

DETERMINATION OF THE ^{14}N TO ^{15}N RATIO IN NITROGEN-CONTAINING SAMPLES

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It is known that nitrogen nutrition plays very important role in increase of plant crop and the albumin content in food rural cultures. Producers widely use nitrogen fertilizers. Their non-controlled or too extensive use can lead to contamination of air and water, resulting in hazardous sequences for human health and environment.

The studies related to determination of nitrogen nutrition efficiency are based on utilization of the ^{15}N isotope, in view of determination of the best forms, time and place for introduction of nitrogen fertilizers, in order to provide the most reasonable nitrogen consumption by plants, avoiding waste and reducing the nitrogen fertilizer volumes required for obtaining a desired level of crop [1].

In the course of natural experiments, scientists of various countries studied the processes of nitrogen consumption by plants from fertilizers, the processes responsible for nitrogen fixing in soil, nitrogen losses in a gaseous form or in liquids, in a form of solutions with ground water. The studies have shown that a fresh organic mass (manure) introduced to soil causes acceleration of decomposition of organic substance and renewal of the humus composition in soil. These phenomena can be detected by means of radioactive or stable isotopes [2].

Agricultural lands throughout Kazakhstan are characterized by various spectra of the soil agrochemical properties. Every zone requires the specific technology for utilization of nitrogen fertilizers, depending on types of soils, plant species, conditions of environment. In the frame of these studies, the Kazakhstan scientists can arrange the special data bank and use various a variety of nuclear-physics techniques in combination with modern bio technologies.

Determination of isotope composition of chemical compounds is performed traditionally by means of emission spectrometers and mass spectrometers. It should be marked that the efficiency of the industrial-production emission spectrometers is insufficient for isotope studies with the labeled nitrogen, depleted relatively to ^{15}N , or for the studies requiring small spread in isotope composition of a labeled nitrogen, compared to natural one.

In this work we have applied an alternative technique based on nuclear –physics techniques of investigation of the element composition. Trial of the technique for determination of the percentage of ^{15}N in a nitrogen fertilizer is based on measurement of energy spectra of the

elastic scattered deuterons from the nuclei entering the composition of ammonium sulphate (natural fertilizer).

Measurement of the scattered particle energy spectra were performed at the angles 60 and 90° at the INP cyclotron 25-MeV deuteron beam.

The film of the ammonium sulphate deposited onto a thin aluminum oxide film is used as a target. In all experiments the targets have a thickness of an order of one mg/sq. cm. In this work we have studied nitrogen fertilizer with non-enriched labeled atoms of ^{15}N .

According to the scattering kinematics, the difference in energies of elastically scattered deuterons from nuclei of ^{15}N and ^{16}O comprises 400 and 700 keV respectively for the angles mentioned before. Isolation of scattered particles from the accompanying reaction products is carried out on a base of the standard dE-E technique for identification of particle sorts. The energy calibration of the system registration channels is produced on a base of the scattered particle spectrum on a thin polyethylene film (see fig. 1). As figure shows, prominent peaks of the (in)elastically scattered particles from nuclei of oxygen and carbon are observed. Processing the energy spectra from the ammonium sulphate film provides clear separation of elastic peaks originating from nuclei of (natural) nitrogen and oxygen beginning with the angle 60° with an accuracy not worse than 2 to 3% (figure 2). Thus, if ^{15}N is present in a sample, the separation like this can be reached at 90°. In figure 3 the energy spectrum of scattered particles from the target enriched with respect to boron-10 is presented. A comparative measurement of the concentration of boron-11 in the target enriched relatively boron-10 has allowed determining a fraction of the heavier isotope in the target with an accuracy 0.15 ± 0.005 .

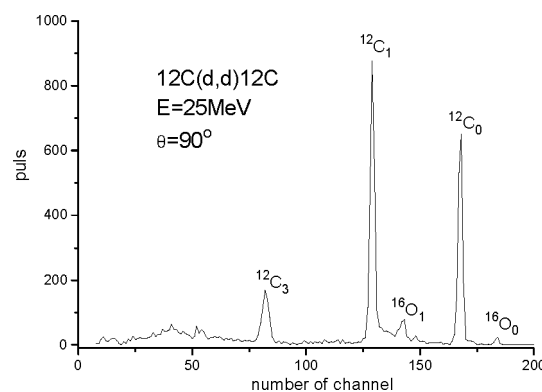


Fig.1. The energy spectrum deuterons scattered from polyethylene film

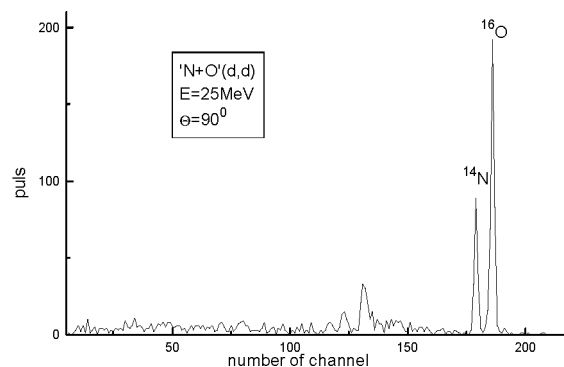


Fig. 2. The energy spectrum deuterons scattered from ammonium sulphate

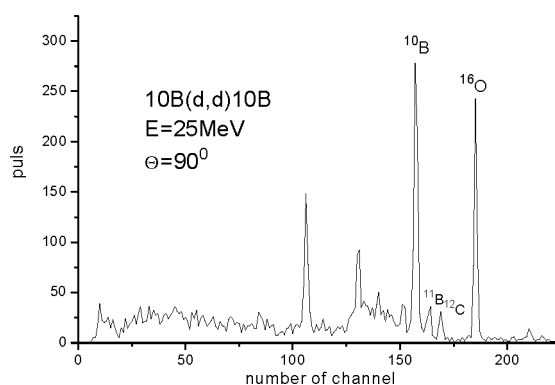


Fig. 3. The energy spectrum deuterons scattered from the boron film

Use of the energy spectra of elastically scattered alpha particles can increase the accuracy in determination a percentage of a content of ^{15}N in sample, at least, twice at the expense of a steeper trend in kinematics of elastic scattering.

Thus, with this technique, one can determine reliably the concentration of the ^{15}N isotope in nitrogen-containing samples with an accuracy not worse than 2 to 5%, if they a nitrogen fertilizer up to 10 to 15%.

REFERENCES

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2. Annenkov B.n., Yuditseva E.V. Basis of agricultural radiology. Moscow: Agropromizdat, 1991, p. 287.