New technology and products of deep chemical work of peat

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Summary

New mechano-chemical methods for deep chemical processing of peat have been developed and humic preparations have been prepared on his basis. The oxidation of peat using hydrogen peroxide in an environment of water ammonia or sodium hydroxide results in the formation of humic products with a high output oxidizer with high biological activity. The resultant humic preparations are stimulators of growth and humus fertilizers that raise grain productivity 25-35 %.

Key index words: peat, humic acids, fulvic acids, oxide humates, deep chemical modification

Introduction

The more complex use of peat is one of the significant challenges of a modern peat industry. It is optimal in this context to pursue the deep chemical processing of peat biomass with the purpose of producing (without division into separate components) various polymeric materials (Gorovaya, 1995). The most interesting aspects of this approach relate to oxide humates; these are recommended for application as quality humus growth stimulators and fertilizers. Previous work (Naumova, 1987) derived oxide humates from peat by oxidation of hydrogen peroxide in an alkaline environment in rather severe constraints at 125 ^{0} within 4 hours in the presence of cobalt and cuprum salts as catalysts. This method resulted in fertilizer humus with an output 75 - 93 % of the organic weight of peat containing cobalt and cuprum as microelements. One of the prospective methods of activating peat for its chemical modification is cavitation; this involves the processing of the peat in a water environment in cavitation devices (Petrakov et al., 2007). The peat subjected to cavitation processing in various environments is activated such that its chemical structure is changed.

The agrochemical value of peat is determined by its basic organic constituents (humic and fulvic acids) and the nitrogen content. Peat, however, initially displays poor fertilizer properties owing to the low availability of organic substances. The activator of the organic material in peat can be water ammonia, which extracts the humus in the substance as a water solution of humates of ammonium (Naumova, 1987). The method of enhancing the nitrogen content of organic fertilizer - ammonization of peat - is determined by processing peat of a certain humidity by water ammonia. The basic unknowns in the ammonization of peat are its duration, which results in losses of ammonia, and also the low content of the connected nitrogen in the peat (Gorovaya, 1995).

The method of producing plant growth stimulators from peat was developed from its treatment by hydrogen peroxide in an environment of water ammonia at a hydro module 9.5:1, ammonia content 20 - 50 % and hydrogen peroxide content 20-30 % on an absolutely dry weight of peat basis at 120 ^{0}C for 4 h. The essential technological difficulties of this method are: high process temperature (120 ^{0}C), duration up to 4 h, and it is a two stage process (Kasimova, 2003).

The authors have developed a new mechano-chemical method of enhancing the nitrogen content of organic fertilizers by oxidation of peat hydrogen peroxide in a water-ammoniac environment resulting in a humus derivative at a satisfactory quantitative output (Efanov et al., 2007). Heretofore, work on the regular study of oxidation and oxidizing ammonolyse of peat in various environments in mechano-chemical conditions and cavitation processing has not been available in the literature. In this paper the authors submit the development of a new mechano-chemical and cavitation technology for enhancing the nitrogen content of organic fertilizers and oxide humates from peat.

Materials and Methods

The initial raw material for the mechano-chemical oxidizing ammonolyse used top peat from a deposit of Tomsk Territory of humidity 60 %, containing 2.2 % of general nitrogen, 13.8 % humic and 18.5 % fulvic acids. The initial raw material for cavitation oxidizing used bottom peat from a deposit of Altai Territory with a degree of decomposition 25 %, ash content 22.1 %, and humidity 50 % containing 2.1 % of general nitrogen, 24.6 % humic and 23.4 % fulvic acids.

The mechano-chemical synthesis of nitrogen contains polymeric humic preparations from peat carried out in the following way. A cylindrical reactor vibro-mill of capacity

300 ñì3 with 15 steel cores of 10*100 mm (industrial vibrator, frequency 2800 minute^{-1}) was loaded with peat of weight 5.0 g, to which was added a 25 % water solution of ammonia (at the rate of 0.25 - 0.5 g NH_3/g peat), then was added a 30 % water solution of hydrogen peroxide (at the rate of 0.1 - 0.6 g H_2O_2/g peat) and the whole subjected to intensive mechanical crushing from 0.5 - 3 h. The temperature in the reaction chamber was - 25 ^{0}C. The resultant product was then unloaded from the mill, and air-dried until the disappearance of the smell of ammonia. The general nitrogen content and its forms were determined in accordance with techniques given in the relevant manual (Orlov, Grishina, 1969).

