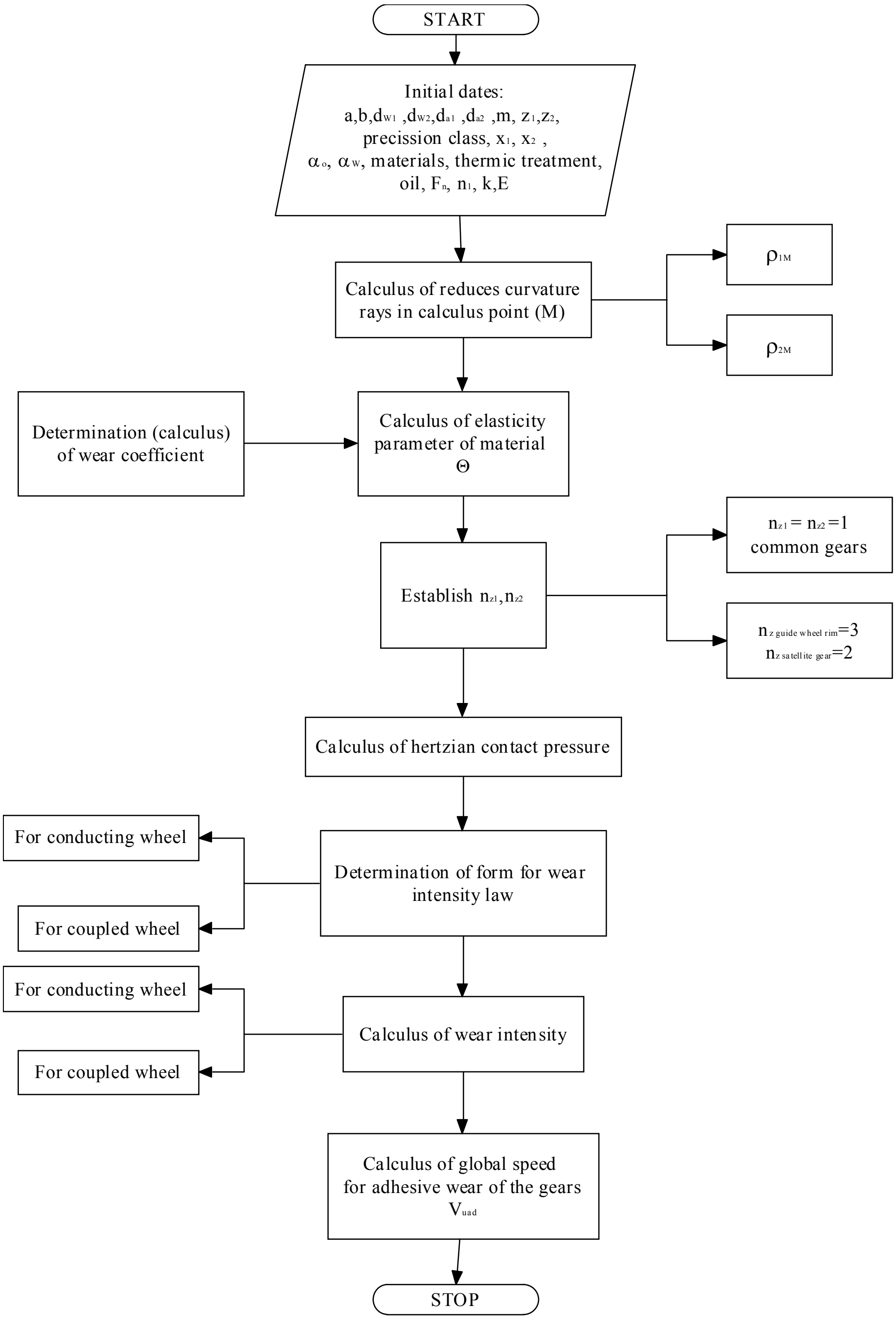

Fig. 1 The logical diagram for calculus of adhesive wear of the gears

Calculus of reduced curvature rays in calculus point:

$$\rho_{2A} = 0{,}5 \cdot d_{b2} \cdot tg\alpha_{a2} = 0{,}5 \cdot z_2 \cdot m \cdot \cos\alpha \cdot tg\left(\arccos\frac{d_{b2}}{d_{a2}}\right) \tag{1}$$

$$\rho_{1A} = a_w \cdot \sin\alpha_w - \rho_{2A} \tag{2}$$

Where:

- ρ_{1A} ρ_{2A} - reduced curvature rays for wheel 1,2;
- d_b - head diameter;
- d_w - rolling diameter;
- α_o - angle of mesh for references gear rack (20^o);
- α_w real angle of mesh;
- z_1 ,z_2 - numbers of teeth;
- m - modulus;
- n_1 - revolutions per minute, r.p.m.

$$d_{b2} = d_{w2} \cdot \cos\alpha_w \tag{3}$$

$$a_w = a \cdot \left(\frac{\cos\alpha_o}{\cos\alpha_w}\right) \tag{4}$$

Calculus of elasticity parameter of material:

$$\Theta = \frac{1-\mu^2}{E_1} + \frac{1-\mu^2}{E_2} \tag{5}$$

- μ - wear coefficient;
- E - coefficient of elasticity.

