анықталды. Көл суында темір мен мырыш нормаларының біршама асып кетуі байқалды. Сынамалардың 16,7%-ында көл суындағы мұнай өнімдерінің мөлшерінің артық болуы анықталды, бұл көлдің қорғалатын аумаққа жататын акваториясында антропогендік жүктеменің болуын көрсетеді. Тұрғояқ көлінің су сапасын зерттеу судың ауыз судың сапасына толық сәйкес келмейтінін көрсетті, әсіресе жазда, бұл су қоймасынан су қоймасына оңай тотыққан органикалық заттардың түсуінен болуы ықтимал.

***Түйін сөздер**: Турғояқ көлі, судың pH, судың мөлдірлігі, мұнай өнімдері, БОД5, КОД, темір, мыс, мырыш, марганец, қорғасын.*

POSSIBILITIES OF USING THE WATER OF LAKE TURGOYAK FOR DRINKING PURPOSES

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The article is devoted to assessing the suitability of Turgoyak lake water for drinking purposes. Water quality assessment was carried out according to the following hydrochemical parameters: BOD5, content of petroleum products, pH of water, compounds of copper, zinc, manganese, lead. It was revealed that according to indicators of pH of water, compounds of copper, lead, water of the lake in 2020. met the established norms. In the water of the lake, some excesses of iron and zinc norms were noted. An excess of the content of petroleum products in the water of the lake was found in 16.7% of the samples, which indicates the presence of anthropogenic load on the water area of the lake, which belongs to the OOPT. The study of the water quality of Lake Turgoyak showed that the water does not fully correspond to the quality of drinking water, especially in the summer period, which is most likely due to the introduction of easily oxidizable organic matter into the reservoir from the catchment.

***Key words:** lake Turgoyak, water pH, water transparency, oil products, BOD5, COD, iron, copper, zinc, manganese, lead.*

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STRUCTURE AND MECHANICAL PROPERTIES OF THE Ni-Cr-Al COATING OBTAINED BY DETONATION SPRAYING METHOD

***Abstract:** This paper discusses the results of studies of the properties of Ni-Cr-Al wear-resistant detonation coatings obtained at different values of the volume of filling the detonation barrel with an explosive acetylene-oxygen mixture. The thickness of the obtained detonation coatings NiCr-Al was 214-288μm. When the barrel is filled with an explosive gas mixture of 40%, the coating is not dense enough, with noticeable boundaries between individual particles, which may be the result of insufficient heating and acceleration of the particles of the sprayed powder. Higher values of microhardness were obtained at 50% filling of the barrel. The results of tribological tests of coatings have shown that the coating applied when the volume of filling the detonation barrel with an explosive mixture is up to 60 %, has a lower wear rate than other coatings. Visible that the mass loss at 50% of the detonation barrel filling volume is less than other coatings.*

***Key words:** detonation spraying, NiCr-Al coatings, structure, wear resistance, steel 12Kh1MF.*

Introduction

The influence of abrasive flows at high temperatures and oxidative effects with combustion products on the working surfaces of the boiler plant tubes brings to their active wear, loss of performance and failure [1]. One of the possible way to counteract these problems is to use wear-resistant coatings on the surface of the boiler plant tubes.

Owing to low porosity and good adhesion, detonation spraying can effectively reduce the interior diffusion of oxygen. This provides hard, wear-resistant and dense microstructural coatings and is the best method of thermal spraying [2]. Ni-Cr-Al based powders are traditionally used for applying wear-resistant gas-thermal coatings to constructional alloys. Ni-Cr-Al based coatings are characterized by relatively low wear resistance and high oxidation resistance (up to 1100 °C) [3].

In the technology of spraying detonation coatings, it is essential to identify the relationship between the technological modes of spraying and the quality of the resulting coatings [4]. One of the essential technological parameters of detonation spraying that affect the temperature and speed of movement of particles of sprayed powders is the filling volume of the combustion chamber with a gas mixture. This work is dedicated to the study of the effect of the barrel filling volume during detonation spraying on the wear resistance of Ni-Cr-Al coatings.

