

SEDIMENTATION PROPERTIES OF AQUACULTURE WASTEWATER SLUDGE DURING THE CULTIVATION OF CLARIAS GARIEPINUS

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*The aim of the article is to study the parameters of wastewater settling in recirculating aquaculture systems (RAS) during the cultivation of African sharptooth catfish. The volumes of freshwater fish farming using such systems are steadily increasing. However, RAS have a disadvantage in that they require the disposal of contaminated wastewater generated during the washing of the filter meshes of the mechanical filters through which the recirculated water passes. It is advisable to use wastewater settling tanks in RAS because they are quite effective in removing total suspended solids (TSS) and have a relatively low cost, which leads to their high economic efficiency. The results of studies on the settling of wastewater from mechanical filters using RAS during the cultivation of *Clarias gariepinus* confirmed the possibility of carrying out this process with high efficiency and using simple equipment in the case of further utilization of sludge and settled wastewater. The TSS content in the settled wastewater after the settling tank was 0.07 ± 0.015 g/l, while the TSS content in the recirculating water after the mechanical filter was 0.057 ± 0.023 g/l, which allows the use of the settling tank to replace the mechanical filter for RAS during the cultivation of *Clarias gariepinus*. Such a replacement will make it possible to remove only the sludge from the RAS, with its amount not exceeding 7 % of the amount of mechanical filter flush water. The expediency of creating a settling system based on two settling tanks was established: the first one for settling the wastewater from mechanical filters and the second one for settling the sludge obtained at the first stage of settling, which will reduce the amount of sludge for further utilization to 3 % of the amount of waste rinse water from mechanical filters. The settled wastewater from the settling tanks can be used in hydroponics systems or for irrigation, and the sludge after two-stage settling can be used for biogas production.*

Keywords: recirculating aquaculture systems, settling tank, total suspended solids, sludge, settled wastewater.

Aquaculture is one of the fastest-growing sectors in the food industry. The increasing demand for fish and seafood is accompanied by a steady growth in aquaculture production. To meet human demand for fish products by 2029, annual production should increase to 102 million tonnes [1].

Aquaculture produces more than half of the world's fish products. The production of aquaculture products using recirculating aquaculture systems (RAS) is becoming increasingly common. RAS are systems where water is reused in aquaculture production after mechanical and biological treatment. Such systems have a low environmental impact and reduce water and energy consumption. The volumes of freshwater fish (mainly eel and catfish) and trout produced using such systems are steadily increasing, reaching several thousand tonnes in Europe, and the use of freshwater

aquaculture is also growing in Asian countries. The use of RAS is the most promising global trend [2].

According to experts, aquaculture produces much less greenhouse gas emissions compared to livestock production. This means that breeding and consuming protein from fish can help mitigate the effects of climate change. However, RAS are not without a drawback, which relates to the need to dispose of waste-contaminated water generated during washing of the filter meshes of mechanical filters through which recirculated water passes [1, 2].

One of the methods of aquaculture wastewater purification is the use of wetlands. For example, when treating wastewater from a trout aquaculture farm using wetlands, it was found that the highest treatment efficiency for removing total suspended solids (TSS) reached 68 % at a

hydraulic loading rate (HLR) of 13.6 m³/day. Although wetlands show some efficiency in the treatment of aquaculture wastewater under the influence of natural factors, the pollution factors themselves are not eliminated from the ecosystem. [3].

Hydroponic systems are also used to treat aquaculture wastewater. [4]. Thus, it was found that a hydroponic system with barley cultivation allowed to reduce TSS by 52.7 to 60.5% [5], and therefore the authors recommend the use of additional sedimentation.

The simplest and most cost-effective way to treat aquaculture wastewater is to settle it and then use the sludge and settled wastewater [6]. The use of sedimentation (the process of separation of wastewater into sludge and settled wastewater due to the settling of sludge particles by gravity [7]) for sludge separation in RAS is considered inefficient due to the large volumes of recirculated water, which leads to a short residence time in the settling tank. However, the use of settling tanks may be appropriate for settling wastewater sludge from rotating microsieve mechanical filters that treat the main stream of recycled water [8]. The particles retained on the mesh are washed into a collection chute and discharged from the RAS. The volume of wastewater from the mechanical strainers is less than 1% of the recirculation flow, and therefore, sedimentation is considered to be an effective way to concentrate sludge [9]. The sedimentation efficiency (settling tank efficiency) is determined by the following expression [10]:

$$E = \frac{C_0 - C_\tau}{C_0}, \quad (1)$$

where: C_0 – TSS concentration at the inlet to the settling tank, %; C_τ – TSS concentration at the outlet of the settling tank at the current time τ , %.

A review article [11] concluded that settling tanks are relevant for use in thickening wastewater from mechanical mesh filters.

A review was conducted in [12], which found that the density of fish faeces was in the range of 1,050–1,080 kg/m³, and fish feed was 1,150–1,200 kg/m³. The average density was 1,190 kg/m³, and according to other data, the average density range was in the range of 1,050–1,160 kg/m³. The authors concluded that the low-density difference between TSS and freshwater (1,000 kg/m³), combined with the wide size distribution, makes it challenging to separate TSS from RAS wastewater.

