

**Industrial Technology of Decontamination of Liquid Radioactive Waste
in SUE MosSIA "Radon" - 12371**

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ABSTRACT

SUE MosSIA "RADON" – this enterprise was created more than 50 years ago, which deals with the recycling of radioactive waste and conditioning of spent sources of radiation in stationary and mobile systems in the own factory and operating organizations.

Here is represented the experience SUE MosSIA "Radon" in the field of the management with liquid radioactive waste. It's shown, that the activity of SUE MosSIA "RADON" is developing in three directions - improvement of technical facilities for treatment of radioactive waters into SUE MosSIA "RADON" development of mobile equipment for the decontamination of radioactive waters in other organizations, development of new technologies for decontamination of liquid radioactive wastes as part of various domestic Russian and international projects including those related to the operation of nuclear power and nuclear submarines.

SUE MosSIA "RADON" has processed more than 270 thousand m³ of radioactive water, at that more than 7000 m³ in other organizations for more than 50 years. It is shown that a number of directions, particularly, the development of mobile modular units for decontamination of liquid radioactive waste, SUE MosSIA "RADON" is a leader in the world.

INTRODUCTION

Among the areas of industrial activity of SUE MosSIA "Radon" is the processing of non-nuclear fuel cycle LRW originated in the national economy of Russia. The majority of LRW streams are processed at the stationary ion exchange facility with the throughput of 4 m³/hr and at the mobile "Aqua-Express" facility with the throughput of up to 1 m³/hr comprising the filtration, ultrafiltration, and selective radionuclide sorption units. Now start to operate the new LRW decontamination facility with the throughput up to 10 m³/hr where the reverse osmosis, filtration, and selective sorption techniques are incorporated.

TECHNOLOGY

Since the middle 80s in SUE MosSIA "Radon" they started the design and construction of mobile LRW processing facilities based on the processes of filtration, sorption, ultrafiltration, electrodialysis, etc. Starting from the 1984, over 2500 m³ of LRW has been decontaminated

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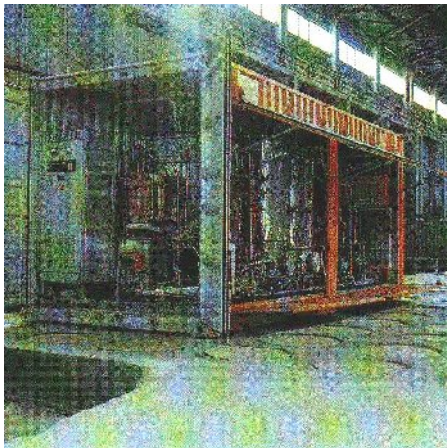
using the mobile MosSIA “Radon” facilities at special “Radon” combines located in Lvov, Riga, Volgograd, and Murmansk [1-4]. The mobile facilities (throughput with regard to the decontaminated radioactive effluent of 0.5-1 m³/hr) could be readily transported to the required site on a short notice by vehicle, railroad, or ship. Those were the facilities of “EKO” series – “EKO-1” and “EKO-2” mounted on the car trailer and “EKO-3” installed in a maritime container (see Fig.1). The facilities were set up based on modular principle as the LRW to be decontaminated varied greatly in composition even between the objects located on a single site. The mobile “EKO-3” facility comprising the filtration, selective sorption, and electro dialysis units allowed the efficient processing of the first 400 m³ of salt-bearing LRW originated at the “Zvezdochka” enterprise of the State Russian Nuclear Shipbuilding Center as a result of the repair and decommissioning of nuclear powered submarines. Decontaminated water has met the requirements of the sanitary norms for release of decontaminated effluents into an open basin [5, 6]. Further expansion of the waste type range for processing demanded to include the additional reverse osmosis module and reagent softening module equipped with electroosmotic



a



b



c

Fig.1. General view of “EKO” mobile facility series: a–“EKO-1”, b–“EKO-2”,c–“EKO-3”

concentrator. To date the upgraded “EKO-3” facility was used to process over 4000 m³ of salt-bearing LRW.

Since 2010 SUE MosSIA “Radon” started to operate the new LRW industrial decontamination facility with the throughput up to 10 m³/hr where the reverse osmosis, filtration, and selective sorption techniques are incorporated. General view of the reversal osmosis unit is given in Fig.2. Capacity industrial facility – 10 m³/hr.



Fig. 2. General view of reversal osmosis unit 10 m³/hr

SUE MosSIA “Radon” produces the filter- container including sorbents selective to ¹³⁷Cs and ⁹⁰Sr [7]. General view of the filter- container is given in Fig.3. Capacity each filter- container – 0.5-1.0 m³/hr.



a



b

Fig. 3. General view of filter- container for MLRW (a) and LLRW (b)

In cooperation with FSUE VNIHT the SUE MosSIA “Radon” has developed the electromembrane technology for producing primary products in uranium industry [8]. Yellow cake is obtained by treating the stripped product with ammonia salt solution produced as a result of the electrochemical decomposition of the uranium precipitation supernatant. Proposed

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electromembrane technology eliminates the need in the precipitating agent supply (ammonia water), prevents the accumulation of waste nitrate solutions, and produces the uranium concentrate (finished product) with high physical-chemical characteristics. Developed technology was successfully tested at the experimental electrochemical stand with the capacity of 50 L/hr by the stripped product. In 2006 a pilot membrane electrolyzer with the capacity of 0.4 m³/hr by the stripped product has been constructed (see Fig.4).



