INFLUENCE OF THE MAGNETIC FIELD ON CORROSIVE WEAR

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Keywords: corrosive wear, passivating layer, magnetic field, experimental- theoretical method.

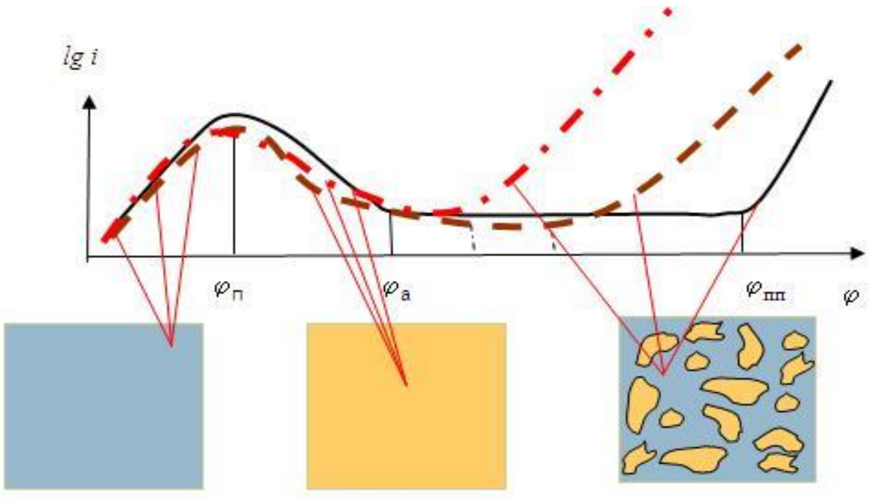
Abstract

Corrosion wear essentially reduces a resource of equipments and constructions, leading to their technogenic both ecological failures and accidents. In this connection protection against corrosive destruction of elements of designs and constructions is one of the major technical problems.

Introduction

There is a constant search of new ways of protection against corrosion. For practice represents the big interest of research of influences of various external factors on change of mechanical characteristics of a material in the course of corrosive wear.

According to the electrochemical theory of corrosive wear, on the surface of a metal located in a corrosive medium, a passivation layer forms (fig. 1) [1-5]. Upon approaching a certain potential, this layer is destroyed and corrosion damage begins. Then, along with the changes in geometrical characteristics of construction elements, the material loosens, which is especially dangerous for thin-walled elements.



metal surface | formation of a passivating layer | destruction of a passivating layer

the continuous line - deformation is absent
the shaped line - static loading
the shaped with point line - dynamic loading

Fig. 1. Dependence of speed of anode dissolution on anode potential

Among the factors influencing destruction of a protective film, it is possible to note presence of physical fields [6-12], and also preliminary updating of a surface of elements of designs, for example, a method of ionic implantation [13-14].

Works on research of corrosion of pipelines are known at magnetisation of pumped over [15-16] environment. Influence of connections of benzene on steel corrosion at magnetic field influence is considered in [17].

There are begun works on studying of influence of a magnetic field on process of corrosive wear [6, 7, 9, 11, 12, 18-20]. In the given work the experimental research of influence of a magnetic field on corrosive wear [18-20] is spent.

The research scheme. Installation (fig. 2), consisting of an electromagnet (1) with fixing elements, platforms (2) for placing of capacity with medium (3) for the investigated sample (4) is collected. Out of a zone of influence of a magnetic field the capacity with medium (5) for the control sample (6) takes places. Prior to the beginning and after experiment gauging of a thickness of investigated samples is made. Samples (4) and (6) place in corresponding capacities and maintain certain time in the set environment, thus the sample (4) is exposed to influence of an electromagnetic field. On coil windings pressure U = 50V. For an exception of influence of deformation on corrosive wear, samples have in parallel lines of influence of a magnetic field.

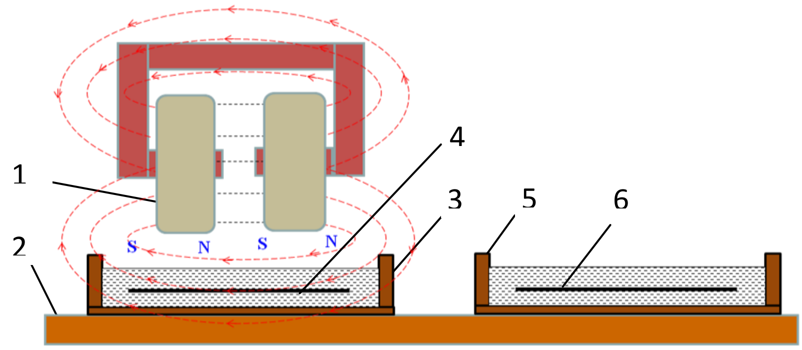


Fig. 2 Scheme of the set up

The scheme of processing of results. To estimate the effect of the magnetic field on corrosive wear, we used the experimental—theoretical method [21-26]. Samples *(4)* and(6) held for a certain time in a corrosive medium are alternately fixed along the contour on the set up the schematic of which is presented in Fig. 3 and loaded by uniform pressure *p*.

