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Research Article

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The conversion of thermal energy into electrical energy using graphite and lead electrodes

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ABSTRACT

The influence of the temperature difference in the electrode of the cell spaces on the electromotive force and SCC in the presence of an electrolyte in the red - ox system. It was found that using lead and graphite electrodes in the iron red - ox systems, you can create the conditions for the formation of EMF. It is shown that the maximum voltage in the galvanic couple Pb-C observed when the concentration of iron (II) 1 g / l of iron ions and (III) 1 g / l, a thermostatic at 90^{0}C and space cell, it is equal to 630 mV, and the value SCC ion concentration is set at the Fe (II) 20 g / l and is 3,5mA.

Keywords: reduction-oxidation potential, the electromotive force (EMF), short circuit current (SCC), the electrodes, the electrolytic cell.

INTRODUCTION

Nowadays renewable energy is growing sector of the energy sector and the global economy as a whole. With the development of renewable energy linked hopes for solution of complex socio-economic problems of today. These challenges include ensuring energy security of individual countries and regions, the eradication of energy poverty on our planet, the problems of employment of the population. Also, the development of renewable energy sources aimed at mitigating the global phenomena that affect the lives of virtually every inhabitant of our planet's climate change, which is not without reason, associated with the constant growth of the use of fossil fuels for energy, transport and industrial purposes [1].

The use of renewable energy sources is relevant for all countries in the world for various reasons. For industrialized countries dependent on imports of energy resources - it is primarily energy security, for industrialized countries, energy-rich - is environmental safety and developing countries - is the fastest way to improve the social conditions of the population [2].

Contribution to the development of renewable energy sources can be accomplished in several ways such as creation and improvement of these alternative sources, such as wind, solar, etc. Today it is carried out by many researchers.
It is important to resolve such problems and develop ways to convert some types of energy into another, such as converting thermal energy into electrical energy.

The aim of our work is to study the process of converting thermal energy into electrical energy using graphite and lead electrodes in the presence of electrolyte redox systems.

The most promising and environmentally friendly way could serve as chemical sources of electricity of thermal energy into electrical energy.

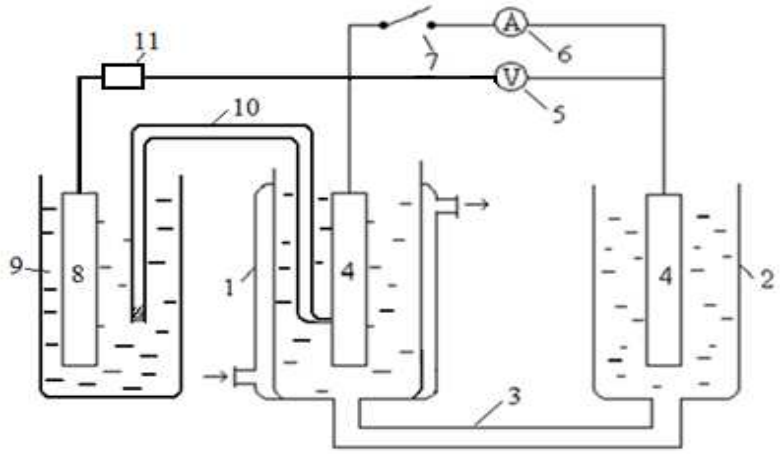
In this regard, it is relevant that the development and creation of ways to convert thermal energy into electricity

Laboratory installation for converting thermal energy into electrical energy is glass electrolysis with electrode spaces interconnected through a lower portion in the form of an electrolytic bridge tube (Figure 1). The electrolytic cell is filled with a solution of the test electrolyte. Single cell electrode space (conventionally note 1) has a thermostatic jacket, and where necessary it can be installed in any temperature within the range of 20-90 ^{0}C. It thermostated cell space (1) in which is located a working electrode (4) connected through the glass bridge (10) with the vessel (9) filled with a saturated solution of potassium chloride. In the vessel (9) is placed silver chloride reference electrode, which measure the relative potential at the working electrode (4). Glass bridge (10) is filled with the test solution. The electrolyte solution of sulfuric acid was used, and as the electrodes - graphite cylindrical in shape and lead plate.

Graphite - is an inert electrode, stable in aqueous solutions, and the lead is insoluble in sulfuric acid solutions electrode assumed in this connection that the lead electrode will exhibit a high resistance.

The influence of the temperature difference between the electrode spaces in the presence of a redox systems Fe (III) - Fe (II).

The authors of invention show that [3], the two electrodes when immersed in the aqueous electrolyte solution and create temperature difference in the electrode spaces in the system an electromotive force (EMF). Emf between the two electrodes in solutions with different temperatures and the amount of short circuit current (SCC) depend on the value of the temperature difference.



Picture 1 - Schematic diagram of the apparatus for carrying out research on the conversion of thermal energy into electrical energy

1 - thermostatically controlled space of the cell; 2 – not thermostatically space of the cell; 3 - a bridge to connect the electrode spaces, 4 – main electrodes; 5 - high-impedance voltmeter to measure the EMF; 6 - ammeter to measure the short-circuit current; 7 - key; 8 - a reference electrode; 9 - a container with a saturated solution of potassium chloride; 10 - a glass bridge filled with test solution; 11- potentiometer for measuring the electrode potential

It is known that the indicator electrode is immersed in solution containing ions of the oxidized and reduced forms, on the electrode mounted red - ox potential value is determined by the Nernst equation [4]: $= E^0 + \frac{RT}{nF} ln \frac{a_{ox}}{a_{Red}}$, Red, from which implies that the value of the redox potential, set on an inert electrode at a constant ion activity in the lower and higher oxidation depends on the temperature (T) solution.

