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Fluorine coatings influence on the performance characteristics of flexible bellows

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Bellows expansion joints (BEJ) are widely used in various fields of technology, such as:

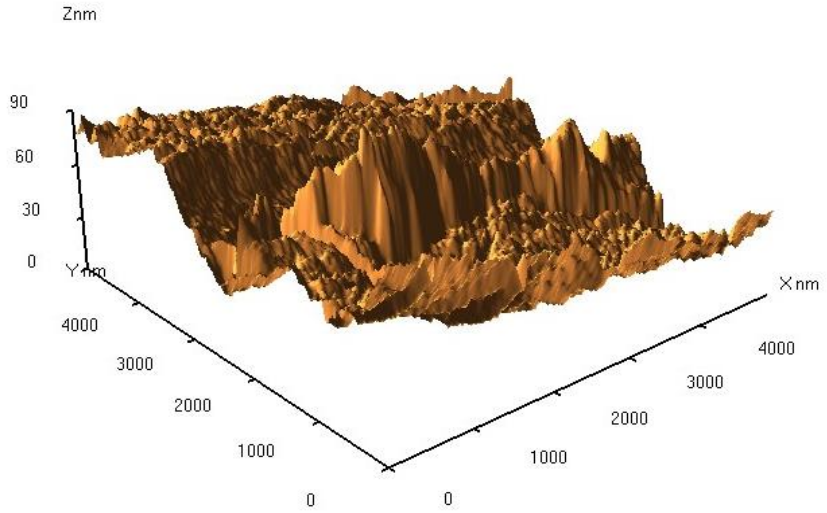
- nuclear engineering,
- oil and gas industries,
- shipbuilding,
- electrical engineering,
- mining engineering, etc.

Increasing BEJs reliability is very important problem. As, there are various technologies of BEJs manufacturing, including modified technologies of applying fluorine nanocoating (FNC) to the layers of BEJs.

Results of applying FNC technology for metal surfaces (“NANOEDUCATOR”)

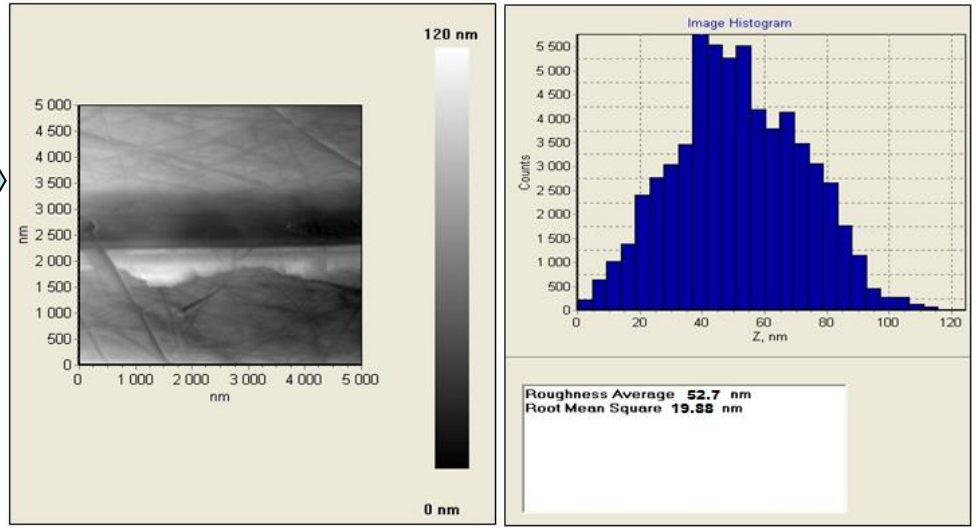
sample

3D image (nm)



Results processing. Average value of thickness is 52,7nm; STD – 19,8 nm.

Normal distribution of FNC thickness.



