Radioecological monitoring of water resources in the Chernobyl exclusion zone

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Abstract – The general characteristic of water resources of the Chernobyl exclusion zone is presented. Methods of radiological monitoring of groundwater in Chernobyl exclusion zone is given. Monitoring results can be used for prediction the state of pollution and they are the basis for calculations of radionuclide migration in the Dnipro cascade. In closed ponds of exclusion zone for many years will be kept high levels of water pollution. The main factor in the self-cleaning of none closed water objects from pollution are internal processes and sedimentation in the soil. Water objects to compared with closed ponds relatively quickly cleared from radionuclides by constant washout.

Key words – environmental radiation monitoring, exclusion zone, radioactive pollution, radioactive elements, water resources, radioactive waste.

I. Introduction

The Chernobyl disaster is one of the largest and the most complex disasters in the history of nuclear energy, which made impact on the environment as Ukraine, Belarus, Russia and many European countries. But the most significant consequences were the ecological consequences of the disaster in areas directly near to the Chernobyl nuclear power station.

The Chornobyl exclusion zone is an open source of radioactivity, in which there are various types and forms of radionuclides, and it is the real potential danger for the population living in the surrounding area for the whole population in general. Therefore, a radiation monitoring is one of the main necessary measures.

The system of environmental radiation monitoring in the exclusion zone exist more than 25 years of formation and development in difficult conditions, which identifies high levels of radioactive contamination dynamics in time, anthropogenic activities. Conduction radiation monitoring made it possible to constantly monitor the radiation situation in the area of environmental objects exclusion. Monitoring results can be used for prediction the state of pollution and they are the basis for calculations of radionuclide migration in the Dnipro cascade. Also using these results we can determine the suitability of water for drinking water supply, for irrigation, definite priorities in water protection activities to reduce the negative impact of radioactive pollution on staff and the public.

II. Results and discussion

The aim of this work is evaluating the state of underground water resources in the Chernobyl exclusion zone on the results of radiation monitoring.

To achieve this goal we must define the dynamic distribution of 90Sr and 137Cs in water in the exclusion zone and conduct radiological assessment of water facilities in Chernobyl exclusion zone.

On figure 1 is shown placement of water resources and sampling points in the Chernobyl exclusion zone.

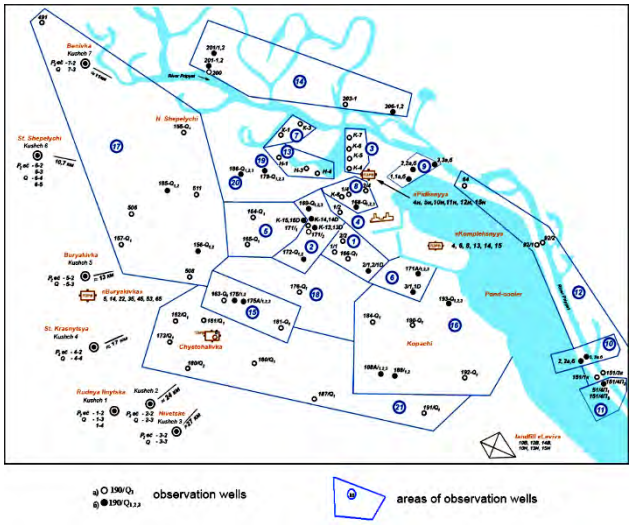

Fig. 1. Layout of network of observation wells in 2014

Monitoring of exclusion zone is a system of supervision component of State environmental monitoring system aimed at collecting, processing, transmission, storage and analysis of information about radiological stage of environment; forecasting its changes and development of scientifically-based recommendations for management decisions in accordance with the department program of emergency.

In the exclusion zone and mandatory evacuation zone, radiation monitoring of groundwater was carried in 138 wells, 21 of these is located in the network of operational radioactive waste. Temporary point of radioactive waste "Red Forest" in *districts of Budbasa and Yanivsky backwater* is controlled by 21 wells. In the district cooling pond involves 32 wells. Other wells located in places of temporary points of radioactive waste and characterizing groundwater in the regional plan.

All water samples were analyzed for contents of ^{90}Sr and ^{137}Cs. The value of the errors in the determination of volume activity of ^{90}Sr in water less than 2% when the content of a ^{90}Sr 1000-10000 Bq / m3, increasing to 2-3% at values not exceeding 1000 Bq / m3. Errors definitions of ^{137}Cs in the water in most cases do not exceed 3-4% in volume activity of ^{137}Cs within 100-200 Bq / m3, increasing to 5-9% at smaller values of ^{137}Cs in the water.

