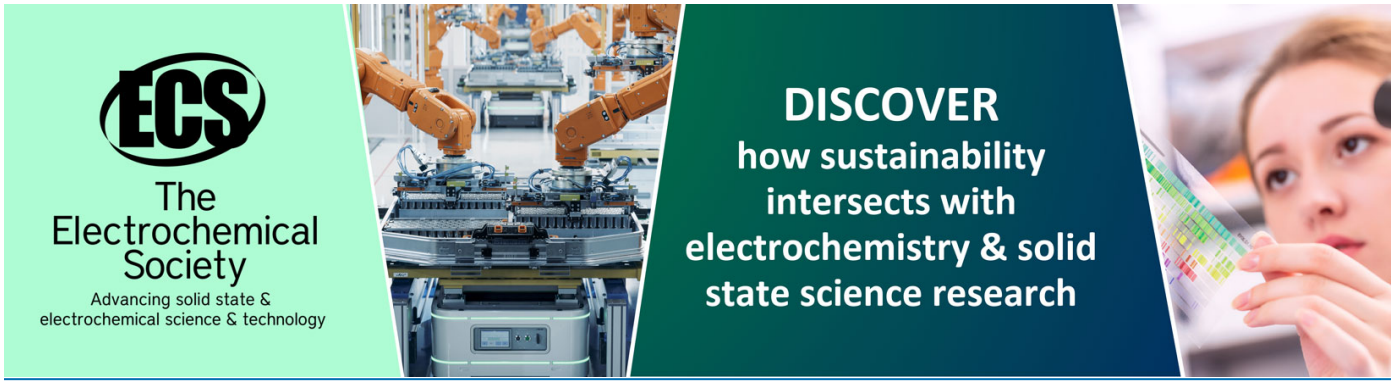
Ecological and technological criteria for the efficient utilization of liquid manure



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Ecological and technological criteria for the efficient utilization of liquid manure

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Abstract. The article discusses the prospects for the development of environmental management in the disposal of livestock waste, in particular liquid manure, as part of an industrial approach to it. The data on the concentration of nutrients in liquid manure depending on its moisture are presented. Based on the analysis of empirical data and the results of previous studies, an exponential dependence is derived that indicates the relationship between the initial moisture content of liquid manure and its final volume. Criteria of effective utilization of liquid manure are formulated taking into account environmental and technological specifics.

1. Introduction

One of the main aspects of environmental management in animal husbandry is the use of effective, environmentally friendly methods of processing its waste. Efficiency and environmental friendliness of its utilization directly depends on approaches to technology management. The development of import substitution of livestock products requires the growth of production capacities of farms and an industrial approach. Under these conditions bedless husbandry of animals is the most perspective from the point of view of efficient disposal of waste.

Based on the analysis of information sources [1-6, 8], it was found that bedless husbandry in comparison with bedded has the following advantage:

– an increased degree of mechanization and automation of keeping animals in an epidemiologically safe condition and environment;

– a high degree of mechanization and automation of operations of removal, storage, transportation and introduction of manure;

– the ability to minimize the number of pathogenic organisms and their impact on the environment;

– about 55 ... 70% of nitrogen is in the ammonium form, which significantly prolongs its effect and the level of digestibility by soils;

– operating costs of the recycling process are reduced by minimizing the solid fraction and the cycles of operations of loading / unloading / adding;

– the liquid fraction of manure is an effective filler in the production of composts;

– effective application to the soil with straw, which leads to an increase in organic matter and favorable dynamics of the nutrient regime of soils.

However, despite the above advantages, there is a number of environmental and technological problems, such as increased water consumption and the volume of epidemiologically hazardous liquid media that require disinfection. Accordingly, improving the methods of disposal of this type of waste is an urgent scientific and technical task.

The first step in improving methods for the efficient disposal of epidemiologically hazardous liquid media is the development of environmental and technological criteria for them, which was the purpose of this study.

2. Materials and methods

The object of the study is liquid manure, which is a heterogeneous polydisperse system, including a suspension of an aqueous solution of mineral salts, organic compounds, as well as suspensions with mineral inclusions: solid animal excrement, undigested feed, etc.