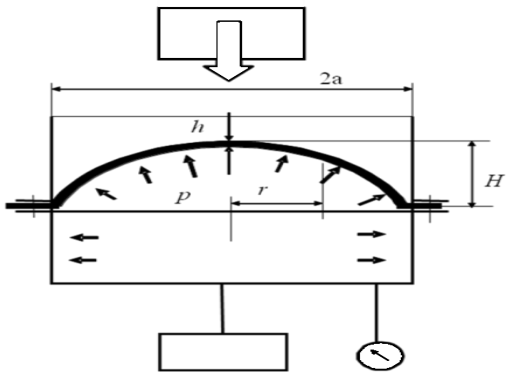


Fig. 3. The scheme of investigation of mechanical characteristics of samples

With increasing pressure *p*, the shape of the arch formed by the sample, in particular, arch peak height H, is monitored and pressure *p* versus bending *H* is plotted. Knowing sample bending *H* at given pressure *p* and using the relation of the theory of shells, one can determine the moduli of elasticity. In the case of linear deformation of the samples, we can use, for example, the Timoshenko formula [27]

$$E = \frac{3(1-\nu^2)pa^4}{16hH(h^2 + 0.488H^2)} , \quad (1)$$

where *p* is the uniformly distributed pressure, ν is the Poisson ratio of the material, *h* is the membrane thickness, *a* is the membrane radius, and *H* is the arch height (bending).

Effect of the magnetic field on corrosive wear in water. Steel 3 samples with a thickness of 0.5 mm were subjected to corrosive wear for 79 days (the magnet was switched off at night). Simultaneously, the reference samples with a thickness of 0.5 mm without a magnetic field were investigated. The thickness of the sample subjected to corrosion under the action of a magnetic field was 0.475 mm; the thickness of the sample without the magnetic field was 0.452 mm. The curves of pressure *p* versus bending *H* for the samples under consideration are presented in Fig. 4.

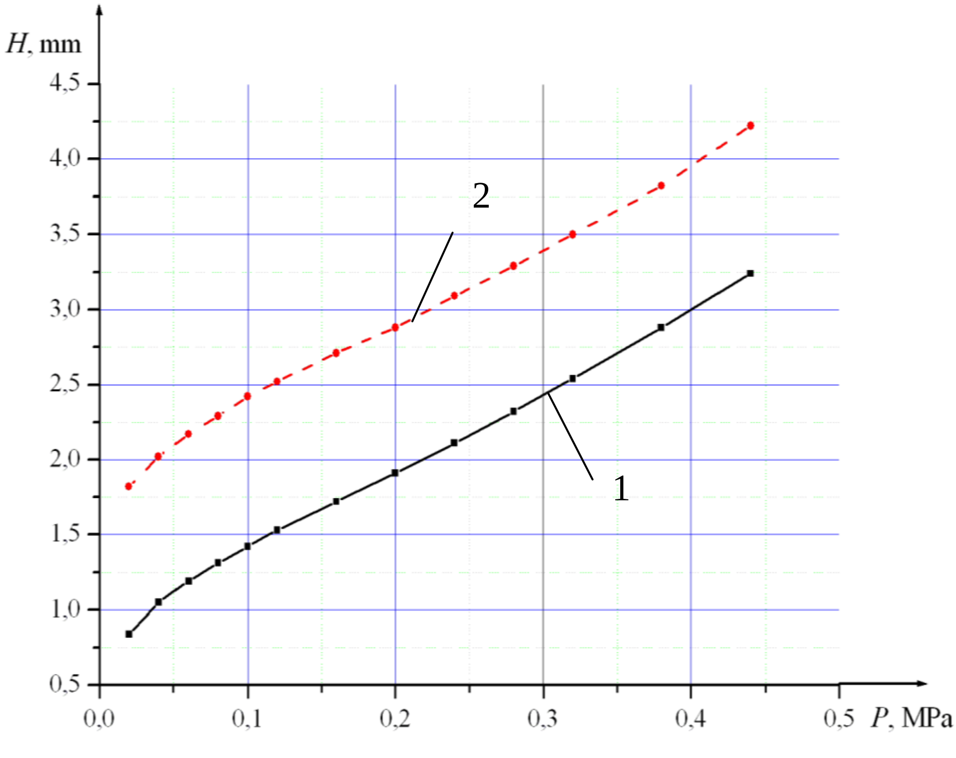


Fig. 4. Dependence «pressure p - deflection *H*» (the research environment - water);
1 - the sample under a magnet, *2* - without a magnet

