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ECOLOGICAL AND SAFE METHODS OF PURIFICATION OF POULTRY PLANTS SEWAGE

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Досліджено якісний та кількісний склад стічних вод бройлерного птахопідприємства. Фізико-хімічні, санітарно-мікробіологічні показники значно перевищують гранично допустимі нормативи. Обгрунтовано необхідність пошуку інноваційних методів знешкодження забруднення стічних вод. Запропоновано використовувати коагуляцію як ефективний метод очистки води. Проведено фізико-хімічні дослідження щодо пошуку оптимального коагулянту. Доведено, що екологічно безпечним та економічно вигідним є застосування поліалюмінійхлориду.

Ключові слова: *промислове птахівництво, стічні води, очищення, коагулянт.*

Currently, the agriculture is the one of the leading consumer and, at the same time, pollutioner of natural waters due to the use of not only mineral fertilizers and pesticides, but due to functioning powerful industrial complexes for poultry production. Agriculture is considered as the eighth part of the whole volume of wastewater discharged into natural water reserves.

Depending on production technology and region, the poultry farms discharge almost 50% of the received water. The economic losses from water sources pollution account for about 90 million UAH. The water supply is a national asset which is used by modern and will be used by the future generation. It requires an appropriate attitude to their use, protection and reproduction. Ukraine takes one of the last places among European countries on the degree of water supply. Obviously, water in Ukraine is used and hence contaminated several times more intensively comparing to other countries. The volume of discharged waste waters into natural water reserves in Ukraine, amounted to $1.05 \cdot 10^{10}$ m^3, of which without purification is $7.57 \cdot 10^8$ m^3, which is 71% of total. Considering the dynamic development of the poultry industry in the last decade the ecological status of waste water is becoming a particular concern because their amount grows in proportion to the poultry industry. The environmental quantity and quality of waste water assessment and a reliable protection of the environment from local and global pollution is a today's crucial environmental problem for the majority of the poultry farms [1, 2].

The aim of this work is the quantitative and qualitative analysis of the ecological state of waste water from industrial poultry farming, improving its cleaning and disinfection methods.

MATERIALS AND METHODS

The laboratory studies were conducted in the laboratory of agrobioresource monitoring of Institute of agroecology and environmental management. To assess the status of wastewater was done using physic-chemical methods. The measurement of composition and properties of wastewater was carried out by using a photometer KFK–3, spectrophotometer DR 2000, pH meter A, the fluid analyzer «Fluorat–02–02M» [3, 4]. The microbiological analysis of waste water was carried out using conventional microbiological and sanitary microbiological methods [5]. The method of obtaining and purification colloidal systems was used while performing the experimental work on the waste water purification [6–8].

RESULTS AND DISCUSSION

There were analytical researches conducted on waste waters of the poultry production

of broilers. It is indicated that they have low opacity, grey in colour and have unpleasant odor. These physical characteristics indicate the presence of soluble and suspended impurities. The colour of the water is caused by the presence of humic substances and by many parameters exceeding the established standards for discharged waters into water reserves, which are rich in mineral and organic substances, disinfectants, insecticides, medications, nitrates, those are used for birds drinking, processing of products, premises cleaning, equipment, waste storage and disposal. The major deviations are documented relative to biological demand in oxygen and suspended parts, due to broiler production technology.

Microbiological analysis of waste water of poultry farms confirms the presence of a large amount of different forms of mobile and immobile bacteria and pathogenic fungi. The total number of microorganisms (meat-pepton agar) in the waste water is $3 \cdot 10^8$ CFU/ml, and lactose forming coliforms (Endo agar) from $2 \cdot 10^5$ CFU/ml.

However, our observations indicated that these traditional technologies of waste water purification facilities with grease traps, septic tanks and platforms not always provide the required quality of purification. Therefore, the maximum concentration of suspended solids in the purified water of the company exceeds twice a temporarily agreed amount of discharged waste water (TAD), nitrates — by 15–18%, phosphates — in 5.5 times, total iron — 3 times.

This situation requires searching and applying more effective ways and purification of waste water methods. TAD is the amount of pollutants emitted or discharged into the environment from a separate source of contamination per time unit, which is installed on the appropriate time to achieve the maximum allowable emission or discharge.

At the first stage of achieving the maximum-possible concentration and annually taking into account the implementations of planned activities, the value of TAD substances are established on the project or normalized (technically achievable at the currently working or newly established water protection structure) composition, and the best average results of the actual composition of wastewater after purification for the previous 12 months, if they are worse than project or normalized [9].

By discharging not purified wastewater into water reserves that is still allowed in many places, the normal composition of the water in reserves is completely disrupted and makes it completely unfit for consumption. This is evidenced by the results of analytical studies of the surface water of rivers and reservoirs, which have drains from the poultry productions.

