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# Formation and transformation of physical and chemical iodine forms by foreign substances in the primary coolant

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Iodine radionuclides largely define radiation hazard at nuclear power plants under both normal operation and emergency. The factors that determine the high level of potential hazard of iodine are its volatility and a possibility to remain in various physical and chemical forms such as iodide (I-), molecular (I2), iodine organic, for example, methyl iodide (CH3I), iodate (IO3-) or periodate (IO4-). The problem of accidental release confinement requires considering the efficiency of capturing various physical and chemical forms of iodine using the existing methods. The most hardly perceptible are iodine organic compounds, in particular, iodide methyl that accounts for the main proportion of radioiodine organic fraction.
The life-time tests of naval marine nuclear prototype investigated the content of volatile forms of the iodine radionuclides in gas phase that are formed during the the primary coolant degassing while sampling. It was considered that partitition coefficient of volatile organic forms of iodine (primarly, iodide methyl) in water/gas system was from 3 to 5; partitition coefficient of volatile inorganic forms (primarly, molecular iodine) was from 20 to 200. The volatile physical and chemical forms passing from the coolant into a gas phase during sample degassing are defined only for the most long-lived radionuclides of iodine 131I and 133I. The fraction of volatile organic and inorganic forms of the iodine radionuclides passing into a gas phase does not exceed 3,3·10-2% and 2,5·10-4%, respectively.
Also, the life-time tests defined the fraction of iodate ions in the primary coolant. It was found that the fraction of iodate ion did not exceed 3,2% under steady-state operation of prototype facility, and after filtration process using ion-exchange filters the fraction considerably increased which can be indicative of various coefficients of iodide and iodate purification. The main form of iodine nuclides in the primary coolant is iodide form. The observed deviation of coefficient was related with reactor operating modes and disabling of filters. Content of the iodine radionuclides (as iodate ions) in the primary coolant depends not only on the reactor power operation, but also on concentration of ammonia. The regularities of iodate ions formation for 131I differ from regularities of iodate ion formation for other iodine nuclides (132I, 133I, 134I, 135I). It can be related with large life-time of 131I nuclide in the coolant. A certain dependence on ammonia concentration, and, accordingly, on pH is observed for 132I, 133I, 134I, 135I iodate ions. The content of 132I-135I iodate ions did not exceed 2-3% and did not depend on pH oscillations within admissible values of actual water chemistry.
The research of iodine radionuclide transformation in the coolant has been conducted at reactor power cutback 60% ⟶ 10% ⟶ 0%. The content of iodates in the coolant upon the first power transient did not change. The volume of iodates has considerably increased at reactor power reduction at the second transition to minimum controlled power level. After the reactor shutdown, the content of iodates of 131I and 133I has increased almost to 25%. This growth can be explained by the change of oxidation-reduction potential and decrease in coolant temperature when the reactor is shutdown.

**Primary author:** EPIMAKHOV, Vitalii (Russian Federation)

**Presenter:** EPIMAKHOV, Vitalii (Russian Federation)

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