

MEASUREMENT OF THE EFFICIENCY OF IODINE AND IODINE METHYL VAPORS ABSORPTION FROM THE VENTILATED AIRFLOW

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Facility for measurement of the efficiency of the iodine and iodine methyl vapors adsorption from the ventilated air flux is described. Different methods used for measurement of the adsorption filters cleaning coefficients are analyzed. Their sensitivity and optimal scheme of their usage is considered. It is shown that the "labeled atoms" method has the highest sensitivity but it is difficult and expensive, and the weight method is the most available and suitable for express-analysis of the efficiency of admixture adsorption.

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Main radiation danger for NPP stuff comes from isotope iodine-131 (half-life ~ 8.05 days) and iodine methyl due to their ability to accumulate in human body [1]. Carbon adsorbers AU-1500 are used for localization of such vapors in the NPP air ventilation systems. The main adsorber characteristics are working resources, efficiency of the cleaning from mixtures and aerodynamic resistance for given ventilated air fluxes. It is difficult to measure cleaning efficiency and to estimate working resource because of small concentration of the vapors of iodine-131 and iodine methyl. Bulk concentration of the iodine-131 vapors in the ventilated air during the normal functioning of the power plant at the adsorber input is $c_{in} \sim 2 \times 10^{-16}\%$ and at the output $c_{out} \sim 1 \times 10^{-18}\%$ [2]. Almost all methods of the measurement of efficiency of adsorption of mixtures small concentrations in the gas-carrier are based on their accumulation in the sorbing elements. In these methods at the adsorber input and output controlled gas flux is filtered through package of analytical adsorber filters or sticks where admixture component is accumulated.

Gas flux is taken till mixture weight accumulated in the package of adsorber filters or sticks will be sufficient for analysis. Flux values may differ for adsorber input and output and in this case weight of the admixture component is normalized by flux value to determine cleaning coefficient. Efficiency of the iodine and iodine organic compound adsorption by AU-1500 adsorbers is preferably to be measured in the real working conditions: first of all cleaning coefficient is measured at the plant-producer, then incoming test is done at NPP and then cleaning coefficient is periodically measured during exploitation.

Such measurements may ensure full control on efficiency of iodine and iodine compounds adsorption and working resource of the AU-1500 adsorbers, but such measurements are not done neither at the plant-producer, nor at the NPP. It may be probably caused by complexity of 'tracer elements' method, high-cost of measurement devices with necessary accuracy of activity measurements (10^{-14} Curie/l or 0.1 Bq/m³) and complexity of preparing and calibrating letting-to gas mixture with iodine-131 and iodine methyl. Efficiency of the radionuclide adsorption can be measured using real radioactivity of the ventilated air, but iodine(iodine methyl) vapors concentration is unstable, and in some ventilation lines is absent at all. That's why our propositions to measure cleaning coefficients for AU-1500 adsorbers using iodine methyl vapors at the working ventilation system weren't accepted at the ZaNPP. But at the Rovenskoi NPP integral cleaning coefficient for some adsorbers is measured by measuring the accumulation of radionuclides at the analytical filters at the input and output for the period of several days. Model tests are other method of determining of adsorber characteristics.

Gaseous scheme of stand for studying of efficiency of iodine and iodine vapors adsorbing by adsorber models in the conditions simulating NPP ventilation system is shown at Fig. 1.

Stand design is based on method of the sampling at the input and output of the adsorber model and accumulation of the sorbed admixture in the several analytical filters. Such method of concentration of small admixture component is used in many stand designs. Mass of the mixture sorbed in the analytical filters can be determined using the different methods: mass-spectrometric, weight, radioactive tracers,

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gamma-activation analysis etc. Method sensitivity defines the minimal concentration of the admixture in the ventilated air that can be measured. In our stand adsorbed admixture is determined by weighing the analytical filters at the weights VLR with accuracy $\sim 5 \times 10^{-6} g$ for filter mass $10 g$. Adsorbent mass in the analytical filters $\sim 1 \dots 1.5 g$. Previously regenerated activated fibrous carbon material AUVM "Dnepr" [3] is used as filter element in the analytical filters. Value of the sorbed admixture component

is determined as difference between mass of the analytical filters during sampling of the ventilated air with admixture component and mass without admixture component. Before each experiment analytical filters were being regenerated for 2 hour at temperature $350^\circ C$ and pressure 1 Pa. Value of the sampled fluxes is measured by PM-rotameters and is selected to don't allow the reaching of the admixture component the filter F3 and F9.