The waters of these reservoirs are estimated as alpha mesosaprobic with 2–2.5 index, and poliphonic with 3.5 to 4.5 indexes,

Table 1

Analysis of waste and purified water of poultry production

Physico-chemical characteristics	Concentration mg/dm^3	
	Waste water	Purified water
Suspended combinations	183–897	37–140
Biological demand in oxygen (BDO_5)	446–899	42–67
Ammonium nitrogen	21–101	33–63
Nitrate nitrogen	0.5–1.7	0.32–1.62
Phosphates	4–15	7–8
pH	7.4–8	7.6–8.1

Table 2

Quantity of polluting substances in accordance with TAD (Temporary Agreed Discharged) in discharged waste waters of broiler poultry production

The list of polluting substances	Content of polluting substances		Factual volume of dumped waters, tonnes
	mg/dm^3	In calculation of the whole volume of water, tonnes	
Suspended combinations	15.0	11.4	9.9
Ammonium nitrogen	1.6	1.2	1.5
Nitrates	1.6	1.2	2.6
Phosphates	0.08	0.06	0.5
The total iron	0.03	0.023	0.78
Sulfates	49.2	37.4	23.26
Total quantity	67.51	51.49	155.7

by lactose forming microorganism's pollution index 2 and 3. In such water the MAC of nitrate nitrogen exceeded in 3–5 times; the ammonium nitrogen is 8 to 10 times; water-soluble sulfates in 8–10 times; chlorides 2–3 times and others [10].

Thus, the results of the environmental assessment of the qualitative and quantitative status of wastewater in the conditions of comercial poultry indicates that almost all surface sources according to pollution level approached to the III^d class and the technology and composition of purification facilities of broiler production requires improvements. There are different methods of waste water purification, such as mechanical, chemical, physical-chemical and biological. When these methods are combined to purify the disposal wastewater, it is called integrated method. Coagulation method allows separating sludge from wastewater through sedimentation processes inherent in the coagulants action. The particular method in each case depends on the nature of pollution and the degree of impurities harmfulness.

Considering the results of the physical-chemical analysis discussed above, the coagulation method was selected as an optimal. Therefore, the most relevant direction in solving the issue of waste water purification is the search for eco-safe and cost-effective coagulants. Comparison the electrolytes coagulate action with their influence on electro kinetic properties shows that the coagulation threshold corresponds to the decrease of electro kinetic potential approximately to 30 mV. By the Schultz-Hardy`s empirical rule the coagulation threshold is determined mainly by the valence of the counter ions: the ratio of coagulation thresholds of one-, two - and trivalent counter ions approximately equals to 1:0.016 with 0.0013 [11]. Based on given data, the choice of coagulants was made on reagents from following: ferric chloride $FeCl_3$, aluminum sulfate $Al_2(SO_4)_3$, hudroxochloride aluminum $Al_2(OH)_5Cl$ (polyaluminum-chloride, abbreviated to PACh).

Experimental researches were conducted by agrobioresources monitoring laboratory of Institute of agroecology and environmental management to assess the level of wastewater purification by using different options of coagulants:

Option 1. Ferric chloride (III), $FeCl_3$

Option 2. Aluminum sulfate, $Al_2(OH)_3$

Option 3. PACh, $Al_2(OH)_5Cl$

The results given in table. 3 show that chemical oxygen demand (ChOD), biological oxygen demand (BOD), ammonium nitrogen, phosphates in option 3 are significantly reduced, compared to options 1 and 2 and relative to the control. For instance, these figures are reduced accordingly 6.7; 24.8; 12.7; 6.6 times when NaCl applied together with the

Table 3

The results of waste water purification by coagulants

Samples of experience		Physical-chemical characteristics, mg/dm^3			
		Chemical oxygen demand	Biological oxygen demand	Ammonium nitrogen	Phosphates
Sample1	Control 1	520±7.07	660±21.93	95.4±1.06	40.5±0.7
	NaCl	88±1.41	26.5±0.71	8.5±0.46	7.3±0.42
	$CaCl_2$	82±2.82	21.1±0.21	6.4±0.17	5.1±0.07
Sample 2	Control 2	540±17.67	620±17.2	93.1±2.12	40.6±1.06
	NaCl	97±2.48	26±1.27	7.8±0.21	7.5±0.16
	$CaCl_2$	86±1,55	22.8±0.76	5.2±0.28	4.9±0.24
Sample 3	Control 3	530±4.61	670±5.66	94.2±0.76	41.3±0.42
	NaCl	78±3.07	27.3±0.53	7.4±0.17	6.2±0.27
	$CaCl_2$	57±1.67	12.1±0.3	1.8±0.05	1.3±0.05

Table 4

The results of waste waters purification after coagulation usage of PACl with calcium chloride

Index	Control	PACh + $CaCl_2$
Chemical oxygen demand	530±4.61	57±1.67
Biological oxygen demand	670±5.66	12.1±0.3
Nitrogen ammonium	94.2±0.76	1.8±0.047
Phosphates	41.3±0.42	1.3±0.05

coagulant. When applying PACh + $CaCl_2$ the purification process takes place more intensively, the physical-chemical characteristics of wastewater are reduced: ChOD in 9.2 times, BOD in 55.8 times, ammonium nitrogen 52.2 times, the phosphates in 31.2 times.

