HOW TO ISOLATE RADIONUCLIDES? ON THE ELECTROCHEMICAL PURIFICATION OF TECHNOLOGICAL EQUIPMENT FROM RADIONUCLIDE CONTAMINATION — DEVELOPMENT BY CHEMISTS OF THE ACADEMY.

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Abstract. Scientists of the V.I. Vernadskii Institute of General and Inorganic Chemistry of National Academy of Sciences of Ukraine developed a method of electrochemical removal of radionuclide contamination from the surfaces of the technological equipment of nuclear power plants. The method was successfully tested at the Chornobyl nuclear power plant and on the Research Nuclear Reactor of the Institute of Nuclear Research of the National Academy of Sciences of Ukraine. Based on the results of the tests, a device for the electrochemical decontamination of metal surfaces of equipment in non-stationary conditions was created and design and technological documentation for its serial production was developed.

Key words: radionuclide contamination, nuclear power, electrochemical removal, surface, technological equipment.

Ukraine has its own nuclear power, which it will develop in the future. Therefore, the urgent tasks are to ensure a high level of safety of service personnel, to reduce environmental pressure on the environment. According to regulations, the equipment of nuclear power plants and experimental reactors (heat exchange equipment, pipelines and connections, devices for loading fuel elements, etc.) should be periodically inspected for damage and preventive repairs. During operation, this equipment is contaminated with radionuclides, becoming a source of increased operating and the

environment, so it requires decontamination. Given the events at the Chornobyl Nuclear Power Plant (ChNPP) in 1986, the problem of decontamination of technological equipment in Ukraine is even more acute than in any other country in the world. The need to decontaminate particularly valuable equipment and machinery requires the creation of effective technologies and equipment that would meet international standards.

Radionuclides accumulate mainly in the defects (microcracks and microcavities) of the surface layer of equipment formed by oxide

compounds. They (radionuclides) can be removed by mechanical, chemical and electrochemical methods. The thickness of this layer is estimated at about 50 μm .

Analysis of the current state of the problem showed that among the currently known methods of removing radionuclide contamination (these include chemical, mechanical, abrasive and electrochemical), only the electrochemical method provides high dissolution of the surface layer and high-quality decontamination at low specific consumption of reagents and electricity retaining the initial shape, size, quality of processing and mechanical properties of equipment surfaces.

The essence of electrochemical decontamination is to destroy the surface layer of contaminated equipment under the action of electric current (direct current, alternating current and alternating polarity) and to convert the elements that form it into compounds that accumulate in the solutions by which this operation is performed.

It should be noted that the known methods

of electrochemical removal of radionuclides in stationary conditions are practically not suitable for the decontamination of equipment of large overall dimensions. Such equipment requires the creation of baths of appropriate size, which causes high specific consumption of reagents and electricity, does not provide the removal of radionuclides from internal surfaces (eg, pipe surfaces).

The specialists of the VI Vernadskii Institute of General and Inorganic Chemistry of the National Academy of Sciences of Ukraine have developed a device that avoids these shortcomings.

The essence of the development is that the surface to be decontaminated is connected to the positive pole of a direct current (DC) source (or made one of the electrodes if alternating current AC is used). The cathode, which contacts the anode through a layer of porous dielectric material saturated with solution with which radionuclides are removed, is moved with it by translational movements (Fig. 1).

Fig. 1. The principle of extraction of radionuclides in the remote electrode mode from open (in the scheme on the left) and internal (on the right) surfaces.

The remote electrode (cathode) developed by scientists is equipped with a telescopic rod on which devices providing electric current supply, continuous supply of solution to a porous dielectric, movement of the anode surface

with the any inclination, fast replacement of the porous material when it is saturated with radionuclides are mounted, it prevents the service personnel from contact with the source of radioactive contamination (Photo 1).

Photo 1. General view of the remote electrode (left) and the working area without porous material.

Radionuclides that go into solution during electrolysis accumulate in the porous material. As the porous material, silica or basalt multilayer fabrics are recommended. They have a high ability to retain working solutions and sorb radionuclides that pass into solution during electrochemical treatment. The specific consumption of the solution when using these materials is estimated at approximately 3–4 ml / dm² of surface. In contrast to the stationary mode, the developed method allows to decontaminate the equipment without disassembly at the place of operation and without size restrictions.

In contrast to electrochemical decontamination in stationary baths, which is accompa-

nied by the accumulation of significant volumes of spent solutions contaminated with radionuclides, which, in turn, requires additional operations of decontamination, the use of a remote electrode allows to localize radionuclide contamination in small volumes of porous dielectric materials suitable for long-term storage or regeneration.

The equipment was created by scientists of the V. I. Vernadskii Institute of General and Inorganic Chemistry of the National Academy of Sciences of Ukraine and has been tested together with colleagues from the Research Nuclear Reactor of the Institute of Nuclear Research of the National Academy of Sciences of Ukraine (Photo 2, 4).

Photo 2. During electrochemical decontamination experiments and discussion of the results obtained at the Chernobyl NPP (left) and on the Research Reactor of the Institute of Nuclear Research of the National Academy of Sciences of Ukraine (right).

Photo 3. Fragments of equipment after electrochemical decontamination.

The obtained results showed that electrochemical decontamination allows to reduce the level of surface contamination of various

fragments of technological equipment to the standards that allow safe operation by service personnel.

Photo 4. From left to right: Corresponding Member of the National Academy of Sciences of Ukraine Anatoliy Omelchuk, Candidate of Chemical Sciences Inna Yudenkova, Candidate of Technical Sciences Mykola Maslo, Candidate of Technical Sciences Valery Shevel.

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**ЯК ІЗОЛЮВАТИ РАДІОНУКЛІДИ?
ПРО ЕЛЕКТРОХІМІЧНЕ ОЧИЩЕННЯ ТЕХНО-
ЛОГІЧНОГО ОБЛАДНАННЯ ВІД РАДІОНУКЛІД-
НОГО ЗАБРУДНЕННЯ – РОЗРОБКУ ХІМІКІВ
АКАДЕМІЇ.**

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Науковці Інституту загальної та неорганічної хімії ім. В. І. Вернадського НАН України розробили метод електрохімічного вилучення радіонуклідного забруднення з поверхонь технологічного обладнання атомних електростанцій. Суть електрохімічної дезактивації полягає у руйнуванні поверхневого шару забрудненого обладнання під дією електричного струму (постійного, змінного струму та змінної полярності) та переведенні елементів, які

його утворюють, у сполуки, що накопичуються в розчинах, за допомогою яких виконують цю операцію. Метод пройшов успішну апробацію на Чорнобильській атомній електростанції та Дослідницькому ядерному реакторі Інституту ядерних досліджень НАН України. За підсумками випробувань створено пристрій для електрохімічної дезактивації металевих поверхонь обладнання у нестаціонарних умовах і розроблено конструкторсько-технологічну документацію для його серійного виготовлення.

Ключові слова: забруднення радіонуклідами, ядерна енергетика, електрохімічне видалення, поверхня, технологічне обладнання.

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