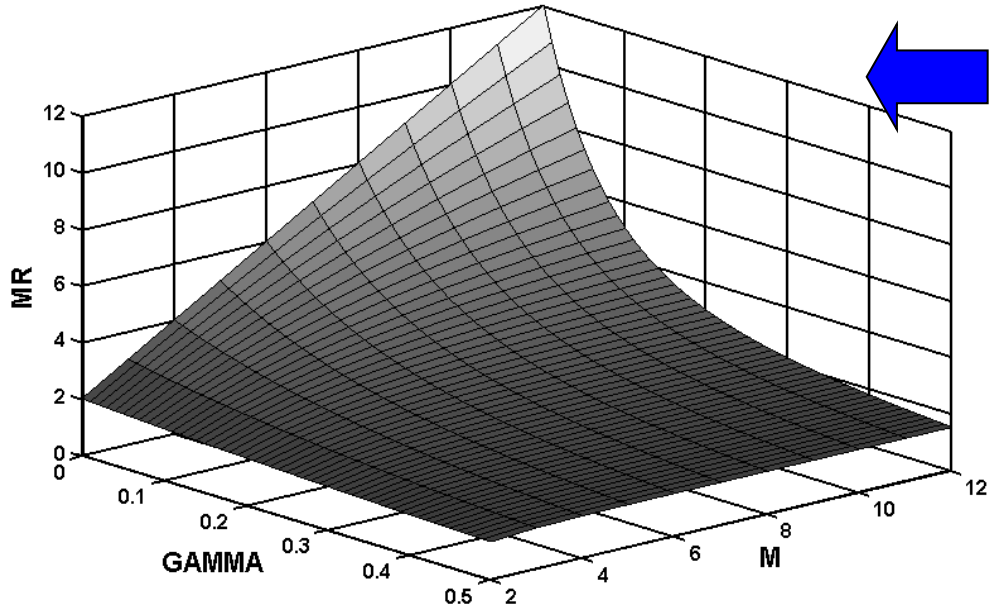
To evaluate the FNC influence on the performance characteristics of BEJs, the physico-mathematical model of functioning and measuring the reliability performance of BEJs is developed. The model includes two mechanisms of fatigue breakdown and wear: the Rehbinder effect and fretting.

The model allows to calculate cyclic operation life, N for various technologies. The first is usual (mechanical or hydraulic) technology without FNCs. The second is usual technology with FNCs for all layers of BEJ. Three technology has protective FNC layer between BEJ and a liquid.

BEJ reliability is determinated by operation life, N_K (k=1,2,3) , where K is a number of technologies for BEJs manufacturing. It are formulas for N_K :`

$$N_1=K_0*M_R(Y_1, M); \quad N_3=N_1+N_{00}*F(Y_1, M);$$

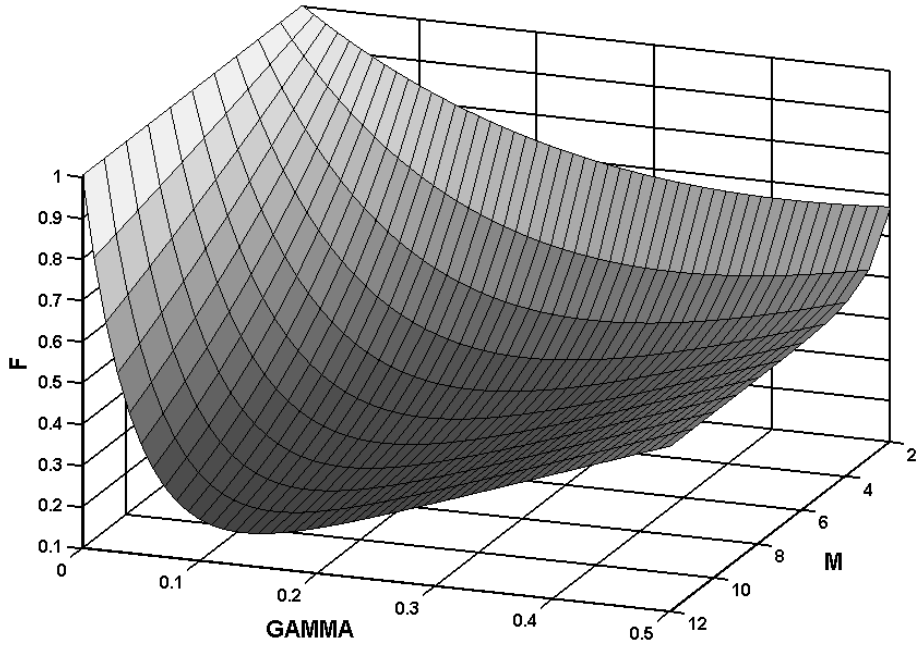
$$N_2= N_1*M_R(Y_2, M)/M_R(Y_2, M)+N_{00}*F(Y_2, M).$$



Dependency between function M_R and γ parameter for BEJs with different number of layers (M). A parameter, γ characterizes a ratio of the fretting wear cyclic rate to the microcrack growth cyclic rate.

Dependency between function F(γ , M) and γ parameter for BEJs with different number of layers (M).

For technologies with numbers k=2,3, a protective layer exists, therefore, $N_{00} > 0$.



CONCLUSIONS

1. **Applying modified technology with FNCs to all BEJ layers allows to increase the cyclic operation life of BEJ into some times (up to 6 times).**

2. **Also modified technology with protective FNC layer between BEJ and liquid has high efficiency to increase cyclic operation BEJ life.**

3. **Optimal technology option with the account of engineering and economic reqirements is elected.**

THANK YOU FOR YOUR TIME