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ON THE EFFECTS OF GAS DISCHARGE ON THE SOIL SURFACE *)

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The tasks of soil treatment by gas discharge seem to be relevant for applications.

Corona discharge in air at voltages of 10 kV and currents of about 100 μA was used in the experiments. The discharge action time varied from 30 minutes to 4 hours. The experiment showed that the electrical conductivity of the sample of arable horizon of sod-podzolic soil increases with the time of plasma exposure, the electrical conductivity of soil paste after treatment of 2 hours is 285 μS/cm, after treatment of 4 hours - 317 μS/cm, control 115 μS/cm. The oxidation-reduction potential of the soil aqueous extract rises to +187 mV at 2 hours, and then falls to +180 mV after 4 hours treatment.

The nitrate content in the aqueous extract from the soil shows an increase in 2 hours to 14.5 mg/l, and a further drop in the treatment at 4 hours of 12.8 mg/l, relative to the control of 9 mg/l.

The present paper presents the results of modeling studies to evaluate the effect of corona discharge plasma on the properties of the surface layer of air near the soil surface.

The model calculations were performed with the Kinet program, with verification in Maple 2024 software using the Rosenbrock method. The model includes 150 chemical reactions and 34 components involved in the transformations, such as: e, O, O_2, O_3, O^-, O_2^-, O_3^-, O_4^-, O^+, O_2^+, O_4^+, N, N_2, N_2^+, N_2O, NO, NO_2, NO_3, N_2O_5, NO^+, NO^-, NO_2^-, NO_3^-, NO_2^+, H_2O, H_2O^+, H_3O^+, H_2, H, H^-, OH, OH^-, HO_2, HNO_3.

Calculations were carried out for values of the reduced electric field: 80 Td, 100 Td, 150 Td and humidity of 1%, 2%, 4% (in this case ‘humidity’ characterizes the ratio of concentration of water molecules in the air to the total concentration of components in the air), as well as for dry air. It was found that for values of 80 and 100 Td a significant yield of reaction products was observed only for particles O3, N2O, H2, H, OH (concentrations $\sim 10^9 - 10^{14}\ cm^{-3}$) and each value of air humidity. In the case of an electric field with value of 150 Td, the number of products increased, the concentration of O3 increased to $\sim 10^{18} cm^{-3}$, OH $\sim 10^{17} cm^{-3}$, (N_2O, NO, NO_2, NO_3, N_2O_5, HNO_3) $\sim 10^{11} - 10^{15} cm^{-3}$.

With increasing humidity, the electron concentration increased by up to 2 orders of magnitude, which leads in the model to accelerated component acquisition, so for example for ozone at 1% humidity the ozone O_3 concentration rises to a value of $1.8 \cdot 10^{18} cm^{-3}$ in 50 μs, while in dry air it rises to $3.8 \cdot 10^{17} cm^{-3}$ in the same time. The maximum attained values of the components also differed, especially for the nitrogen components, which become 2-3 orders of magnitude larger in the absence of water.

The components H_2O^+, H_3O^+, H_2, H, H^-, OH, OH^-, HO_2, HNO_3 without water are not included in the calculated system. Calculation times for humid air were set at 600 μs, calculation times for dry air were set at 600 μs and 100 s.

The experiments show the promise of using discharges to increase nitrate concentrations in soil from air.

*) abstracts of this report in Russian