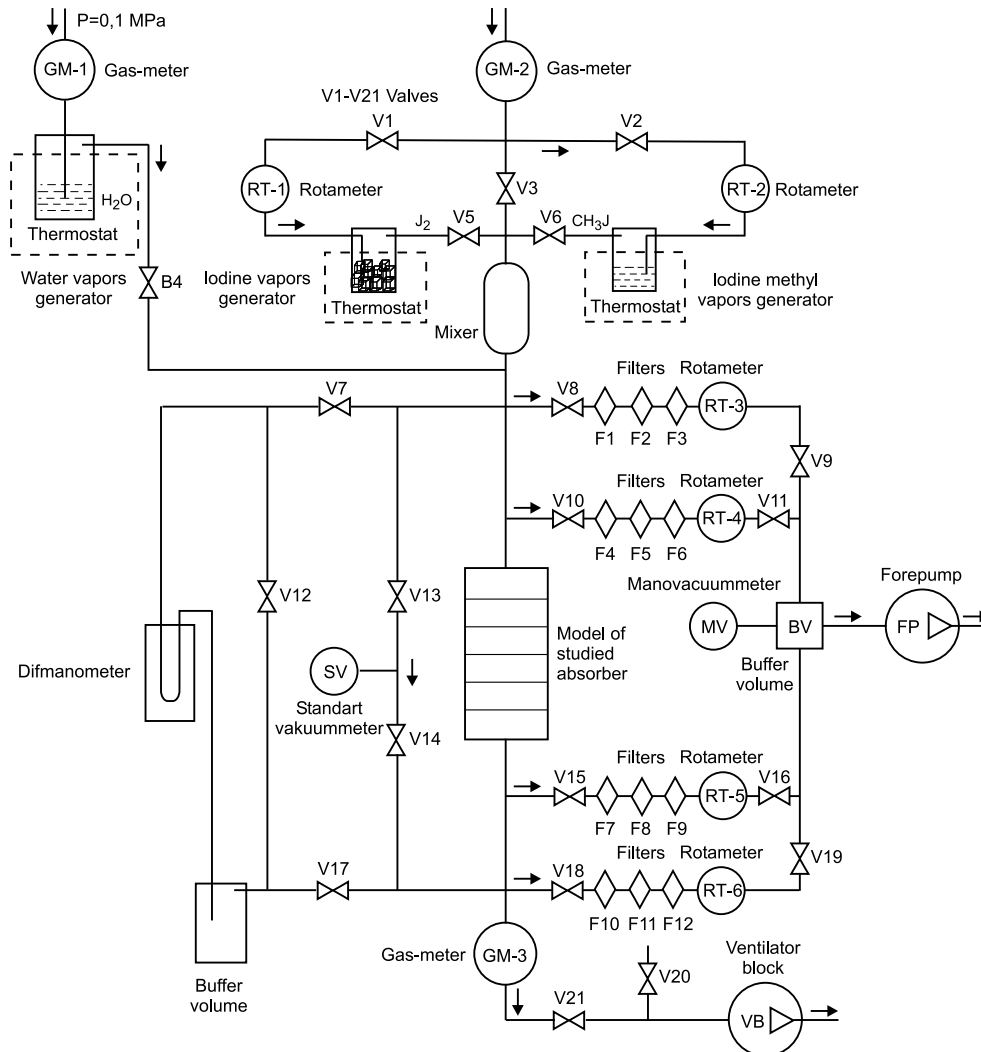


Fig. 1. Gaseous scheme of stand for studying of efficiency of iodine and iodine vapors adsorbing by adsorber models in the conditions simulating NPP ventilation system

Earlier sensitivity of the method of measurement of iodine (iodine methyl) vapors adsorption is determined by minimum admixture concentration in the air that can be measured via its accumulation at the analytical filters. From our analysis of different methods of measurement of admixture sorbed by analytical filters [4] it comes that method of iodine-131 radioactive tracers is the method of cleaning coefficient measurement with the highest sensitivity - $5 \times 10^{-14} \%$. Mass-spectrometric, weight, gamma-activation analysis have sensitivity $10^{-5} \dots 10^{-7} \%$.