Calculus of hertzian contact pressure:

$$p_h = 0{,}418 \cdot \left(\frac{F_n \cdot E}{2 \cdot b \cdot \rho}\right) \tag{6}$$

- F_n normal force;
- b width of teeth;
- $\rho = \dfrac{\rho_{1A} \cdot \rho_{2A}}{\rho_{1A} + \rho_{2A}}$.

Determination of form for wear intensity law:

$$I_{uh} = k \cdot p^{1,1} \tag{7}$$

- $k = 3.6 \cdot 10^{-12}$

Calculus of global speed for adhesive wear of the gears:

$$V_{uad} = 0.0375 \cdot n_1 \cdot \left| \rho_1 - \frac{\rho_2}{\frac{z_2}{z_1}} \right| \cdot \left(F_n \cdot \Theta \cdot \rho\right)^{\frac{1}{2}} \cdot \left(\frac{I_{uh1} \cdot n_{z1}}{\rho_1} + \frac{I_{uh2} \cdot n_{z2}}{\rho_2} \right) \quad (8)$$

Considering for a gear knows the initial data in MathCAD was built an application for the calculus of the adhesive wear. This calculus was made for two points: the beginning of meshing and the end of meshing.

Interesting for research is variation of adhesive wear when some of the parameters have variations of values. The following parameters were considered as important:

- the normal force;
- friction coefficient;
- number of teeth for conducting and coupled wheel.

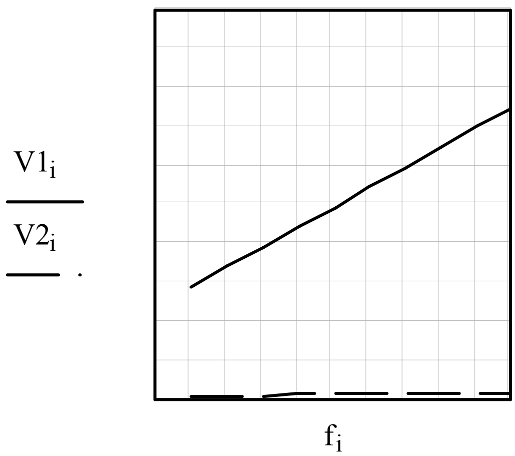

Fig. 3 Variation of adhesive wear of the gear in condition of variation of normal force

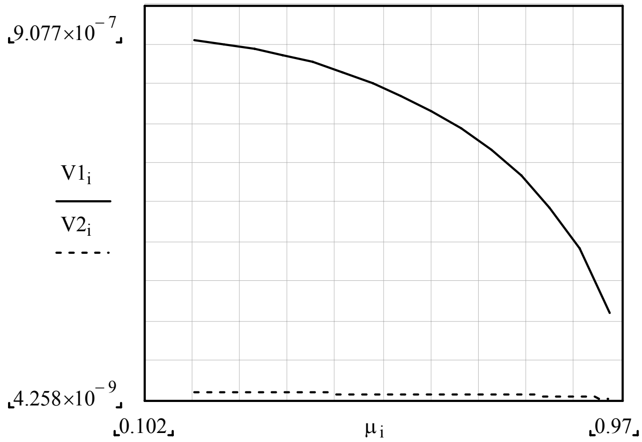

Fig. 4 Variation of adhesive wear of the gear in condition of variation of friction coefficient

