ABSTRACT

• The paper presents the results on the decrease in the activity of the beryllium sample after the studies carried out using the dry chlorination method [1] for the thermonuclear industry.
• Experimental work was carried out on the chlorination of beryllium and the separation of beryllium chloride from a mixture of products of the technological process.

BACKGROUND

• In the above studies, the problem of beryllium purification from radioactive nuclides, which are resulted from exposure to a neutron flux during operation as a plasma-reversible element of the first wall of thermonuclear reactors, was solved [2].
• ITER will require at least 50 tons of beryllium for the first wall of the vacuum chamber, which has to be replaced every 5 years of operation when the reactor is operating at rated power. At present, the total world production volume is only about 300 tons per year [3], therefore, the return of beryllium to the TNR production cycle is a necessity.

CHALLENGES / METHODS / IMPLEMENTATION

The dry chlorination method [4] of irradiated beryllium is shown in the Figure. The Be sample is heated in a reaction chamber to a temperature of 730 °С. Then the supply of Cl₂ is switched on. Based on the surface reaction between chlorine and irradiated beryllium, chlorides of the main radionuclides are formed: BeCl₂, CoCl₂ + 2HCl, etc. H₂ is supplied to the resulting gas mixture, which binds free Cl₂. Passing through a filter with a nickel element temperature of ~600°C, CoCl₂ is precipitated from the gas mixture, which undergoes a phase transition. Then the gas mixture is transported through the heat exchanger to the BeCl₂ collection tank, which is heated to a temperature of ~500°C. Then the gases HCl, ²HCl and H₂ are fed into the tritium chloride collection tank, where HCl and ²HCl dissolve in water, and an insignificant stream of H₂ was released into the atmosphere.

Measurements of the radioactive impurity activity in the samples of materials were carried out using the gamma-spectrometric complex “CANBERRA” InSpec-tor-2000 with the detector GC1518. The determination of the ²H content was carried out by liquid scintillation method on a beta-spectrometer “TRI-CARB 2900”.

CONCLUSION

• The measurement results confirmed the fact of a chemical transport reaction, during which purified beryllium chloride is separated from irradiated beryllium, cobalt chloride is deposited on an appropriate filter, and tritium chloride is partially dissolved in the tritium chloride storage ring.
• One of the key technological parameters that determine the productivity of the installation was calculated - the rate of surface interaction of beryllium and chlorine 0.115 mg/cm²·s⁻¹.

ACKNOWLEDGEMENTS / REFERENCES