All mentioned methods of measurement of adsorber cleaning coefficients on iodine and iodine methyl can be used only in model tests for admixture concentrations much higher than real ones for AU-1500 filters. Cleaning coefficient of the AU-1500 filter for input and periodical control can't be used by these methods, because adsorption volume in adsorber is drastically decreased during the measurements, resulting in working resource shortening. Adsorption volume corresponding to admixture partial pressure may be even fully filled up resulting in impossibility

of AU-1500 filter to adsorb the iodine and iodine methyl vapors from the ventilated air flux. Even one measurement of iodine vapor adsorption using the method with highest sensitivity - method of radioactive tracers will reduce the AU-1500 working resource by $(8 \times 10^4 \text{ hours})$ 9.1 years of continuous works that mean adsorber total fail. From the carried out analysis it is seen that radioactive tracers method is the best one that satisfy our requirements. Radioactive iodine methyl can be obtained on the basis of iodine-131 for measurements of cleaning coefficient by CH_3I . Measurement devices for determining the iodine-131 quantity are the most expensive part of the using of radioactive tracers method.

Our special stand for comparing measurements of the cleaning coefficients where weight method is used for high concentrations of admixture component can be used for express-analysis of efficiency of iodine and iodine methyl vapors adsorption in different adsorbents. These measurements together with other one will make it possible to choose the adsorbent that is the most suitable for AU-1500 iodine filters. Final conclusion about possibility of using of new adsorbent in NPP air ventilation systems will be done after measurements of cleaning coefficient at stand in Obninsk using the radioactive tracers method.

References

1. Y.V. Chechetkin, E.K. Yakshin, V.M. Yeshkon. *Cleaning of the NPP gaseous radioactive wastes*. M.: "Energoatomizdat", 1986, 149p. (in Russian).
2. V.G. Kolobrodov, M.A. Khazhmuradov. Development of the technology, design documentation and production division for regenerating of the spent filters of NPP ventilation systems // *Proceedings of the projects of program "Problems of resource and exploitation safety of constructions, building and equipment"*. Kyiv, Paton electric welding institute, 2006, p.206-211 (in Russian).
3. V.G. Kolobrodov, M.A. Khazhmuradov, T.K. Grygorova, et al. Studying of possibility of activated fibrous carbon materials "Dnepr" using in NPP ventilation and special gas cleaning systems // *Problems of Atomic Science and Technology. Series "Radiation damages physics and radiation material science"*. 2006, N4(89), p.104-110 (in Russian).
4. V.G. Kolobrodov, V.I. Sokolenko, M.A. Khazhmuradov. Some questions of measurement of characteristics AU-1500 adsorbents in NPP air ventilation systems // *Proceedings of II International Science and Practical Conference "Ecological safety: problems and ways of solving"*. Alushta, September 11-15, 2006, v.1, p.198-203 (in Russian).

ИЗМЕРЕНИЕ ЭФФЕКТИВНОСТИ ПОГЛОЩЕНИЯ ПАРОВ ЙОДА И ЙОДИСТОГО МЕТИЛА ИЗ ПОТОКА ВЕНТИЛИРУЕМОГО ВОЗДУХА

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Описана установка для измерения эффективности поглощения паров йода и йодистого метила из потока вентиляруемого воздуха. Сделан анализ различных методик, используемых для измерения коэффициента очистки адсорбционных фильтров. Проведена оценка их чувствительности и предложена оптимальная схема их использования. Показано, что наибольшей чувствительностью обладает методика "меченых" атомов, но она довольно сложная и требует значительных капиталовложений, а самая доступная и пригодная для экспресс-анализа эффективности поглощения примесей - весовая методика.

ВИМІРЮВАННЯ ЕФЕКТИВНОСТІ ПОГЛИНАННЯ ПАРІВ ЙОДУ ТА ЙОДИСТОГО МЕТИЛУ З ПОТОКУ ВЕНТИЛЮЄМОГО ПОВІТРЯ

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Описано установку для вимірювання ефективності поглинання парів йоду та йодистого метилу з потоку вентиляруемого повітря. Зроблено аналіз різних методик, що використовуються для вимірювання коефіцієнту очищення адсорбційних фільтрів. Проведено оцінку їх чутливості та запропоновано оптимальну схему їх використання. Показано, що найбільшу чутливість має методика "мічених" атомів, але вона досить складна і вимагає значних капиталовкладень, а найдоступніша і придатніша для експрес-аналізу ефективності поглинання домішок - вагова методика.