

THE INVESTIGATION OF DYNAMIC OF SORPTION PROCESSES IN THE SYSTEM “COMPOSITE ADSORBENT – HETEROGENEOUS MEDIUM”

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Introduction

After accident of Chernobyl power station in 1986 almost 9 millions hectares of soil, 5 millions of which are agricultural ones [1], have been polluted by radioactive substances. The polluted ground is the main accumulator of long-living radionuclides. The letter stays in it for a longest time in comparison with other links of biological chain [2]. The polluted of ground by radionuclides causes not only the high radiation level, but also danger of agricultural products' contamination. That's why the problem of soils purification and recultivation is of great importance.

Different methods are used for ground decontamination. The most widely used one is the following. The layer of polluted ground is changed for the clean one. Or the layer of contaminated soil is taken away and the remaining ground is used in accordance with destination. Sometimes this process is preceded by preliminary layer processing [3]. As a result, the most fertile soil layer is being lost and its utilization is labour-intensive.

Another decontamination method is phytodecontamination. It includes the cultivation of plants such as : sunflower, rape, lucerne and others, whose roots accumulate radionuclides and utilization of vegetative mass [4]. But this method doesn't provide sufficient area decontamination.

Institute for Sorption and Problems of Endoecology of Academy of Sciences of Ukraine (ISPE) proposed the method of purification of radiopolluted soils combining the usage of sorptive means and radioaccumulative plants.

Experimental

The work over optimization of composition and study of technological peculiarities of process of formation of carbonmineral composite material for selective radionuclides extraction from polluted soils has been carried out. The process of radionuclides adsorption from model and natural polluted environment has been conducted.

The carbonmineral composite material has been obtained according to technology of aerated concrete manufacture by non-autoclave method [5].

Lime and portland -cement was used as a linking material, quartz sand was used as a siliceous material, water suspension of aluminic additives of natural zeolites and other sorbents were used as a sorptive material. Hard components were mixed with water the rate of water/solid = 0.2 - 0.3; granules were shaped in the form of balls or cubes and were streamed out at special chamber at 95°C after their drying at room temperature. The material with different porousness and stress-strain properties has been obtained by method of composition selection.

Investigation of effectiveness of Cs-137 ions absorption from soil by a composite material with different material additives (30% mass) in conditions of laboratory was carried out with soil samples from Polesky region (polluted was 24457 Bq/kg). The period of sorbent contact with soil constituted 90 days; soil humidity was kept at the level of 50%.

The result showed that the most effective composite sorbent for Cs-137 extraction from polluted soil is carbonmineral material with vermiculite additive as a mineral component. This fact defined the further vermiculite usage as the main mineral component in manufacture of combined sorbents.

Full-scale experiment was carried out in Chernobyl polluted zone (soil contamination by Cs-137 ions constituted 23310 Bq/kg).

The results of experiment, shown in table 1, include levels of Cs-137 ions accumulation in plants and sorbents. The experiment showed that level of Cs-137 accumulation by plants in the presence of sorbent was twice higher that in the case of plants growing without sorbent. Thus, sorbent usage provides the possibility of intensifying the phytosorption process by plants. The total plants and sorbent activity during vegetative period reached 51% (for potato) and 80% (radioaccumulating plants) of total soil pollution.

Table 1. Intensiveness of Cs-137 accumulation by vegetative mass and sorbents from radiopolluted soil*

Investigation object	Sample activeness, Bq/kg	Accumulation level
1. Cultivation of potato by usual method - potato tuber - green mass	444 1406	1.9 6.0
2. Cultivation of potato with carbonmineral sorbent usage - potato tuber - green mass - sorbent	851 2310 2479	3.7 10.0 10.6
3. Cultivation of potato with usage of natural sorbent (vermiculite) - potato tuber - green mass - sorbent	962 3522 7400	4.1 15.2 31.7
4. Cultivation of radioaccumulating plant: a) by usual method b) with (vermiculite) sorbent usage - plant mass - sorbent	2849 5180 11840	12.2 29.2 50.8

* Activeness of polluted soil by Cs-137 ions constitutes 23310 Bq/kg.

Conclusions

1. It is proved experimentally that the refining level of radiopolluted soils in the process of usage of carbonmineral sorbents and radioaccumulating plants attains about 80% during one vegetative period.
2. Usage of different sorbent types in the planting period allows to intensify the process of phytosorption by plants twice as much.

References

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