

THE CORROSION RESISTANT COATING WITH HALLOYSITE NANOPARTICLES

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Preliminary Note – Prethodno priopćenje

The process of application of coating on metal surfaces is described in this article. The composition with 100 % corrosion preventing substance + 42,5 % acetone + 10 % halloysite was recognized as the most appropriate for coating, and it provides the best corrosion resistance of hydraulic pump details. The impellers of circulation pumps for water delivery in heating system fail after 5 - 6 months because of the galling of work flutes, as water doesn't pass through the chemical purification. After applying corrosion resistant coating with halloysite the lifetime of impellers increases. The essence of which is dipping the impeller into hydrochloric acid with 24 hour keeping in it, then it is dried in dryer up to 4 hours. The lifetime of this impeller increases 1,8 fold and it was approximately 9 months.

Key words: corrosion, surface, coating, polystyrene foam, quality

INTRODUCTION

The metalwork fail, lose their properties and change their exterior under the influence of corrosive medium. The metalwork made of carbon and low alloyed steel, aluminium and its alloys, copper and its alloys, zinc-galvanized ones suffer under corrosion. The rate of corrosion of different metals and alloys are different under the same external influence, but all metal details are subject to failure. That's why to exclude corrosion effect, it's necessary to use agents for preventing corrosion of metal. The most multi-purpose, cost-effective and broadcast method is using the special corrosion preventing coatings. It's well known, that using halloysite as a container of corrosion preventing liquid is promising [1-2].

The circulation pump is meant for centralized and home heating systems. It has two process speeds. Mainly it is used in one- and two-pipe heating systems, also in stirring loops of large systems. The assembling type: 15 radiators. The heated area is 250 m². The description of model: UP BASIC pumps are "wet impeller" pumps: pump body and electric motor are joint into one unit without intermediate coupling, but with two compactors.

The circulation pump's operation principle is based on the using of centrifugal force. The impeller with radially bent blades is attached to the shaft of electrical engine. The water from inlet pipe goes to the center of impeller and under the inertia (centrifugal forces) it is thrown along blades to its periphery.

At the outlet of impeller the water goes into volute channel, where a kinetic energy given to the water by impeller transforms into the potential energy, which increases its static pressure.

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At the circulation pumps with wet impeller, the impeller of engine rotates directly in the transferred water, which has two functions – cooling and lubrication of radially thrust bearings.

The work parameters of circulation pumps strongly depend on rotation speed and impeller's diameter:

- Changing pump delivery is proportionally equal to the changing impeller's rotation speed.
- Changing pump head (pressure) is proportional to the square of the changing impeller's rotation speed.
- Input on pump shaft is proportional to the cube of the changing impeller's rotation speed.
- The delivery and pump pressure developed by pump changes proportionally to the square of impeller's diameter.

The centrifugal pumps are the most capacious segment of pump equipment and they are used for water intake, water transportation, water removal and transferring the liquid mediums in technological and manufacturing processes. The centrifugal pumps differ with its radial direction of stream motion in tool (Figure 1) from other dynamic vane-type pumps (axial and diagonal).

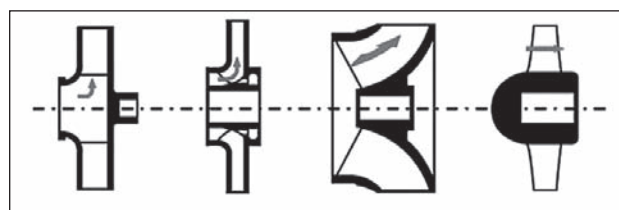


Figure 1 The scheme of liquid's stream motion in tool (from left to right) of the centrifugal pumps with conventional construction of impeller, the centrifugal pumps with 3D construction of impeller, diagonal pumps and axial pumps.

EXPERIMENTAL PART

Equipment and tools

The composition and technology of application of corrosion-resistant coatings with halloysite nanoparticles was determined experimentally. The halloysite particles with the size of nanotubes were obtained by mechanical method. The corrosion resistance of hydraulic pump details was tested under working conditions.

The circulation pump is meant for centralized and home heating systems.

The basic design of centrifugal pumps includes tool – impeller planted on shaft driver (or engine shaft if the centrifugal pump with engine have monoblock design), it is made of two retention disks with blades between them, which are bent against rotation of shaft with impeller (Figure 2).



Figure 2 Impeller of circulation pump

The impellers of centrifugal pumps are made of stainless steel, high-strength and graphite cast iron, non-ferrous alloys, composite materials, mostly with fixed blades, sometimes with ability to move along the axis of disk with blades (centrifugal pumps, which transfer heavily polluted liquids).

The blades with impeller disks form interblade channel, which are filled with transferred liquids during work of pump. The centrifugal force acts on discrete volumes of liquids, it determined by product of mass of liquid's volume, squared angular velocity and radius of impeller. Under influence of this force the liquid in interblade channels is thrown out of impeller, moreover, the high pressure area is formed at the periphery of interblade channel and impeller, at the same time, rarefied area occurs in the center of impeller, it provides suction of liquid from inlet pipe.

These researches were conducted on details of hydraulic pumps in the "Porkhomenko Karaganda Engineering Plant" LLP (Karaganda, Kazakhstan).

The impeller of SCH15 circulation pump was taken for research (Figure 3).