The use of a pilot aquaculture wastewater treatment system showed that the efficiency of TSS removal by sedimentation was more than 70%, and due to the subsequent combined action of ozonation and chemical flocculation, 99% of TSS was removed [13].

Article [14] presents the results of a study of a wastewater treatment system for trout farming, where a mechanical filter and a flush wastewater sludge settler were used at the

last stage of treatment. Low TSS removal efficiency by a mechanical filter was found (at the level of 33–53%).

Coagulation was also studied to ensure the sedimentation of sludge from aquaculture wastewater [15]. For this purpose, the following coagulants were used: gypsum, alum with agricultural limestone, ferric chloride, and ferric chloride with non-ionic polymer (polyacrylamide) in doses that are commonly used in wastewater treatment [16]. The use of coagulation for aquaculture wastewater treatment, although it shows the effectiveness of pollutant removal, still requires further research and raises the issue of disposal of chemical-contaminated sediments generated during the coagulation process.

Based on the review of scientific publications, the following conclusions can be drawn: it is advisable to use wastewater settling tanks in RAS, as they are quite effective in removing TSS; settling tanks have a relatively low cost, which leads to their high economic efficiency; settling tanks in RAS wastewater treatment systems are used at the first stage of wastewater treatment and do not allow for the complete utilization of the generated sludge and settled wastewater.

The aim of the article is to study the parameters of wastewater settling in RAS during the cultivation of African sharptooth catfish (*Clarias gariepinus*). To achieve this goal, the following tasks need to be completed:

1. To study the process of sedimentation of the effluent from mechanical filters using RSA in the culture of *Clarias gariepinus*, with subsequent disposal of the sediment and sludge removed;
2. To determine the content of TSS in the settled effluent after the settling tank and in the recirculated water after the mechanical filter with further conclusions on the possibility of using the settling tank instead of the mechanical filter for RSA in the cultivation of *Clarias gariepinus*.
3. To determine the average value of the TSS removal efficiency and to prove the feasibility of creating a settling system based on two settling tanks: the first one for settling the waste rinsing water of the mechanical filters; the second one for settling the sludge obtained in the first stage of settling.
4. To investigate the possibility of using the sludge, after settling in the settling tank, as an organic fertiliser.
5. To determine the biogas yield from sewage sludge for a typical RSA system, based on the methodology for calculating the parameters of the process of preparing aquaculture sewage sludge for methane digestion.

Materials and Methods

The objects of study are the sludge from the rinsing water of the mechanical filters of the RSA, sedimentation tanks, and biogas plant.

The subject of the study is the sedimentation properties of the sludge from the rinsing water of the RSA mechanical filter during the cultivation of *Clarias gariepinus*.

Hypothesis – achievement of optimal values of RSA sludge moisture content to ensure its further anaerobic digestion can be achieved by two-stage sedimentation of mechanical filter flushing water.

The assumptions and simplifications in this article are due to the fact that only RSA mechanical filter sludge was used in the *Clarias gariepinus* culture. It does not take into account the different growth stages of the *Clarias gariepinus* in each tank and the associated different feeding regimes.

The research was conducted using the mechanical filter flush water for RAS during the cultivation of *Clarias gariepinus*. The general scheme of the RAS, which is equipped with a settling tank for separation of mechanical filter flush water into sludge and settled wastewater, is shown in Fig. 1.

At the first stage of the study, the mechanical filter wastewater was collected in measuring cylinders for settling (Fig. 2). The flush water was sampled before it entered the settling tank (position 5 in Fig. 1).

At the second stage of the study, the wastewater from the mechanical filter was settled in a sump (position 6 in Fig. 1). The sludge and wastewater were sampled after settling in the settling tank for a day (Fig. 3). To compare the TSS content of the wastewater after settling in the settling tank and the recirculating water after the mechanical filter, samples of the recirculating water after the mechanical filter were collected and analyzed.

After settling in the settling tank for a day, the sludge was further settled in a measuring cylinder and directly in the settling tank for several days (Fig. 4).

The experiments were conducted on three different days to neutralize the influence of technological factors and in

triplicate. Based on the data obtained, the standard deviation of the data and the confidence interval were determined at a 5% level of significance. The amount of sludge in the cylinders was determined with a change in the settling time, and the dry matter content in the mechanical filter wastewater, sludge and settled wastewater in the cylinders, wastewater and sludge after settling in the settling tank, and recirculation water after the mechanical filter were determined at the end of the settling process.

