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THE EFFECT OF TEMPERATURE ON ADSORPTION PROPERTIES OF NATURAL ZEOLITE IN THE SOLID FRACTION OF PIG EXCREMENTS FROM THE MICROBIOLOGICAL AND CHEMICAL POINTS OF VIEW

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Summary

The effect of an addition of natural zeolite was observed at various temperatures and the times of action from the microbiological and chemical points of view within the scope of solving the problems arising from manipulation with the solid fraction of pig slurry. The addition of zeolite resulted in a decreased number of germs in the solid fraction during the entire period of observation although the decrease in per cent varied considerably in dependence on the temperature (4, 20, 37°C). The chemical examination showed a decrease in the content of dry matter, total organic substances and a significant decrease in the content of ammonium nitrogen. The decrease in the number of microorganisms can be evaluated positively in relation to the decreased chemical contamination resulting from application of the solid fraction of pig slurry following the addition of zeolite.

Key words: zeolites, adsorption properties, solid fraction of pig slurry, water treatment plant, chemical and microbiological parameters.

Introduction

The large-capacity pig farms produce big quantities of pig slurry. This waste material contains high concentration of organic substances and microorganisms and as a result of this poses a serious hygiene problem when applied to the agricultural land. For this reason, the agricultural facilities and particularly the animal production belong among the biggest point sources of environmental pollution (Pokorný, 1994).

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The most frequently used water treatment plants in Slovakia are those operating on the basis of a mechanical-chemical-biological system (Venglovský et al., 1994, Ondrašovič et al. 1994). The water treatment plants operating on animal farms, mainly on those that rear pigs, use the process of aerobic stabilization of wastes. Some problems may arise at the treatment of the solid fraction of excrements (obtained by separation on vibrating screens) which is important from the epizootiological point of view with regard to its ability to concentrate pathogenic germs (Plachý, Juriš, 1994), because considerable number of germs is not devitalized in the treatment process.

Within the scope of solving the problems arising from manipulation with solid wastes, we investigated the possibility of utilization of zeolites in the first stage, the mechanical treatment, under laboratory conditions.

Materials and methods

Experiments were carried out on the solid fraction of pig slurry obtained by separation on vibrating screens in the process of treatment of slurry from a large-capacity pig farm and natural powder zeolite (clinoptilolite) from Nižný Hrabovec - Slovakia, with the grain size of the main fractions 0.125-0.25 mm (76.95%) and above 0.25 mm (12.3%).

The zeolite was added to the sample in the ratio 1:10 and the mixture was mixed for 30 min. Portions of this mixture were stored at 4, 20 and 37°C in closed containers together with the zeolite-free control. The solid fraction was subjected to physical-chemical and microbiological examination before adding the zeolite and after 72 h, 7, 14 and 28 days and 6 weeks. The numbers of psychrophilic, mesophilic, coliform and fecal coliform microorganisms were determined using the methods according to STN 83 0531 and Štěpánek et al. (1982). The pH value was measured in a water extract by means of a digital. pH meter OP 205 and a combined electrode. The content of dry matter was obtained by drying to the constant weight at 105°C. The total number of organic substances was determined as a residuum after ignition (550°C). The content of ammonium nitrogen in a water extract was determined employing the distillation method by means of a Parnas-Wagner apparatus (Sedláček et al., 1978).

Results and discussion

Results of the influence of zeolites on the number of microorganisms and those obtained in the control are shown in Table 1.

	Mean number (of 3 concurrent count) of CFU in 100g solid fraction of pig manure			
	Mesophilic	Psychrophilic	Coliform	Fecal coliform
Control without zeolite	$1.9x10^9$	$7.4x10^9$	1.6×10^7	1.9×10^6
4 °C				
After 72 h.	1.8×10^8	1.9×10^8	1.4×10^6	1.3×10^5
After 7 days	1.2×10^7	2.0×10^7	1.3×10^5	1.0×10^5
After 14 days	1.8×10^7	1.8×10^6	1.1×10^5	6.1×10^4
After 28 days	1.7×10^6	1.1×10^6	0	0
After 6 weeks	1.4×10^5	1.9×10^6	0	0
20 °C				
After 72 h.	2.2×10^8	1.1×10^8	1.0×10^5	9.8×10^4
After 7 days	1.2×10^7	1.4×10^7	6.5×10^4	5.4×10^4
After 14 days	1.4×10^6	1.8×10^6	0	0
After 28 days	1.4×10^5	5.8×10^5	0	0
After 6 weeks	8.4×10^4	9.6×10^5	0	0
37 °C				
After 72 h.	1.9×10^7	8.4×10^7	1.2×10^5	9.2×10^4
After 7 days	6.1×10^7	1.6×10^7	7.2×10^4	6.0×10^4
After 14 days	1.4×10^5	9.8×10^5	0	0
After 28 days	1.6×10^5	8.3×10^4	0	0
After 6 weeks	9.6×10^4	7.2×10^4	0	0

The numbers of microorganisms in the solid phase of pig slurry ranged from 10^5 to 10^9 before the addition of zeolite. Our results confirm the findings of Juriš et al. (1989) and Venglovský et al. (1994) indicating high bacterial contamination of the solid fraction from agricultural wastewater treatment plants.