The subject of the study is the environmental and technological criteria for the effective utilization of liquid manure, the implementation of which ensures the most effective development of the concept of rational nature management.

3. Results and discussion

Based on the analysis of a priori information, research results, as well as empirical data, it was established that the correct development of environmental and technological criteria for the effective utilization of bedrock manure requires consideration of its properties from a physical, chemical and biological point of view [1-10]. The physical parameters characterizing the properties of liquid manure are:

– relative humidity$B_н$, %;
– density ρ, kg/m^3;
– dynamic viscosity η, Pa•s;
– the initial shear stress τ_0, Pa;
– set of qualitative parameters characterizing the adhesion-cohesive properties (stickiness, i.e. the force of separation of a flat stamp from a given material from a cohesive fluid, the time of deposition of the dispersed phase, etc.);
– uniformity of particle size distribution (estimated using probability density distribution functions).

The chemical parameters characterizing the biogenic properties of liquid manure are:

– content of mineral substances (SM),%;
– total nitrogen content N_{total}, kg/m^3;
– content of ammonia, ammonia, organic nitrogen NH_4, kg/m^3;
– content of phosphoric anhydride (phosphorus oxide) P_2O_5, kg/m^3;
– content of potassium oxide K_2O, kg/m^3.

Biological parameters characterizing the epidemiological properties of liquid manure are:

– number of colony forming units (CFU) of bacteria of the group of Escherichia coli, pcs;
– number of CFU bacteria of the staphylococcus group, pcs;
– number of CFU of bacteria of the group of enterococci, pcs;
– number of CFU bacteria of the group of aerobic spore-forming microorganisms, pcs;
– number of CFU of eggs: roundworm, trichocephalus, esophagostom, fasciol, Strongylata larvae, rat tapeworm, ticks, pcs;
– number of CFU cysts of protozoa and Eimeria oocysts, pcs.

Based on the analysis of information sources and the results of preliminary studies [1-5, 10, 11], the dependence of the nutrient content in semi-liquid, liquid manure and manure runoff depending on their moisture is presented (see Figure 1).