The cavitation processing of peat in the presence of an oxidizer (H_2O_2) and water alkali was carried out as follows: an initial sample of peat of weight 2.0 kg, humidity 50 %, previously processed from 2 - 10 % in a solution of NaOH was placed in a cylindrical tubular reactor of capacity 10 liters, connected with rotor cavitators (frequency of rotation of a rotor 3000 rev/min) at a hydro module 1:2-4 during 15 minutes at 60 ^{0}C. Then a 50 % water solution of hydrogen peroxide (at the rate of 0.025 – 0.2 kg of H_2O_2/kg of absolutely dry peat) was added to the reactor and the suspension was subjected to cavitation processing at a temperature of 60 ^{0}C for 15 - 60 minutes. The suspension was eventually poured into polyethylene containers of 10 liter capacity. The analyses of the resultant liquid humic fertilizers were undertaken in volumes of 1 litre. The liquid phase (target product) was separated and the general organic carbon content, as well as the carbon content of the humic and fulvic acids was determined by the modified method in Turin (Orlov, Grishina, 1969).

Results and Discussion

In Table 1 the data on the influence of the duration of the mechano-chemical synthesis of the contents of the connected nitrogen, humic and fulvic acids in products resulting from the oxidation of peat by hydrogen peroxide in water-ammoniac environment is given.

The results of the experiments show that increasing the duration of vibro-milling of peat in the presence of ammonia and the oxidizer (hydrogen peroxide) results in a natural increase in the content of humic and fulvic acids in the peat. The increase of the content of the connected nitrogen by 2.5 times for 3 h mechano-chemical synthesis testifies to the course of reaction of the oxidizing ammonolyse of organic substance of peat.

The influence of the duration of the cavitation processing was also investigated at 60 ^{0}C on an output water solution of organic substances from the bottom peat. The results of this research are given in Table 2.

As the results of the experiments show, an increase in the duration of the cavitation processing of peat at 60 ^{0}C in the presence of hydrogen peroxide in a water-alkaline environment, results in a natural increase in the concentration of the water solution of organic substances in the produced extracts from 22 up to 39 g/l. For 60 minutes of peat oxidation in the cavitation processing conditions, the output water solution of organic substances produces 39 g/l.

Conclusions

Thus, the proposed method in the reported mechano-chemical and cavitation processing of peat provides both intensification of the technological process, as well as production of the highest output of water solution of organic substances in a target product with a simpler and less power-intensive way by comparison with analogues. It is therefore established that the products of oxidation of peat by hydrogen peroxide, in a water-alkaline and ammonia environment in cavitation processing conditions, are effective in producing plant growth stimulators.

Acknowledgements

The authors wish to express their gratitude to the organizational committee of the congress for financial support towards participation in the conference. The work was carried out with financial support from the Ministry of Education and Science of the Russian Federation (Project Number 1.1.06).

Table 1. Influence of duration of mechano-chemical treatment on composition of nitrogen content of fertilizers from peat*

Sample	Duration of crushing, h	Content of general nitrogen, %	Content of general carbon, %	
			humic acids	fulvic acids
Initial peat	-	2.2	13.8	18.5
1	0.5	2.9	15.3	22.9
2	1.0	3.8	18.3	25.4
3	1.5	4.7	-	-
4	2.0	4.9	18.2	27.1
5	2.5	5.1	-	-
6	3.0	5.3	18.7	31.1

*Humidity of peat - 60 %, weight of peat - 5.0 g, quantity of hydrogen peroxide - 0.1 g/g peat, quantity of ammonia - 0.25 g/g peat.

Table 1. Influence of duration of mechano-chemical treatment on composition of nitrogen content of fertilizers from peat*

Sample	Duration of oxidation in cavitation processing conditions minutes	Content of general carbon, g/l	Content of general carbon humic acids g/l	Content of general carbon fulvic acids g/l
Initial peat	–	80.5	41.2	39.3
1	15	22.3	12.2	10.1
2	30	26.4	15.2	11.2
3	45	32.5	19.3	13.2
4	60	39.3	22.2	17.1

*Duration of preliminary alkaline cavitation processing - 15 minutes, quantity H_2O_2 - 5 % by weight of absolutely dry peat, conc. of NaOH solution - 2 %; temperature - 60 ^{0}C.

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