Our results are in an agreement with the data published by Larsen et al. (1988) and indicate considerable survival of individual groups of indicator microorganisms in the solid fraction from the water treatment plant.

The effect of zeolites was manifested by a decrease in the number of microorganisms in the solid fraction of slurry at all temperatures tested (4, 20 and 37 °C) during the entire period of investigation.

The biggest changes in the number of mesophilic microorganisms were observed at 4 °C after 6 week in the sample with zeolite. Coliform and fecal coliform microorganisms were not detected after 28 days.

The storage at 20 °C resulted in biggest changes in the number of mesophilic microorganisms after 6 weeks and in psychrophilic after 28 days. Coliform and fecal coliform were not detected after 7 days.

Samples stored at 37 °C showed most pronounced changes in mesophilic microorganisms after 6 weeks, in psychrophilic after 28 days. Coliform and fecal coliform were not detected after 7 days.

Despite high effectiveness of the removal of microorganisms it is necessary to realize that it meant a decrease by approximately one order and the final numbers were still high (Pačajová et al., 1994, Vargová et al., 1994). This decrease is, however, more important when we realize that it was accompanied by the decrease of chemical pollution.

The storage at different temperatures showed that the effect of zeolites on the decrease in dry matter, total organic substances and the content of ammonia nitrogen was observed mainly at higher temperatures.

The value of pH of the water extract depends on the decomposition processes which take place at different temperatures. The addition of natural zeolites caused a small decrease in pH at temperatures 4 and 20 °C the most marked decrease in pH was observed at 37 °C on day 7. In the course of the experiment, an increase in pH was observed on day 28. At the end of the experiment the pH values stabilized at about the same pH (7.2-7.4) for all three temperatures tested.

The determination of dry matter showed highest decrease at 20 °C on day 28. The smallest changes in the content of dry matter were observed in the sample stored at 4 °C. Toward the end of the experiment (on day 42) a relative equalization of the values of dry matter was observed at all temperatures tested.

The addition of natural zeolite resulted in a significant decrease in the total concentration of organic substances in comparison with the control as early as after 72 hours at all the temperatures. The decrease in the content of organic substances was considerable at 37 °C (by 63%).

The biggest changes were observed in the concentration of ammonium nitrogen in the water extract. Considerable decrease of this parameter was observed at all three temperature as early as after 72 hours. The biggest decrease was observed in the sample stored at 20 °C (by 80.9%) on day 14 of the experiment. Additional storage resulted in further decrease in ammonium concentration on the extract. The results obtained point to the possibility of utilization of zeolites in the preliminary staged of the treatment of pig excrements where they can contribute to better sedimentation of suspended particles, decrease in the concentration of nitrogenous substances and the level of total organics and, to a certain extent to a decrease in microbial contamination (Vargová, 1995).

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UTJECAJ TEMPERATURE NA ADSORPTIVNA SVOJSTVA PRIRODNIH ZEOLITA DODANIH KRUTOJ FAZI SVINJSKOGA GNOJA S MIKROBIOLOŠKO I KEMIJSKOG STAJALIŠTA

Sažetak

Istraživan je utjecaj različitih temperatura i vremena djelovanja na prirodne zeolite dodane krutom dijelu svinjskoga gnoja, a u svrhu rješavanja problema koji nastaju prilikom manipulacije s njim. Dodatak zeolita rezultirao je smanjenjem broja mikrooorganizama u krutoj fazi gnoja na kraju pokusa, a smanjenje u postotcima je variralo tijekom pokusa ovisno o temperaturama (4, 20, 37°C). Kemijska istraživanja su pokazala smanjenje sadržaja suhe tvari, organske tvari te značajno smanjenje koncentracije amonijačnog dušika. Smanjenje broja mikroorganizama može se ocijeniti pozitivnim a u svezi je sa smanjenjem kemijskog zagađenja koje je uslijedilo dodatkom zeolita krutoj fazi svinjskoga gnoja.

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