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STUDY OF CATODE MATERIALS IN THE ELECTROCHEMICAL METHOD OF WASTEWATER TREATMENT

Hapon Yuliana
PhD, Lecturer
Chyrkina Maryna
PhD, Associate professor
National University of Civil Protection of Ukraine
Kharkiv, Ukraine

Annotation: The study deals with an electrochemical method of wastewater purification as one of the modern and promising methods, shows its advantages over the traditional methods as well as the mechanism of action. The work shows a resource-saving way of galvanochemical deposition of coating with alloys of metals of the subgroup of iron (Fe,Co,Ni) with refractory metals. The prospect of alloy usage as the cathode material has been determined.
Key words: ammonia-citrate electrolyte, electrochemical purification, citrate-diphosphate electrolyte, cathode material, plating, cobalt-molybdenum-tungsten alloy, corrosion resistance, wastewater.

Recently, the technologies of wastewater electrochemical purification have been developing very actively. The main advantage of the methods of electrochemical purification is the fact that upon this method occurs an after purification of wastewater from substances, which are hard to remove upon the traditional purification, such as arsenic, antimony, selenium, or residues of metals like cadmium, nickel and copper. The electrochemical purification of industrial wastewater in a number of cases has advantages over wastewater treatment with reagents and other physical-and-chemical ways, since it allows extracting useful chemical products and metals, considerably simplifying the process flow of purification, reducing industrial spaces necessary for the arrangement of purification facilities.

The electrochemical methods of water purification include the processes of anodic oxidation and cathodic reduction, electroflocculation and electrodialysis. All these processes occur on electrodes upon direct current flow through wastewater [1, p. 233].

Electrochemical insoluble materials are used as anodes: graphite, magnetite, manganese and ruthenium dioxides, which are applied on titanium base. Cathodes are made of graphite, stainless steel, molybdenum, tungsten and their alloys, and also of other materials [1, p. 234].

The flow process of alloy synthesis includes preliminary mechanical preparation of part's surface, chemical degreasing, chemical etching, preparation or adjustment of complex citrate–diphosphate or ammonia–citrate electrolyte (table 1), the stage of cobalt-molybdenum-tungsten alloy electrical precipitation on ferrous and non-ferrous metals as well as finish operations of the stage of flushing and drying. Ternary alloy application process modes: constant current (cathodic current density j = 2–8 A/dm^2), pulse unipolar current (j = 4–20 A/dm^2). The process is conducted upon electrolyte heating (t = 20–60 ºC) and continuous agitation. The following materials are used as anode: soluble anode – cobalt plates, or insoluble – of «Ст.3» grade steel.

The calculated mass of chemical agents was separately dissolved upon agitating and heating in a small amount of bidistilled water, after which, the solutions were mixed in the following sequence, based the result of research of complexing mechanism [2, p. 681].

It is known that for intensification of the process of cyanides oxidation NaCl (sodium chloride) is preliminarily added to wastewater [3, p. 68], so one has to analyze the corrosion behaviour of synthesised alloy in a neutral medium adding chloride ions.

Table 1

Compositions of electrolytes for electrolytic precipitation of ternary alloys cobalt – molybdenum – tungsten

Electrolyte components		Concentration range, [mol/dm^3]	Solutions pH index
title	chemical formula		
citrate-diphosphate			
cobalt sulfate	$CoSO_4 \cdot 7\ H_2O$	0,1 – 0,2	
sodium molybdate	$Na_2MoO_4 \cdot 2\ H_2O$	0,04 – 0,12	
sodium tungstate	$Na_2WO_4\ \cdot 2\ H_2O$	0,06 – 0,16	8,5–10,5
sodium citrate solution	$Na_3C_6H_5O_7 \cdot 5{,}5\ H_2O$	0,2 – 0,3	
potassium diphosphate	$K_4P_2O_7$	0,3 – 0,7	
ammonia-citrate			
cobalt sulfate	$CoSO_4 \cdot 7\ H_2O$	0,2	
sodium molybdate	$Na_2MoO_4 \cdot 2\ H_2O$	0,03 –0,7	
sodium tungstate	$Na_2WO_4 \cdot 2\ H_2O$	0,06 – 0,1	
sodium citrate solution	$Na_3C_6H_5O_7 \cdot 5{,}5\ H_2O$	0,2 – 0,3	5–8
ammonium chloride	NH_4Cl	0,3	
sodium sulphate	Na_2SO_4	0,1	
boric acid	H_3BO_3	0,1	

The corrosion resistance of deposited coatings was determined by the method of polarization resistance – registering of cathode and anode potentiodynamic dependencies.

It has been established that for alloy coatings the corrosion behaviour depends on the composition of material, morphology of coating and acidity of medium. So, in a neutral medium (solution of 3% NaCl, pH = 7) the depth index of corrosion rate, depending on alloy composition, amounts to ≈ 0,032 mm / year (corrosion resistance class –2, highly resistant).

Thus, compositions of electrolytes for alloy Co–Mo–W galvanochemical synthesis to steel base have been studied. Based on the chemical properties of components and high corrosion resistance of alloy, the further prospect of using such material in the wastewater electrochemical purification as cathode has been determined.

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