In monitoring wells located in certain areas with significant levels of pollution of groundwater and water supply networks in the city of Chernobyl, frequency control is 1 time per month on other places - 1 time per quarter, 2 times a year.

As a result of radiation monitoring of groundwater in water supply networks of the city. Chernobyl concentration of ^{90}Sr in water is within 1.5 Bq / m3, 137Cs within 1-10 Bq / m3.

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During 2014, using the existing network of observation wells of significant changes in trends in migration of radionuclides and radiation state of formation of groundwater is not fixed. This is due to instability of decrease migration or state of the network of wells and its practical impossibility to provide additional work.

In general, the process of migration of radionuclides from the temporary location of radioactive waste in 2014 was characterized by a certain stability in the annual intensity cut (with strong amplitude fluctuations content 90Sr).

As in previous years, the maximum radionuclide migration at observation wells is detected on such objects as districts of Budbasa, Yanivsky and Semyhodskyy backwaters and lake Azbuchyn, where volume activity of ^{90}Sr reaches respectively 140, 51, 70 and 47 kBq / m^3, the content of ^{137}Cs - 0,53, 0,26, 0,21 and 0.42 kBq / m^3.

According to the physical state of the objects such as points of radioactive waste and temporary points of radioactive waste in exclusion zone, and the total activity of groundwater pollution, the greatest danger in the near future will be on such objects as "Red Forest" - (districts of Budbasa and Yanivsky backwater), district cooling pond PC-14, district "Pidlisny" and Lake Azbuchyn. The smallest danger of groundwater pollution will be on objects in district "Buryakivka" and the solid waste landfill near village Leliv. Other objects are medium dangerous.

Lower rates of content of ^{90}Sr characterized the radiation state of groundwater within the "Red Forest" near the village Lisovyy. The maximum volume activity of ^{90}Sr is 8 kBq / m^3 which fixed in water wells K-13.

The maximum content of ^{90}Sr is fixed in the water well number 2A near the lake Azbuchyn - 47 kBq / m^3. The maximum volume activity of ^{90}Sr in district of the cooling pond is fixed in the well 3b (PC-14) - 9.3 kBq / m^3.

In general, the nature of the dynamics of volume activity of ^{90}Sr in water wells in different areas near plants and the first flood terraces with large amplitude oscillations (depending on the conditions of formation) does not give grounds to assert neither depletion of sources of radionuclides nor their building.

The problem of ^{137}Cs, in general, in the water drinking supplies and in the groundwater currently is not relevant. Only water wells in some areas in districts of Budbasa with high levels of surface pollution and Yanivsky backwater, volume activity of ^{137}Cs is 0.2-0.5 kBq / m^3. Background volume activity of ^{137}Cs in the water wells is about 0.06 kBq / m^3.

The content of ^{90}Sr in water wells near Lake Azbuchyn in September 2014. (right bank of the River Pripyat) reaches a value of 20-47 kBq / m^3. The persistent concentration of ^{90}Sr, with some tendency to increase, there are in water wells that characterize radiation state of the flow of the River Pripyat. In water wells number 1 in district of the lake Azbuchyn (which is located about 150 meters upstream from the railway bridge and 15-20 m from the water district of the River Pripyat) concentration reaches to 18 kBq / m3.

Conclusion

We can make decision about the main sources of radioactive pollution of groundwater and formation water resources of radionuclides are stocks of radionuclides, which are concentrated in temporary points of radioactive waste and distributed in natural landscapes. The volume activity of ^{90}Sr, as the main pollutant in the water of certain areas of the wells in districts of Budbasa, Yanivsky and Semyhodskyy backwaters reaches respectively 140, 51 and 70 kBq / m^3. Outside the area of temporary points of radioactive waste majority of content of ^{90}Sr is within 0.1-0.4 kBq / m^3, ^{137}Cs - 0,01-0,04 kBq / m^3. Results definitions of radionuclides mainly are formed by the specific conditions and geological structures of wells.

Today there is a problem of informative of network's supervisory wells and control of migration of radionuclides in the zone of aeration, which is aggravated. Therefore, the problem of assessing the impact of items radioactive waste and temporary points of radioactive waste in radiological groundwater is more urgent now.

Further development of radiation monitoring of groundwater is associated with the urgent need to improve the state of knowledge of problems of redistribution and migration of radionuclides in water resources. For this purpose it is necessary to perform additional drilling observation wells, determination of macro and micro components of groundwater geochemical environment indicators migration, hydrogeology parameters and zone aeration and periodic technical inspection of existing observation wells using geophysical methods for wells.

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