The obtained data show, that using PACh $Al_2(OH)_5Cl$ as the coagulant is considered as advisable. Its action on salt formation was the lowest compared with others. There are certain advantages over other agents and wide range of its action.

The sizes of the flakes were the largest and low water temperature in the winter period didn`t affect the reaction, the sludge had thixotropic properties. The solution of PACh has the optimum acidity (pH 4.5–7) that does not lead to corrosion of metal constructions of purification facilities. For the treatment of waste water by mixture of PACh + $CaCl_2$ we selected molar ratio of PACh: $CaCl_2$ = 1:2.5 with the mass concentration of coagulant 60–100 mg of Al_2O_3/dm^3 of wastewater.

After the settling, the clarificated water was separated and treated with chloramine (an active chlorine content is 0.2–0.4 mol/dm^3). After treatment the waste water characteristics were as follows: ChOD = 68 mg O_2/dm^3; BOD = 12,1 mg O_2/dm^3; ammonium nitrogen 1.6 mg/dm^3; phosphates, 1.4 mg/dm^3 (the degree of purification is 99.5%). The sludge of waste waters after coagulation was treated by similar reagents and received a mass with a moisture content of 72–73% and such content of nutrients N:P:K=8.78: 3.1: 0.56, in 5–6 hours after the filtering. Re-treatment of sludge with PACh mixtured with calcium chloride and polyethylene glycol makes it suitable and safe for manufacturing organic or organic-mineral fertilizers.

After preliminary coagulation and sludge removing the waste waters, in an amount up to 1% of wastewater volume, were purified at the bio purification station. Physical-chemical characteristics of purified waste waters were fully corresponding to the maximum-possible concentration values for discharging purifired waste water into natural water reserves.

Thus, the prior coagulation of waste waters by removing the sludge at biological purification stations allows significantly reduce pollution and anthropogenic load on natural water reserves to prevent irreversible global violation in hydro ecosystems.

CONCLUSIONS

Therefore, the combination of the processes of production and processing in conditions of intensification of poultry industry leads to the formation significant amounts of wastewater. Assessment of the environmental impact of significant volumes of waste water of poultry farms is a prerequisite for solving further problems of their purification and preventing environmental pollution. Reducing pollution of natural water reserves by waste water discharge into adjacent water reserves is important to ensure the environmental safety of poultry farms. The experimental studies proved the effectiveness of integrated purification of poultry waste water by preliminary coagulation and removing the sludge. Using the proposed coagulant polyaluminumchloride is a promising and eco safe method. Purifiered waste water discharged into natural water reserves corresponded to the values of maximum-possible concentration in terms of quality.

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ВЛИЯНИЕ НИТРАТОВ ПОДЗЕМНЫХ ВОД НА СОСТОЯНИЕ ЗДОРОВЬЯ НАСЕЛЕНИЯ

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Проведено моніторинг стану підземних вод у районах Житомирської обл. Проаналізовано вміст основних забруднювачів (нітратів) щодо гранично допустимої концентрації. Встановлено, що характер розподілу органічних сполук (NO_3^-) у підземних водах зони Житомирського Полісся визначається геохімічними особливостями регіону. Охарактеризовано рівень природного і антропогенного навантажень, від яких залежить вміст нітратів у досліджених пробах води. Вміст нітратів у 39% проб перевищує ГДК у питній воді. Визначено ступінь канцерогенного ризику перорального навантаження нітратів для людини. Розроблено карту санітарного стану підземних вод досліджуваних районів.

Ключові слова: *нітрати, підземні води, забруднення, якість питної води.*

В природных условиях, являясь хорошим растворителем, вода содержит в определенных количествах биогенные элементы. Особенную тревогу вызывает загрязнение естественных вод азотосодержащими соединениями, главным образом, в виде нитрат-ионов (NO_3^-). Нитрит-ионы (NO_2^-), а также ионы аммония (NH_4^+) встречаются реже.

Все азотные соединения поступают в гидросферу из разных источников, особенно нужно выделить следующие:

• природные — связанные с атмосферными, биосферными и геологическими явлениями и процессами;

• искусственные, возникающие в результате деятельности человека [1, 2].

Значительному загрязнению биогенными веществами поддаются подземные