Figure 3 Circulation pump

The corrosion preventing coating liquid was applied on impeller by method of spraying. And results showed that considerable changes did not occur.

The corrosion resistant fluid with halloysite was applied on impeller by method of dipping in hydrochloric acid and it was kept there 24 hours. Then the impeller was put into dryer.

The method of accelerated test was used to carry out experiments. According to them the preparation to tests included next stages:

- preparation of equipment and facilities;
- chamber was put on test regime without samples in it;
- measuring parameters of test regime;
- correction of determined values of concentration, temperature and relative moisture of corrosive medium;
- the test regime lasts no less than 24 hours, it is observed periodically. Then the chamber is switched off [3-4].

RESULTS AND DISCUSSION

According to results of test next functions were obtained – Figure 4.

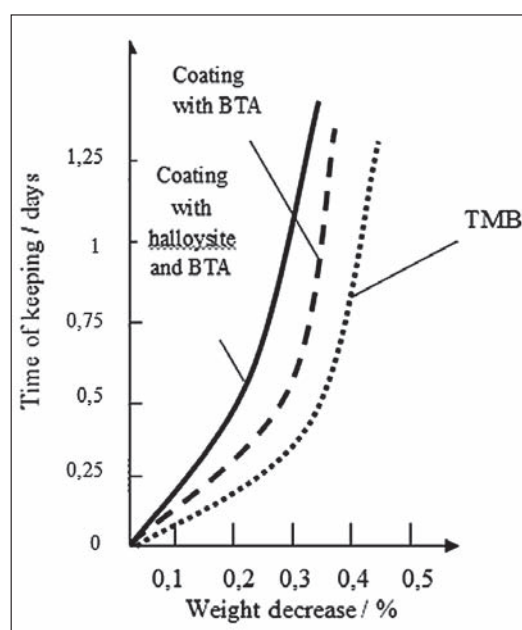


Figure 4 Curve of the corrosion resistance of coatings with different composition versus holding time in corrosive medium

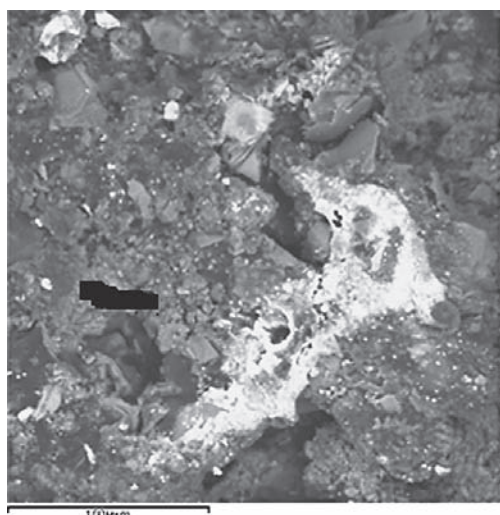


Figure 5 Coating on surface of hydraulic pump at x 800 fold magnification

Ammonium molybdate tetrahydrate (TMB) is an anticorrosive agent. In addition to its oxidation protection, this molecule can be considered as a heavy (electron-dense) radioactive tracer. In the preliminary experiment we were able to visualize TMB load in the cavities of nanotubes, there were aggregates with 5-10 nm diameter.

Benzotriazole (BTA) uses the functional groups of triazole, by its fixation with metal, to form protective layer on the surface of metal. A mechanism of corrosive inhibition of triazole is classified as an electrode reaction inhibitor, at the same time, they dissolve on the cathode side and influence on the reduction process. Later tests showed, that the layer resists mainly to the anode reaction.

It's clear that the best result is shown by coating from halloysite with benzotriazole. And coating composition is 100 % corrosion preventing substance + 42,5 % acetone + 10 % halloysite, it was observed with VEGA TESCAN electron microscope.

During research there was opportunity to observe chemical composition of formed coating, structure transfer of coating-substrate, different elements-impurities (Figures 5-7).

CONCLUSIONS

The composition with 100 % corrosion preventing substance + 42,5 % acetone + 10 % halloysite was recognized as the most appropriate for coating, and it provides the best corrosion resistance of hydraulic pump details. The impellers of circulation pumps for water delivery in heating system fail after 5 - 6 months because of the galling of work flutes, as water doesn't pass through the chemical purification. After applying corrosion resistant coating with halloysite the lifetime of impellers increases. The essence of which is dipping the impeller into hydrochloric acid with 24 hour keeping in it, then it is dried in dryer up to 4 hours. The lifetime of

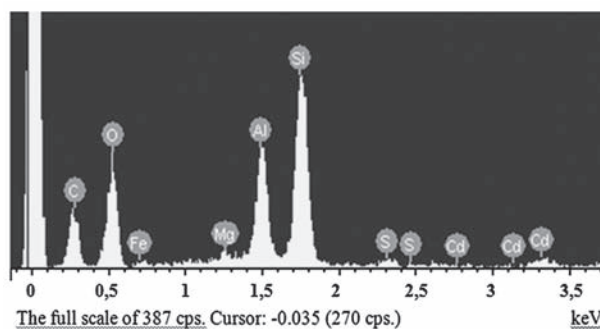


Figure 6 Chemical composition of 3 spectrum



Figure 7 Coating-substrate transfer at x 800 fold magnification

this impeller increases 1,8 fold and it was approximately 9 months.

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Note: The responsible translator for English language is N. M. Drag, Karaganda, Kazakhstan