Materials and methods

For the substrate heat-resistant low-alloy boiler steel 12Kh1MF (equivalent to 14MoV63) was chosen. The samples were grinded to achieve a uniform and flat surface. After grinding the samples were sandblasted. A mixture of 90NiCr-10Al composite powder (wt.,%) was selected as the powder.

The CCDS2000 detonation system was used for obtaining coatings, which has a system of electromagnetic gas valves that regulate the supply of fuel and oxygen, as well as control the purge of the system [5]. The volume of filling the barrel with a mixture of acetylene-oxygen varied from 40% to 60%. Nitrogen was used as a carrier gas.

Research of the phase composition of samples were carried out by x-ray diffraction analysis using X'PertPro diffractometer using CuKα-radiation. For study the general nature of the structure was used an optical microscope «*NEOPHOT-21*». The tribological characteristics of the coatings were studied using a friction machine according to the scheme «ball-on disk» on the tribometer TRB3. The wear volume was determined using the model 130 profilometer. Tests of samples for abrasive wear were carried out according to the scheme "Flat surface – rotating disk" according to GOST 23.208-79. Wear resistance was estimated by weight loss. Weight loss was measured using the weight method on an ADV-200 analytical scale with an accuracy of 0.0001 g. The microhardness of the samples was measured by pressing a diamond indenter on the PMT-3M device in consent with GOST 9450-76.

Results and discussion

Figure 1 shows the microstructure of the surface and cross-section of Ni-Cr detonation coatings when the barrel is filled with an explosive mixture of 40%, 50% and 60%. When the barrel is filled with an explosive gas mixture of 40%, the coating is not dense enough, with noticeable boundaries between individual particles, which may be the result of insufficient heating and acceleration of the particles of the sprayed powder. With an increase in the volume of filling the barrel with an explosive mixture by 50% and 60%, there is an increase in the density of coatings.

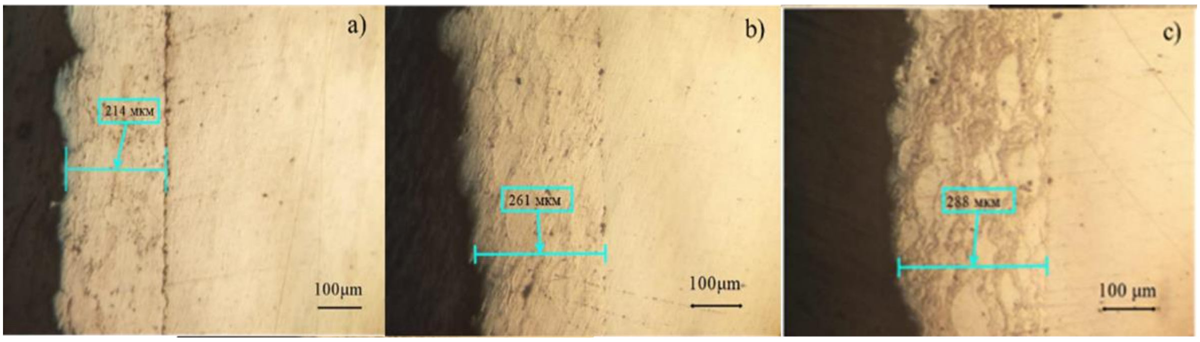

Figure 1 – Microstructure of Ni-Cr detonation coatings: filling volume of barrel 40% (a), filling volume of barrel 50% (b), filling volume of barrel 60% (c).