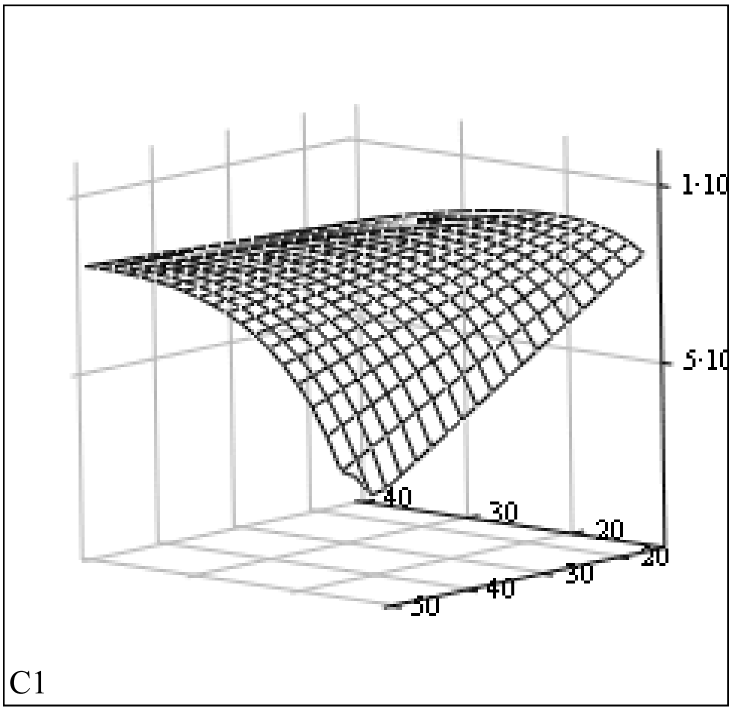

Fig. 5 Variation of adhesive wear of the gear in condition of variation of number of teeth in the beginning point of meshing

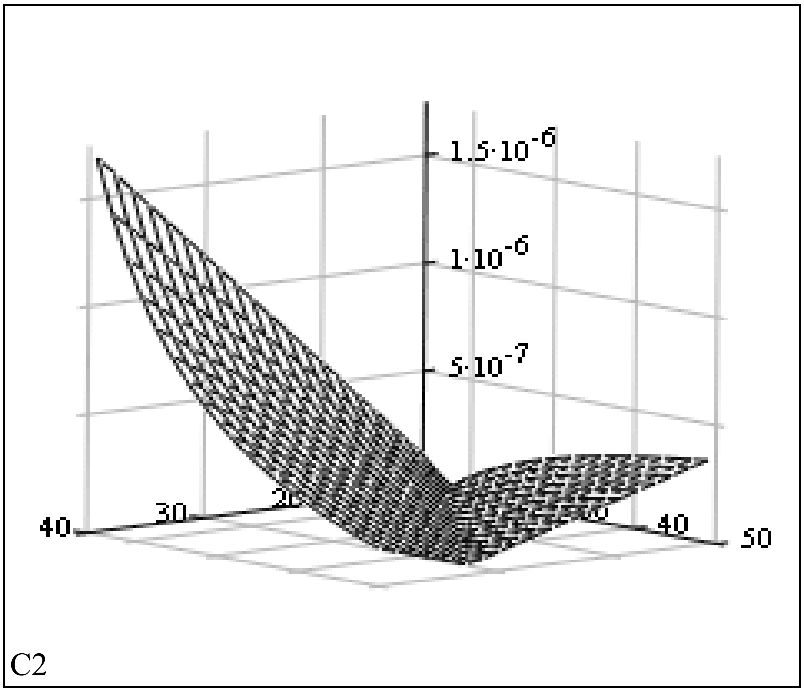

Fig. 6 Variation of adhesive wear of the gear in condition of variation of number of teeth in the ending point of meshing

3. Conclusions

The application permits theoretical calculus of adhesive wear for the gear with a higher precision in a shorter time. The study of variations of different parameters permits some conclusions:

- the value of adhesive wear is direct proportional with the value of normal force;
- the value of adhesive wear is inverse proportional with the value of friction coefficient;
- the rapport between the value of adhesive wear in the beginning meshing point and the value of adhesive wear in the ending meshing point is constant (calculated with the same values of the friction coefficient and normal forces);
- we can optimize the gear reduction rate for a lower adhesive wear.

4. References

1. ***Bowden, F.P., Tabor D***., *The Friction and Lubrification of Solid, Oxford and Clarendon Press 1964*
2. ***Kraghelski, V.I***., *Calcule de l'usure, Paris, 1970, Conferennce G.A.M.I.*
3. ***Pavelescu D., Musat M., Tudor A.,*** *Tribologie, Editura didactica si pedagogica Bucuresti, 1977.*
4. ***Rabinowicz, E***. *Friction and Wear of Materials, New York, J. Willey, 1965*
5. ***Tudor A., s.a.*** *Durabilitatea si fiabilitatea transmisiilor mecanice, Editura tehnica, Bucuresti , 1988*
6. ***Ungureanu N.,*** *Researches Regarding the adhesive wear of the Gears; Manufacturing Engineering / Vyrobne Inzinierstvo, cislo 1 rocnik II, 2003; 24÷27*