

SOIL ABSORBING COMPLEX IN TERMS OF CEMENT DUST POLLUTION

Soil contamination caused by human activities can be described as the sum of the processes due to the redistribution of chemical elements on the surface of the soil and in its depth. As a multiphase complex system with a wide range of genetic characteristics, the soil is an ideal reaction medium for various types of chemical and physico-chemical processes of transformation of minerals within it. Among industrial enterprises that act as chronic sources of pollution by calcium emissions, the dominant position is occupied by cement producing enterprises. The examples of this is JSC «Volyn-Cement» in Zdolbuniv. It annually generates 2000–5000 tons of emissions, accounting for about five percent of the total air emissions in Rivne and almost twenty percent of emissions from stationary sources of the region. The structure of non-localized emissions contains cement dust (0,6–2 thousand tons per year). The amount of its emissions depends on the volume of cement production at the plant. The local geological deposits of carbonate rocks being used as the raw material for cement production, calcium is the dominant component in its chemical structure. The summarized results of many studies on the chemical composition of cement dust generated from cement producing enterprises of Ukraine allow to state that the dominant components in its composition are: CaO – 42 %, SiO₂ – 14,5 %, Al₂O₃ – 5,3 %, SO₃ – 5,1 %, K₂O – 3,2 %, Fe₂O₃ – 2,0 %, MgO – 1,7 % and N₂O – 1,3 %. The accumulation of excessive amounts of these components in the soil will inevitably result in changes in the composition of the soil absorbing complex.

The investigation of cement dust influence on the quality of the soil absorbing complex has been carried out by comparing the different degrees of soil changes in the fixed area of control. The route of soil sampling in the southeastern contaminated areas was determined by the direction of the prevailing winds and carried out at distances of 0,2; 0,6; 2,0; 4,0; 6,0; 10,0; 15,0 and 20 kilometers from the place of anthropogenic emissions. To control emissions offset the soil was taken at a distance of twenty-five kilometers south-east of the plant, four kilometers west of Ostrog.

The results obtained have shown the deep changes in the composition of the soil absorbing complex as well as the reaction of the soil solution under the influence of cement dust. The soil absorbing complex became significantly enriched by absorbing bases, the amount of which at a distance of 0,2–0,6 kilometer from the emissions source was 149 mg-ekv per 100 g. Abnormally high content of them (134,9 mg-ekv per 100 g) was recorded at a distance of two kilometers. However, at the distance of four kilometers the concentration of absorbing bases in 0–20 centimeter layer decreased by half and became normal for this type of soil parameters (70 mg-ekv per 100 g). At a distance of six, ten and fifteen kilometers the content became stable at 30 mg-ekv per 100 g.

Abnormally high content of the calcium exchange was revealed in the soil at a two kilometer's distance, where its concentration exceeded seven-fold permissible levels and rose to 133–146 mg-ekv per 100g. In more distant areas (4 km) there was a twofold decrease of calcium content in the composition of the soil absorbing complex but its concentration still remained at a high level (71 mg-ekv per 100 g). At the distance of more than fifteen kilometers from the emissions source cation concentration remained almost at the level of the regional background (20,2 mg-ekv per 100 g). This distribution pattern can also be used in investigation of magnesium.

Enriching the soil absorbing complex by calcium lead to a significant reduction in the acidity of the soil solution. The most observable leaching of 0–20 centimeter soil layer occurred within six kilometers of the affected area. The index of the hydrolytic acidity was the lowest there, ranging from 0,16 to 0,22 mg-ekv per 100 g and ten-fold exceeded the normal value. The reaction of the soil solution changed from alkaline at a distance of 0,2 kilometer (pH 8,15) to slightly alkaline at the end of the control area (pH 7,58). At a distance of six to fifteen kilometers the most favorable conditions for plant growth in terms of soil acidity were formed. At this distance hydrolytic acidity significantly increased to 1,35 mg-ekv per 100 g while the rate of actual acidity reduced to pH 7,14. On the border of the control area (fifteen kilometers) acidity indices stabilized at the following levels: pH – 7,0 and hydrolytic acidity – 1,6 mg ekv per 100 g.

An important soil indicator is its absorption capacity, that determines the exchange absorptive capacity of the soil absorbing complex. Its value depends on various characteristics of the soil. The most important one is the presence of small dispersion fractions and humus content. In this case, the more is the content of small dispersion particles in soil, the higher is the soil absorbing capacity. In this respect, the crucial role is played by calcium cations. Our research revealed the intensification of soil microstructuring process in colloidal solution resulting in primary microaggregates formation. According to the results obtained in our investigation this process is affected by calcium compounds found in cement dust.

We have established a close dependence of absorptivity index of 0–20 centimeters soil layer on the distance of the calcium emissions source. Within the two kilometers' radius of the affected area the absorptivity index reached maximum values (150 mg-ekv per 100 g) and exceeded six-fold the control index. At a distance of two to six kilometers from the source of emissions there was a decline of the indices from 150 to 38 mg ekv per 100 g. Beyond six kilometers of the affected area the absorptivity index stabilized at 25–32 mg-ekv per 100 g, but still exceeded the control value.

Under the influence of the calcium dust the soil absorbing complex was enriched by absorbed bases and calcium. Within six kilometers from the source of emissions the saturation level was maximum and varied from 99,8 to 99,4 percent of absorptivity index. This increase can be accounted for by a high degree of saturation of the absorbing complex by calcium cations (its amount was 98 percent). In more distant areas the soil hydrolytic acidity increased, the calcium content in the soil absorbing complex decreased and absorptivity index fell to 92,6 percent.

Due to regular cement dust calcium emissions some stable changes in the soil absorbing complex were observed. The changes in the composition of the soil absorbing complex turned out to be closely related with the distance of the fixed area of control from emissions sources. The soil absorbing complex with abnormal characteristics was observed within two kilometers' distance. Optimal metabolic characteristics of the soil were established at the distance of 4–10 kilometers from the source of cement dust emissions.