

**European Federation of Corrosion
National Academy of Sciences of Ukraine
Ministry of Education and Science of Ukraine
Ukrainian Association of Corrosionists
Karpenko Physico-Mechanical Institute
Ivan Franko Lviv National University
Ivano-Frankivsk National Technical University
of Oil and Gas**

XV International Conference

**«Problems of corrosion and
corrosion protection of materials»
(Corrosion-2020)**

(461 event of the European Federation of Corrosion)

ABSTRACT BOOK

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XV International Conference “Problems of Corrosion and Corrosion Protection of Materials“ (Corrosion-2020) was held at Lviv Palace of Arts on October 15-16, 2020. This Book of Abstract contains the results of studies are devoted to fundamentals of corrosion and corrosion assisted mechanical fracture; hydrogen and gas corrosion; new corrosion resistant materials; thermal spray, electroplated and other coatings; inhibitor, biocidal and electrochemical protection; testing methods and corrosion control; corrosion protection of oil and gas industry and chemical equipment.

In the authors edition.

Editorial board: ***S. Korniy,***
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CONFERENCE TOPICS:

- ◆ fundamentals of corrosion and corrosion assisted mechanical fracture;
- ◆ hydrogen and gas corrosion;
- ◆ new corrosion resistant materials and coatings;
- ◆ inhibitor and biocidal protection;
- ◆ electrochemical protection;
- ◆ testing methods and corrosion control;
- ◆ corrosion protected equipment of the oil and gas, chemical and energy industries.

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DEVELOPMENT AND APPLICATION OF MnO_x -BASED COMPOSITE FILMS*Poltavets V., Vargalyuk V.*

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Alternative energy devices have recently become particularly popular. Thus, electrode boilers for direct conversion of electric energy into heat can be installed in any type of premises, they allow to use previously installed pipes and radiators and achieve significant energy savings.

To ensure durability and reliability in operation, the working electrodes of such installations must have high thermal and corrosion resistance under the influence of strong electric fields. In addition, the decomposition of heat carriers, especially water, should not occur on the electrode surface during the operation of the heater, since the result of water splitting is an explosive mixture ($\text{H}_2 + \text{O}_2$).

The use of titanium, lead, nickel, and various steel marks as electrode materials in electrolyzers with the industrial voltage of 220 V is accompanied by their destruction and gas release. Considering the capability of $\text{Mn}^{3+} / \text{Mn}^{4+}$ redox system to provide high-speed cycling of electric charge at potentials significantly lower than the water splitting potential, we have developed composite MnO_x coated electrodes on metal oxidized substrate. Simple carbon steel was used as the substrate. The MnO_x film was deposited electrochemically from an electrolyte containing monobasic carboxylic acids. Mixed electroneutral complexes $[\text{Mn}(\text{L})_2(\text{H}_2\text{O})_4]$ formation ensured the deposition of MnO_x -based composite at low potentials. The corrosion resistance of the obtained composite films was very high. The industrial tests of the developed Fe, $\text{FeO}_y/\text{MnO}_x$ electrodes showed their ability to work for at least 10000 hours.

The potential of $\text{Mn}^{3+} \leftrightarrow \text{Mn}^{4+}$ reaction that ensures electric charge cycling is quite high. If 1 mg MnO_x is placed on an electrode with the geometric surface of 1 cm^2 , such a system will be able to pass an alternating current of 50 Hz with the Faraday component of the reaction $\text{Mn}^{3+} \leftrightarrow \text{Mn}^{4+}$ $\bar{I}_f = 77,8 \text{ A/cm}^2$.

The developed electrodes were introduced into the industrial production of electric boilers "Energy" with direct heat carrier heating of various capacities, which are used in residential premises and other facilities. Their long-term operation confirmed their high performance characteristics.