When submerged graphite electrode in a sulfuric acid solution with concentration of 100 g / l, containing iron sulfate (II) and Fe (III) concentration of 1 g / l and 10 g / l, respectively, on the surface of the graphite electrode is set following equilibrium:

$Fe^{3+} + e \leftrightarrow Fe^{2+}$ $E_0 = + 0.77$ V (1)

When the electrode is immersed in a lead sulphate solution onto the surface of an insoluble compound formed - lead sulphate, and the electrode is an electrode of the second kind, i.e. lead covered his poorly soluble sulphate salt and sulfate-containing solution is in. It is established on the surface of the electrode equilibrium:

$PbSO_4 + 2e \leftrightarrow Pb + SO_4^{2-}$ $E_0 = - 0,36$ B (2)

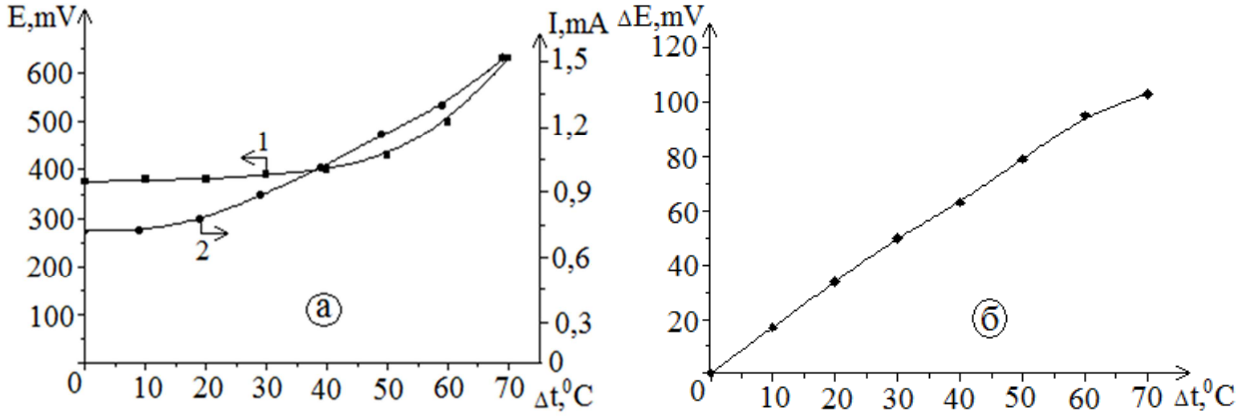
Thus, a galvanic couple forms with the theoretically calculated value of the EMF equal to: $E = E_1–E_2 = 0,77 +0,36 = 1,13$ V.

The influence of different parameters on the formation of short-circuits current and electromotive force, in a plating system Pb - C in sulfuric acid solutions containing ions of Fe (II) and Fe (III). This system can be represented as follows:

(t_0) Pb | Fe (III), Fe (II), | C (t_x),

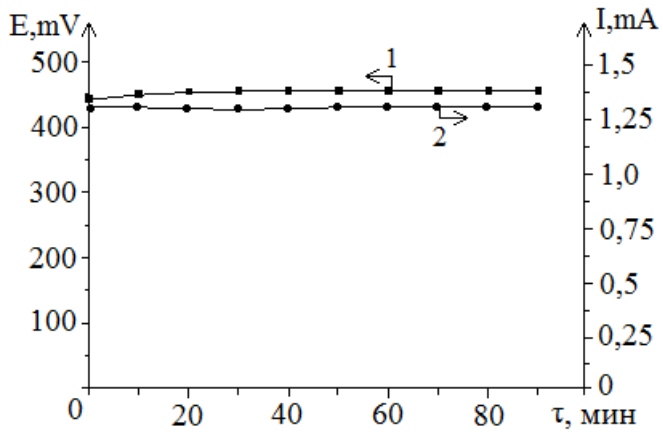
where t_0 - solution temperature in the second (2) thermostatic, t_x- first (1) (no thermostatic) cell space

Increasing the temperature significantly affects the growth of the Electromotive Force and SCC and the value of red-ox potential of the graphite electrode. Figure - 1 and when the temperature difference between the electrode spaces equal to 70^0C, and emf SCC, respectively, is 630 mV and 1.5 mA, the value of the redox potential of the graphite electrode is 103 mV (Pic. 2 b).



Picture 2 - a) the dependence of the change of the electromotive force (1) and SCC (2) between the lead and graphite electrodes on the difference in temperature; b) - impact of changes in temperature of the solution to change the red-ox potential of the graphite electrode

The duration of the experiment did not have a significant influence on the process, it is shown that at the end of 90 minutes the electromotive force and SCC remain constant and equal to 455 mV and the short-circuit current of 1.3 mA.



Picture 3. Changes on the values of EMF (1) and SCC (2) between the lead and graphite electrodes on the duration

Thus, firstly, we have found a solution of sulfuric acid in the presence of ions of Fe (II) and Fe (III) in the presence of a temperature difference between the cell electrode spaces between electrodes of lead and graphite formed EMF, the magnitude of which is much greater than the values in the EMF using two graphite electrodes. It has been shown

that increasing the concentration of the iron ions (II) and the space temperature in a thermostatic cell leads to an increase in short-circuit current and electromotive force electrochemical circuit. When on the surface of the lead electrodes and graphite flow redox reactions involving valence of iron ions present in the solution.

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