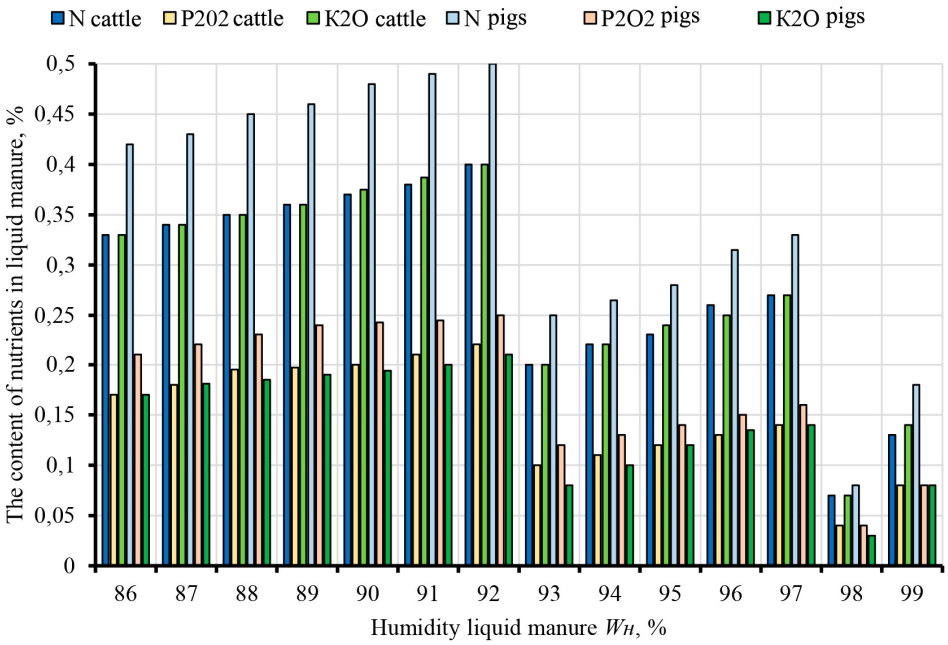

Figure 1. Volume of liquid manure depending on its humidity

It was established that the average yield of liquid manure from one head of cattle is 50 ... 60 l / day (30 ... 35 l of feces and 15 ... 20 l of urine, 5 l of inevitable process water), from one pig - 12 l (8 l of feces, 2 liters of urine and 2 liters of water), the daily output of cattle excrement is about 8%, pigs - about 5% of live weight. In industrial conditions, due to process water, the yield of manure compared to the amount of animal excrement can increase up to 25%.

Basedonananalysisofinformationsourcesandtheresultsofpreliminarystudies [1-11], anexponentialdependencewasderivedthatindicatestherelationshipbetweentheinitialmoisturecontentofliquidmanureanditsfinalvolume, described by the dependence:

$$V_{\text{н}} = 65{,}369 \cdot e^{0{,}3017 \cdot W_{\text{н}}} \quad (1)$$

where V_H – is the volume of manure, m^3;

W_H– is the moisture content of manure, %.

The analysis of statistical data and the results of preliminary studies [8-11] are graphically interpreted in Figure 2.

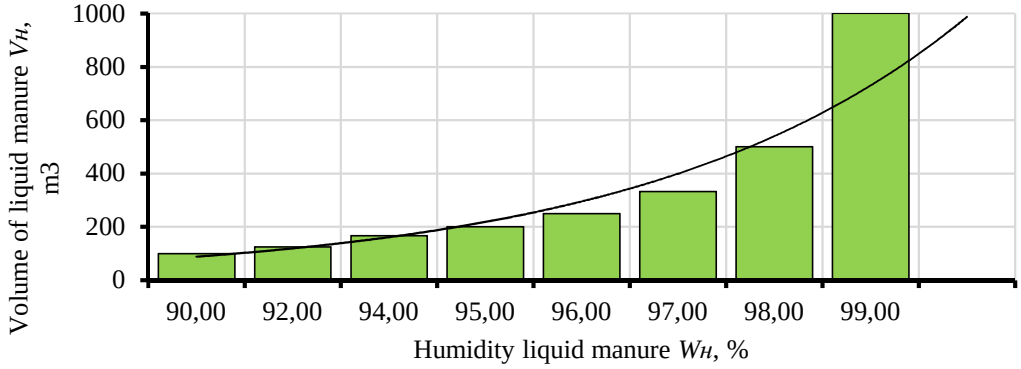

Figure 2. Dependence of the output volume of liquid manure from initial humidity

The analysis of equation (1) and graphical dependence (Fig. 2) showed the following:

– the mathematical model (1) in the form of a polynomial of the exponential equation is adequate according to the Fisher criterion, characterizes the dependence of the yield of liquid manure on its initial moisture at a significance level of α = 0.05, and this is also indicated by the correlation coefficient r= = 0.95221;

– with an increase in the initial moisture content, in the considered range, the volume of liquid manure increases.

4. Conclusion

Based on the study, the following environmental and technological criteria for the effective disposal of liquid manure are formulated:

– rational nature management consists in the creation of utilization chains safe from the sanitary-hygienic, epidemiological and agrochemical points of view;

– the efficiency of utilization, the choice of the direction of further use, the level of environmental load, the choice of technology and technical means for the implementation of the selected methods depends on the method of keeping animals, production capacity of the enterprise, the percentage ratio of sex and age groups;

– the most rational option for keeping animals in the framework of the industrial approach to animal husbandry is bedless;

– the most rational option for the disposal of liquid manure is its separation into solid and fluid fractions, the advantages of which are to minimize the cost of storage, the ease of introducing the liquid fraction into the soil, and the possibility of minimizing the use of homogenizing systems.

The development of the results is the development of software that represents the elements of CAD, allowing maximizing the efficiency of disposal from an environmental, technological and economic point of view.

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