The results of X-ray phase analysis of coatings showed that the powder and coatings consist of CrNi3 phases (figure 2). The diffractograms do not contain aluminum phases due to their low concentration. With the increases filling volume, occurs the widen all X-ray peaks of the CrNi3 phase. On the diffractogram of the coating obtained when volume filling the detonation barrel with an explosive mixture up to 60 %, alongside with widening, a decrease in the intensity of X-ray peaks of the CrNi3 phase is occured. The increase in the intensity of all peaks may be due to the transition of a part of the substance to a nanophase or an amorphous state.

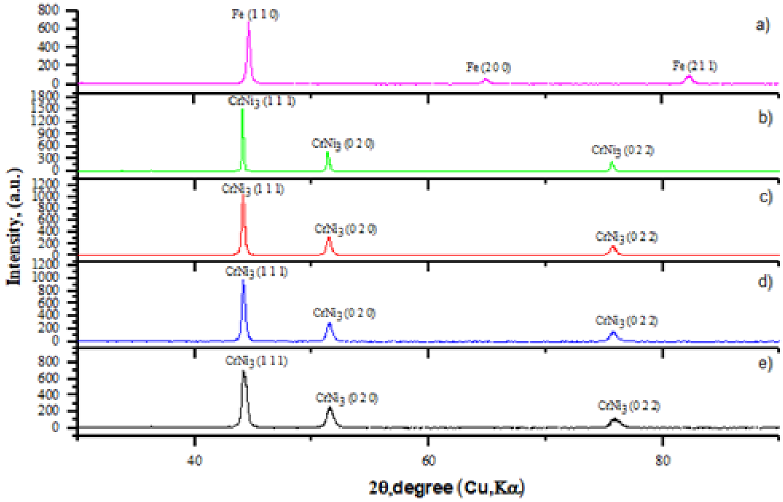

Figure 2 – Diffractogram of Ni-Cr coatings: (a) initial steel 12Kh1MF, (b) powder CrNi3, (c) filling volume of barrel 40%, (d) filling volume of barrel 50%, (e) filling volume of barrel 60%.

Figure 3 shows the results of tribological tests using the «ball-on disk» scheme of a based on Ni-Cr-Al detonation coating. As seen, the coating applied at the volume of filling the detonation barrel with an explosive mixture of up to 60 % has a lower wear volume than other coatings.

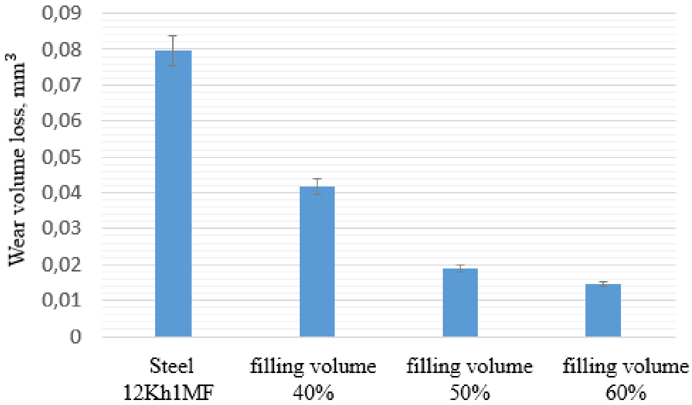

Figure 3 – The volume of wear of Ni-Cr-Al coatings at different filling volumes of barrel

The results of the abrasive wear test are characterized by a loss of mass sample after the testing. Figure 4 shows the loss mass values of 12Kh1MF steel samples with Ni-Cr-Al coating obtained at different values of the detonation filling volume of barrel. visible that the mass loss at 50% of the volume of filling the detonation barrel is less than that of the initial samples and 40%, 60% of the volume of filling the detonation barrel.