It can be seen that corrosive wear of the reference samples is higher than that of the samples emerged in the corrosive medium under the action of a magnetic field. The Timoshenko moduli of elasticity at *p* = 0.02 MPa were 1.677 x 104 and 1.1 x 105 MPa for the samples without and with the magnet, respectively.

Effect of the magnetic field on corrosive wear in an acidic medium. Steel 3 samples with a thickness of 0.5 mm were subjected to corrosive wear for 56 days (the magnet was switched off at night). As a corrosive medium, a 10% hydrochloric acid solution was used. Simultaneously, the reference samples with a thickness of 0.5 mm without a magnetic field were investigated. The thickness of the sample subjected to corrosion under the action of a magnetic field was 0.47 mm; the thickness of the sample without a magnetic field was 0.461 mm. The curves of pressure *p* versus bending *H* for the samples under consideration are presented in Fig. 5.

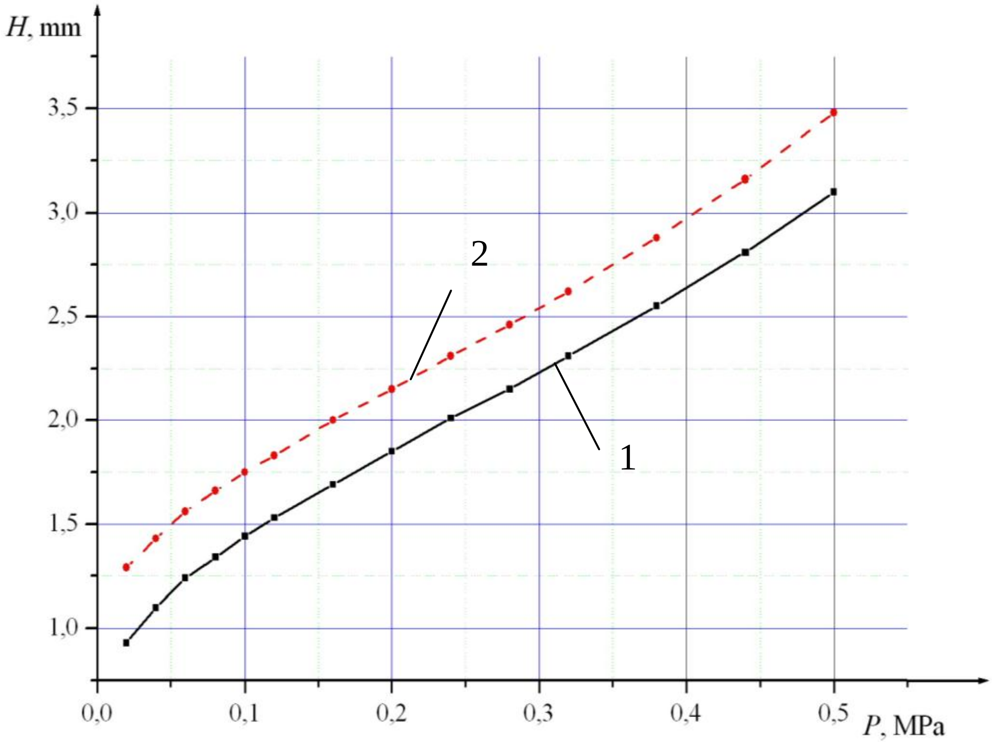


Fig. 5. Dependence «pressure *p* - deflection *H*» (the research environment - 10 %-s' solution of hydrochloric acid); *1* - the sample under a magnet, *2* - without a magnet

As in the previous example, corrosive wear of the reference samples is higher than that of the samples emerged in the corrosive medium under the action of the magnetic field. The Timoshenko moduli of elasticity at p = 0.02 MPa were 5.125 x 10^4 and 1.111 x 10^5 MPa for the samples without and with the magnetic field, respectively.

Summary

Thus, the presence of a magnetic field facilitates retaining a protective passivation film and decreases corrosive wear in both water and an acidic medium.

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