MONITORING OF PROCESSES WITH GAMMA-RAYS OF NEUTRON CAPTURE AND SHORT -LIVING RADIONUCLIDES

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Elemental content is a fundamental parameter of a substance, on which all its properties and character of physical, chemical, biological, technological and ecological processes depend. Therefore monitoring of elemental content (in the course of technological process – "on line"; in natural conditions – "in situ"; or in living organisms – "in vivo") becomes necessary for investigation of aforementioned processes.

This problem can be successfully solved by using the methods of prompt gamma activation analysis (PGAA) and instrumental neutron activation analysis (INAA) on short-living radionuclides. This methods do not depend on the type of substance (biological, geological, technological etc.) , since the content is determined by gamma radiation of nuclei, and allows a

serious requirement like the necessity of achieving a minimal irradiation of the object of investigation, and its minimal residual activity.

Purpose of this work is calculation of the minimal determinable concentrations of various elements based on experimental data by using: 1. Neutron capture gamma-ray spectrometry (PGAA) with using radionuclide ^{252}Cf - source of neutrons with the yield of 10^8 neutron/sec. 2.Instrumental activation analysis (INAA) on short-living radionuclides.

Measurements were carried out on the experimental device with preliminary focusing of neutrons [1]. Analysis of literature shows that for monitoring of processes (technological, biological, physical, chemical) by elemental content of substance it is advantageous to use the PGAA method [2,3].

The table below shows parameters of elements which can be used for monitoring of many processes (gold mining, manufacture of copper (Cu), cement, coal and other production).

Elements	Sensitivity factor	Analytical lines, keV	Minimal industry valuable contents, %	Minimal determinable contents, %
H	33	2223	-	0,05
B	5900	478,8	0,06	0,001
N	1,5	1885	10	0,4
S	1,5	840,3	5	0,3
Cl	9,7	1165	20	0,03
K	2,8	770,4	8	0,1
Ca	0,9	1942	20	0,4
Ti	4,3	1381	2	0,03
V	1,1	645,7	0,3	0,2
Cr	2,7	835	20	0,1
Mn	0,8	1747	25	0,2
Fe	0,5	1725	20	0,3
Cd	1551	558,5	0,1	0,001
Sm	1362	439	0,02	0,0002
Eu	114	221	0,002	0,0005
Gd	1302	944	0,01	0,0002
Hg	26	1693	0,1	0,01

The instrumental neutron – activation analysis (INAA) on short-living radionuclides also allows express determination of elemental content of substance and monitoring of many processes. The monitoring of the following elements for needs of industry: Mg,Al, Ti, V, Fe, Mn, Cu , etc, is very often necessary.

Nuclear physical parameters of these elements are shown below:

Mg^{27}, $T_{1/2}$ = 9,5 min., E_γ= 844 keV and 1014 keV.
Al^{28}, $T_{1/2}$ = 2,31 min., E_γ = 1778 keV
Ti^{51}, $T_{1/2}$ = 5,8 min., E_γ = 320 keV and 928,5 keV
V^{52}, $T_{1/2}$ = 3,75 min., E_γ = 1434 keV
Fe^{53}, $T_{1/2}$ = 2,58 min., E_γ =701 keV and 1011,5 keV
Mn^{56}, $T_{1/2}$ = 2,6 h. E_γ = 846 keV.

For express determination of these elements on short-living radionuclides with good sensitivity it is necessary to use a neutron source with larger yield or a nuclear reactor. Monitoring of processes with short-living radionuclides has the following advantages:

a) one can get high activity in short time;

b) elements with long-living radionuclides appear less.

REFERENCES

1. Aripov G..A., Kurbanov B.I. "Device for determination of element content of a substance". Patent of Rep.of Uzbekistan. 1DP 04491, 2001.
2. Kartashev E.R., Shtan A.S. "Neutron methods of analysis of content of a substance". M.; Atomizdat, 1978, 160 p.
3. Guma V.I., Demidov A.M., Ivanov, V.A., Miller V.V. "Neutron radiation analysis". M.; Energoatomizdat, 1984, 64p.