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ON CHARACTER OF EJECTION OF RADIONUCLIDES OUT OF THE EARTH SURFACE

Ž.Vuković[*], I.V.Melikhov[+], V.Šipka[*], D.Todorović[*]

[*]Radiation and Environmental Protection Department,
Nuclear Sciences Institute Vinča, P.O.Box 522,
Belgrade, Yugoslavia

[+]Faculty of Chemistry, Lomonosov State University,
Moskow, Russia

ABSTRACT

Results of systematic measurements of radioactivity in the ground layer of atmosphere from 1981-1991 at the check points of Nuclear Science Vinča near Belgrade were analysed with the aim to find relations that accompany changes in ejection of radionuclides from earth surface to atmosphere.

The analysis show that average daily activity of radionuclides changes impulsively and as rule, increases within 1-2 days than decreases after 1-4 days. Those changes are the results of random-ergodic processes characterized by distribution density which changes in accordance to Fokker--Plack-equation.

INTRODUCTION

Earth surface constantly ejects radioactive materials (gas products of uranium and thorium, radionuclides in erosive products, etc.) (ref 1,2). The intensity of ejection of radionuclides varies within the wide range, due to the influencing changes of seismic, meteorological and biological conditions (ref 3,4). In relation to this, a problem of determination of the regularities that accompanies the ejection of radionuclides, has appeared. In spite of many efforts, a problem as such is still unsolved. Therefore, in order to contribute to its solution, we have analysed many years data on radioactivity of the ground layer of the atmosphere, which were obtained from the results of monitoring of human environment. This analysis has shown that the process of ejection of radionuclides has been impulsively carried out, whereas the occurance of impulse represents the results of ergodic-random process, characterized by distribution density which changes in accordance to Fokker Planck equation. Symbolically speaking, the earth breathes, impulsively throwing out radioactive materials to the atmosphere.

RESULTS

The results of measurement of beta activity of filter during 1981-91 period show that activity of radionuclides on every examined part changes in accordance to equation

$$\frac{\partial \varphi}{\partial t} = \frac{\partial}{\partial A} \left| (\lambda A-G)\ \varphi + \frac{\partial}{\partial A} (D\varphi) \right| - q\varphi, \quad \varphi(\infty,t) = 0 \qquad (1)$$

where: $\varphi = \frac{\partial N(A)}{\partial A}$, N(A) part of air samples in samples in which radionuclide concentration is more than A at time t, λ-decay constant of radionuclides, G and D are rate of directed changes of A and coefficient of its fluctuation, q-intensity of changes of φ.

The following arguments can serve as the proof of the validity of equation (1).

Local concentration of β active short lived radionuclides ($t_{1/2}<15^h$) in the ground floor layer at three check points near Institute of Nuclear Sciences Vinča-Beograd during 10 years period has changed in accordance with equation (1).

The radioactivity control was performed by standard method of measuring filter samples during 24 hours. Determination level to being 0,2 mBq/m³.

Activity (A) distribution from 1981-91 years excluding one year period after Chernobyl accident are described by the equation:

$$N(A) = \mathrm{erfc}\, \left|\alpha/\beta\ \left(\frac{A}{A_y} - \beta\right)\right| \cdot (1+\mathrm{erf}\cdot\alpha)^{-1} \qquad (2)$$

where: A_y average years values of A, $\alpha=0.68\pm0.2$, $\beta=0.75\pm0.02$. Solving the equation (1) at condition $\partial\varphi/\partial t=q=0$, $G^2/2D\lambda=\alpha$ and $G/\lambda B_y=\beta$ we obtain equation (2).

Local concentration of long lived radionuclides in near surface layer of air has changed impulsively and as a rule, increases within 1-2 days, than decreased after 1-4 days, often down to the identification level (Fig.1). Frequency of impulse appearance was 0.35 i/day and its amplitude $A_1 = \frac{1}{m}\sum_{i=1}^{m}(A_i - A_o)$ were distributed in accordance with formula (2) at $\alpha=0.61\pm0.02$, $\beta=0.60\pm0.02$, where m is number of days in one impulse, A_i, daily activity.

Distribution density of impulses amplitude can described by the equation:

$$\varphi(A_1) = \frac{0.71\pm0.3}{A_y} \exp\left|(-1.03\pm0.05)\ (A_1/A_y - 0.60)^2\right| \qquad (3)$$

The analysis show that equation (3) reflect changes in ejection of radioactivity out of earth surface. Those changes are the results of random ergodic processes characterised by distribution density which changes in accordance to Fokker Planck equation.

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Fig.1. Radioactivity of air at Chekpoint I
Serial begining 1.10.1989.