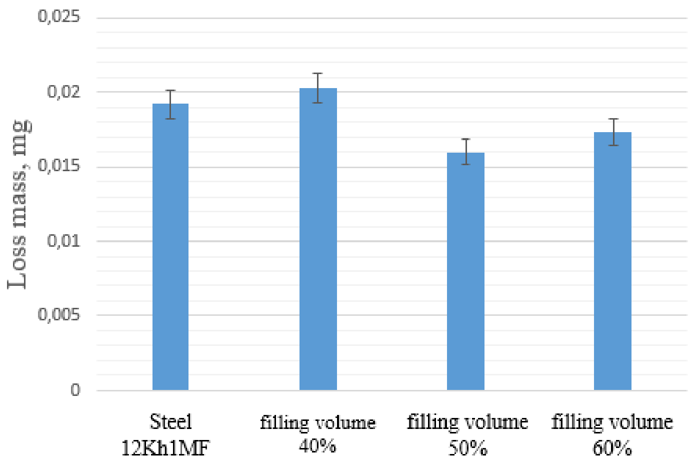

Figure 4 – Abrasive wear of Ni-Cr-Al coatings at different fill volumes of barrel

One of the most important properties of the coatings, which greatly affects the wear resistance, is the hardness. Figure 5 shows changes in the microhardness of a 12Kh1MF coated steel sample. When Ni-Cr-Al powders detonation sprayed, a coating with a higher microhardness is formed compared to the base material. When the barrel is filled with an explosive gas mixture of 40%, the microhardness compose 2570MPa, due to insufficient heating and acceleration of the particles of the sprayed powder. Higher values of microhardness were obtained at 50% and 60% filling of the barrel.

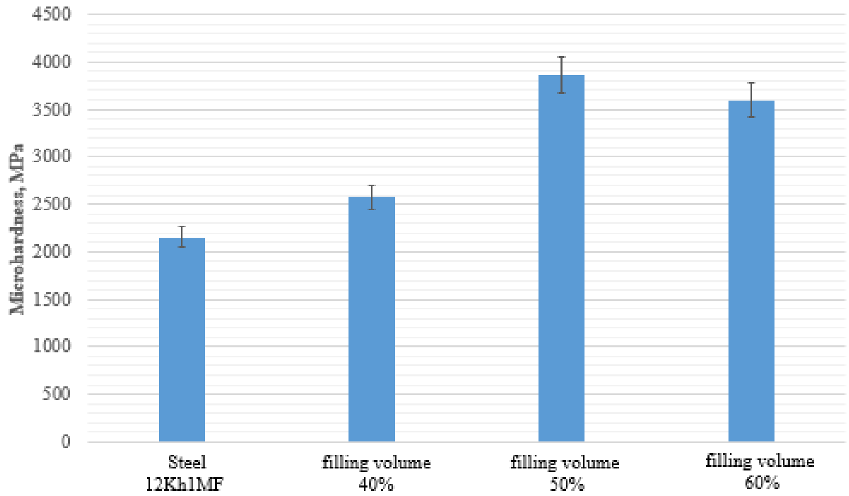

Figure 5 – Graph of changes in the microhardness of Ni-Cr-Al coatings: initial steel 12Kh1MF, filling volume of barrel 40%, filling volume of barrel 50%, filling volume of barrel 60%

Analysis of the obtained experimental results indicates that the properties of detonation wear-resistant coatings depend on the technological parameters of spraying. Based on the results, found that by varying the technological parameters of coating application, such as the percentage of barrel filling, the ratio of the gas mixture, it is possible to control the properties of wear resistance of coatings. Herewith, it is possible to determine the optimal conditions for the development of technological modes for obtaining Ni-Cr-Al coatings. An increase in the velocity pressure of detonation products is achieved by increasing the volume of the detonating mixture (or the degree of filling of the barrel of the detonation installation), which at the time of detonation match to a decrease in the specific volume of detonation products. Increasing the velocity pressure of detonation products contributes to the overall improvement of the quality of coatings, in particular wear resistance and microhardness.