Fig. 4. General view of experimental electrochemical stand

Ultrafiltration for the alpha-bearing waste (LLRW and MLRW) decontamination was built based on a ceramic cylindrical filtering element with the pore size of 50 nm [9]. The principal decision that allowed a significant filtering time increase and a large gain in the concentrating factor was the application of tubular filtering cartridges made of ZrO₂ and α -alumina ceramics. The membrane structure is shown in Fig.5. Capacity test facility – 3 m³/hr. General view of the test facility is given in Fig.6. Capacity industrial facility – 20 m³/hr. General view of the industrial facility is given in Fig.7.

The LLW ultrafiltration unit permeate contains alpha-emitting radionuclides in the concentration 20-30 Bq/dm³. The LLW ultrafiltration unit concentrate contains 150 g/dm³ of suspended solids and is further concentrated using rotor-film evaporators with the shaft rotating speed of 150 RPM. The emerging slurry concentration of suspended solids is within the range of 200-250 g/dm³. It is loaded into 200 dm³ drums and conditioned using the IR drying process. After drying the drums are sealed tight and moved to the repository for long-term storage. The total LRW concentrating factor of the LLW and MLW processing facility reaches the value of 15000.

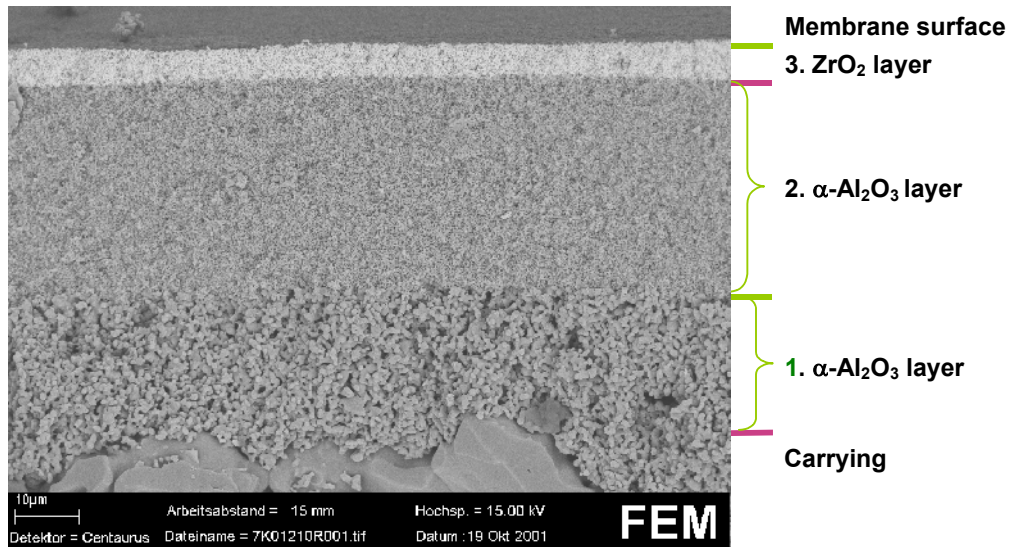


Fig.5. Cross-section view of the nano-structured ultrafiltration membrane



Fig. 6. Full-scale industrial prototype for the suspended solids concentrating



Fig. 7. General view of the industrial facility in processing building-up

In Fig.8 the general layout is shown of our mobile cementation facility for LRW. Capacity facility on cement solution– not less 0.5 m³/h.



Fig. 8. General view of mobile cementation facility

At SUE MosSIA “Radon” the technology for processing regeneration solutions of the ion exchange LRW decontamination stage has been developed and an experimental electromembrane complex has been constructed consisting of two electromembrane units as follows:

solutions of the ion exchange LRW decontamination stage;

the unit for concentrating alkaline regeneration solutions of the ion exchange LRW decontamination stage [10].

As a result of the work performed the possibility of processing acidic regeneration solutions of the ion exchange LRW decontamination facility using electrochemical regeneration stage of the nitric acid production unit has been shown.

The unit yielded nitric acid of over 70 g/l concentration and calcium-magnesium hydroxide-carbonate precipitate intended for the radioactive metal absorption. The alkaline regeneration solution concentrating unit allowed to reduce the volume of LRW for disposal.

Electromembrane method of liquid salt-bearing radioactive waste decontamination and concentrating is being continuously improved which is witnessed by patents of the Russian Federation [11-13].

RESULTS AND DISCUSSIONS

SUE MosSIA “RADON” has now developed three following directions - improvement of technical facilities for treatment of radioactive waters into SUE MosSIA “RADON” development of mobile equipment for the decontamination of radioactive waters in other organizations, development of new technologies for decontamination of liquid radioactive wastes as part of various domestic Russian and international projects including those related to the operation of nuclear power and nuclear submarines.

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CONCLUSIONS

1. SUE MosSIA "Radon" widely employs membrane techniques for the development of new technologies for processing and decontaminating LRW and other effluents.
2. In the development of mobile modular membrane LRW processing facilities SUE MosSIA "Radon" occupies one of the leading positions in the world.
3. During 50 years of its existence SUE MosSIA "Radon" processed over 250,000 m³ of radioactive effluents, more than 7000 m³ being decontaminated off-site at other organizations.

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