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Analysis of Geometry of Rough Surface - Actual Area of Contact

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Keywords **– rheological properties, contact interaction of parts.**

I. Introduction

When determining the characteristics of the frictional interaction of rough surfaces and the area of their contact altitudinal and longitudinal properties of the irregularities, the radius of curvature of protrusions and depressions, the laws of their distribution and regulation are used.

Another most significant aspect of the contacting of the surfaces is the molecular mechanics of contact. The surface energy of solids is so great that it causes the active interaction of the solid with components of gases, liquids and parts of solids, forms adsorption and chemisorption layer on the surfaces, adhesion force to resist motion, setting, deformation, heat and other processes.

II. Geometry of Rough Surface

In a random arrangement of the asperities on the surfaces of contacting solids, actual area of contact which is known by the geometry of contacting surfaces limits bringing closer these contact surfaces under the influence of external load. Fig. 1 shows the main characteristics of the standard geometry of the rough surfaces: roughness with a maximum profile height of R_{max}, the maximum corrugation height Rw_{max} and macrodeviation from horizontal base plane with height characteristic δ.

Fig.1 Main characteristics of the rough surface geometry

Well-known theoretical approaches to calculate the actual contact area [1] do not take into account the effect of time of loading and temperature of the contacting surfaces of solids. However, all materials to a greater or lesser extent have the viscoelasticity and viscoplasticity, i.e. elastic and plastic deformation does not affect immediately after loading, but progress after some time.

III. Rheologic Properties of Contact

The rate of increase of deformation increases with raise of temperature. Such behavior of materials, leading to a change in the actual contact area depending on the temperature and time, is described by means of rheological models. Rheology - a set of deformation study methods for studying the deformation and flow of media having a viscosity and plasticity.

Assessment of contact deformations, considering the microgeometry of the surfaces and the heterogeneity of the mechanical properties of surface layers, surface films, and the stress distribution in the surface layers is necessary for the calculation of nodes with minimal friction and high wear resistance. During the capillary adhesion condensation of water vapors leads to the formation of thin liquid films on solid surfaces.

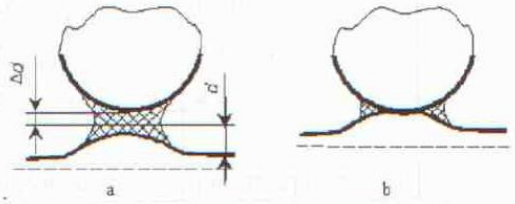

Fig. 2 The scheme of the convergence of the contacting surfaces
a – initial position; b – end position and deformation of the protrusion.

Contact characteristics in the presence of a liquid film depends on the shape of the stamp, the bilateral attraction of two molecular roughness, the energy dissipation in the loop "converging-removal" roughness (see fig. 2).

IV. Conclusions

An important place in the knowledge of the contact process belongs to the interaction between the surfaces, gases and moisture. The size of the gas molecules is equal to 10^{-9} ... 10^{-8} m, the average density is equal to $3 \sim 10^{-19}$ mol/cm^3, the velocity $U \approx 4 \cdot 10^4$ cm/sec., indicating a significant kinetic energy of gas particles interaction with surfaces.

In conclusion, one more important process from the scientific and practical point of view should be noted - the electrochemical interaction of surfaces separated by a layer of grease (which creates the conditions of the electric condenser). According to the laws of electrochemical kinetics the anode is dissolved and the dissolved metal ions are deposited on the cathode.

VII. References

[1] Urbach A. Rijkruis G., Mechanics of contact interaction of parts in friction component with regard to the rheological properties of contact – Proceedings of 14th International Conference. Maritime transport and infrastructure. 2011. p.143-148