Conclusion

Thus, the analysis of the obtained experimental results indicates that the wear resistance of detonation coatings depends on the technological parameters of spraying. When the barrel is filled with an explosive gas mixture of 40%, the coating is not dense enough, with noticeable boundaries between individual particles, which may be the result of insufficient heating and acceleration of the particles of the sprayed powder. It is determined that when the volume of filling the detonation barrel with an explosive mixture is up to 60 %, there is a widening and a decrease in the intensity of the main peaks. Higher values of microhardness were obtained at 50% filling of the barrel. The results of tribological tests of coatings have shown that the coating applied when the volume of filling the detonation barrel with an explosive mixture is up to 60 %, has a lower wear rate than other coatings. Visible, that the mass loss at 50% of the detonation filling volume of barrel is less than other coatings.

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ДЕТОНАЦИЯЛЫҚ БҮРКУ ӘДІСІ АРҚЫЛЫ АЛЫНҒАН Ni-Cr-Al ЖАБЫНЫНЫҢ ҚҰРЫЛЫМЫ МЕН МЕХАНИКАЛЫҚ ҚАСИЕТТЕРІ

М. Маулет, Ж.Б. Сағдолдина, Б.К. Рахадилов, Н.Е.Бердімұратов

Бұл жұмыста жарылғыш ацетилен-оттегі қоспасымен детонациялық оқпанды толтыру көлемінің әртүрлі мәндерінде алынған Ni-Cr-Al тозуға төзімді детонациялық жабындардың қасиеттерін зерттеу нәтижелері талқыланады. Алынған NiCr-Al детонациялық жабындарының қалыңдығы 214-288 мкм болды. Оқпан 40% жарылғыш газ қоспасымен толтырылған кезде, жабын жеткілікті тығыз емес, жеке бөлшектер арасындағы айқын шекаралар бар, бұл жеткіліксіз қыздыру мен бүріккіш ұнтақ бөлшектерінің үдеуінің нәтижесі болуы мүмкін. Оқпанды 50% толтыру кезінде жоғары микроқаттылық мәндері алынды. Жабындарды трибологиялық сынау нәтижелері детонациялық оқпанды жарылғыш қоспамен 60% - ға дейін толтыру көлемінде қолданылған жабынның басқа жабындарға қарағанда тозу дәрежесі төмен екенін көрсетті. Детонациялық оқпанды толтыру көлемінің 50% кезінде массаның жоғалуы басқа жабындарға қарағанда аз екенін көруге болады.

Түйін сөздер: *детонациялық бүрку, NiCr-Al жабыны, құрылым, тозуға төзімділік, 12Х1МФ болаты*

СТРУКТУРА И МЕХАНИЧЕСКИЕ СВОЙСТВА ПОКРЫТИЯ Ni-Cr-Al ПОЛУЧЕННОГО МЕТОДОМ ДЕТОНАЦИОННОГО НАПЫЛЕНИЯ

М. Маулет, Ж.Б. Сагдолдина, Б.К. Рахадилов, Н.Е. Бердимуратов

В данной работе обсуждаются результаты исследований свойств износостойких детонационных покрытий Ni-Cr-Al, полученных при различных значениях объема заполнения детонационного ствола взрывоопасной ацетиленово-кислородной смесью. Толщина полученных детонационных покрытий NiCr-Al составляла 214-288 мкм. Когда ствол заполнен взрывоопасной газовой смесью на 40%, покрытие получается недостаточно плотным с заметными границами между отдельными частицами, что может быть результатом недостаточного нагрева и ускорения частиц распыляемого порошка. Более высокие значения микротвердости были получены при заполнении ствола на 50%. Результаты трибологических испытаний покрытий показали, что покрытие, нанесенное при объеме заполнения детонационного ствола взрывчатой смесью до 60%, имеет меньшую степень износа, чем другие покрытия. Видно, что потеря массы при 50% от объема заполнения детонационного ствола меньше, чем у других покрытий.

Ключевые слова: *детонационное напыление, NiCr-Al покрытия, структура, износостойкость, сталь 12Х1МФ*