

ABSTRACT

The objective of the presented PhD thesis was to describe the process of extraction of humic acids from peat using design of experiments and statistical analysis methods. On the basis of obtained experimental data, dependencies between efficiency of extraction and process variables were defined, what resulted in a design of a new technological solution allowing for the efficient acquisition of humic acids from peat. Created mathematical models may be the basis for the industrial design of technological processes in the considered experimental design space.

In the literature study, the main areas of application of humic substances were discussed. Particular emphasis was placed on the application and role of the humic acids fraction in agriculture. The humic substances market and patents of their acquisition were analysed. Based on the solutions from literature reports, a new method of ultrasound-assisted extraction of humic acids from peat has been developed. Standard procedure of humic substances isolation, recommended by the International Humic Substances Society (IHSS), together with methods of the design of the experiment and a statistical analysis of results were also described.

In the experimental part, the influence of ultrasound on the efficiency of humic acids extraction from peat and on their quality was assessed. Based on the Plackett–Burman experimental design, series of experiments were performed. Obtained results allowed to define effects of changes in values of independent variables, such as: temperature, extractant concentration, extraction time, extractant:peat mass ratio, ultrasound intensity and decalcification of raw material, on efficiency of humic acids extraction from peat using NaOH, KOH and $\text{NH}_3 \cdot \text{H}_2\text{O}$ solutions. The selection of independent variables was done afterwards. In the next step, the three–level fractional factorial design was used. On the basis of the obtained results for the experimental points, a statistical analysis of the impact of selected variables on the obtained response was carried out. It allowed to describe changes of the efficiency of humic acids extraction as a function of process parameters using polynomial equations. Laboratory analyses were also carried out to determine influence of the alkaline extraction process conditions on changes in the chemical structure of acquired humic acids.

According to experimental studies, the potential of using alkaline extraction supported by low-intensity sonication as an effective method of humic acids isolation from peat has been proven. A process to effectively isolate the humic fraction for agricultural application, enriched with fertilizing nitrogen, phosphorus, and potassium was also proposed.