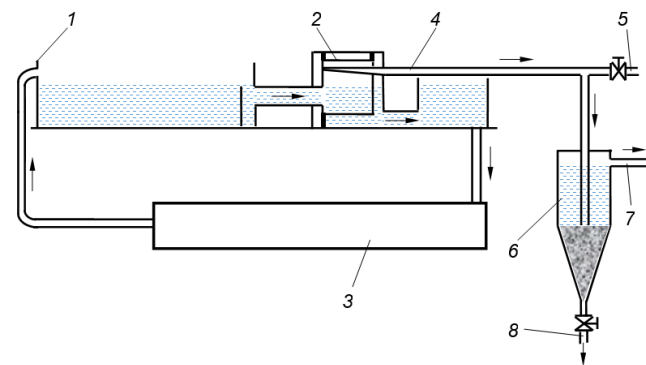


Fig. 1. General scheme of the recirculation system of aquaculture wastewater purification and sedimentation of sludge from the mechanical filter wash water: 1 – fish pool; 2 – mechanical filter; 3 – biological water purification system; 4 – pipeline for discharge of waste washing water from the mechanical filter for utilization; 5 – sampling point for waste wash water; 6 – settling tank; 7 – settled wastewater pipeline; 8 – sewage sludge discharge pipeline



Fig. 2. General view of the sampling site for the waste wash water (a) and the wash water from the mechanical filter in the measuring cylinders (b)



Fig. 3. General view of the sampling site of wastewater after the settling tank (a) and recirculation water after the mechanical filter, wastewater and sludge after settling in the settling tank for a day (b)

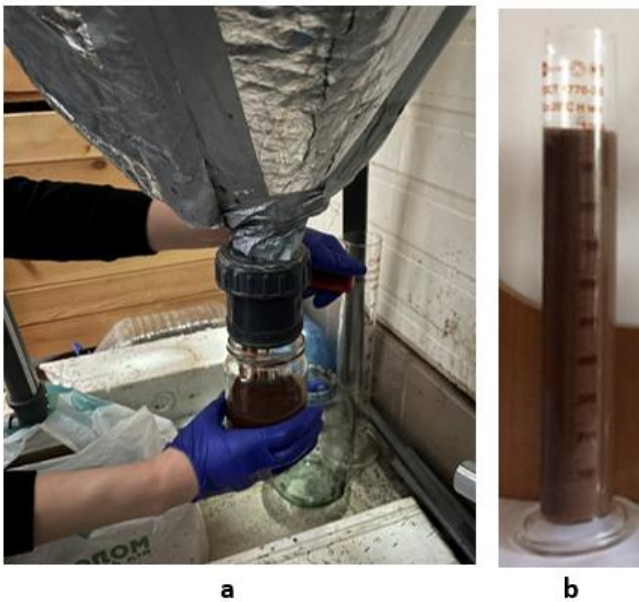


Fig. 4. General view of the sampling site for sludge after the settling tank (a) and sludge after settling in the settling tank for a day (b)

The assessment of agrochemical parameters of sludge and wastewater after settling in the settling tank was carried out according to standard methods in a specialized laboratory of the National University of Life and Environmental Sciences of Ukraine.

The dry matter content was determined by filtering the wastewater and sludge and then drying the residues on the filters in a drying oven at 105°C.

Results and Discussion

Wastewater settling using measuring cylinders

The study of the settling of the mechanical filter wastewater in liter measuring cylinders for RAS during the cultivation of *Clarias gariepinus* showed that the maximum volume of sludge is found at 70 ml (Fig. 5).

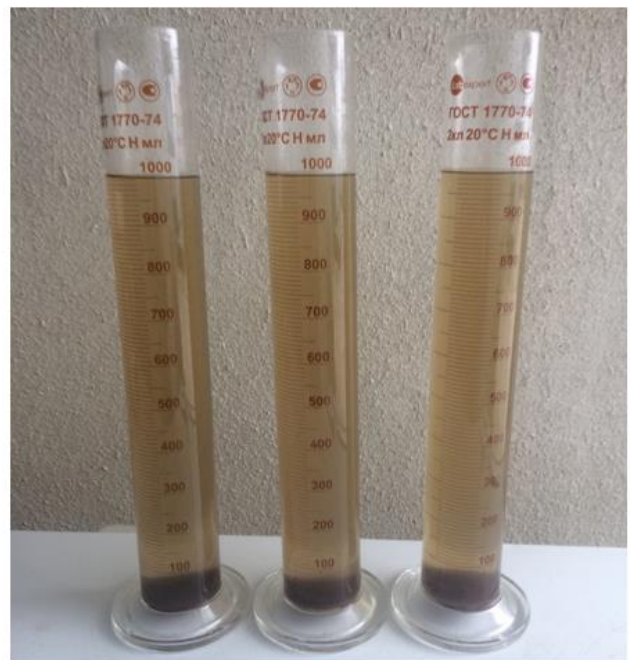


Fig. 5. The result of settling the wash water of a mechanical filter

It was found that sedimentation occurs in 3-4 minutes, and then, within 15 minutes, a combination of wastewater purification (clarification) and sludge compaction under the influence of the weight of the wastewater occurs. This process is completed within 20 minutes (Fig. 6). Thus, it can be assumed that the level of sedimentation in the mechanical filter wash water sludge is about 7% of the total amount of mechanical filter wash water.

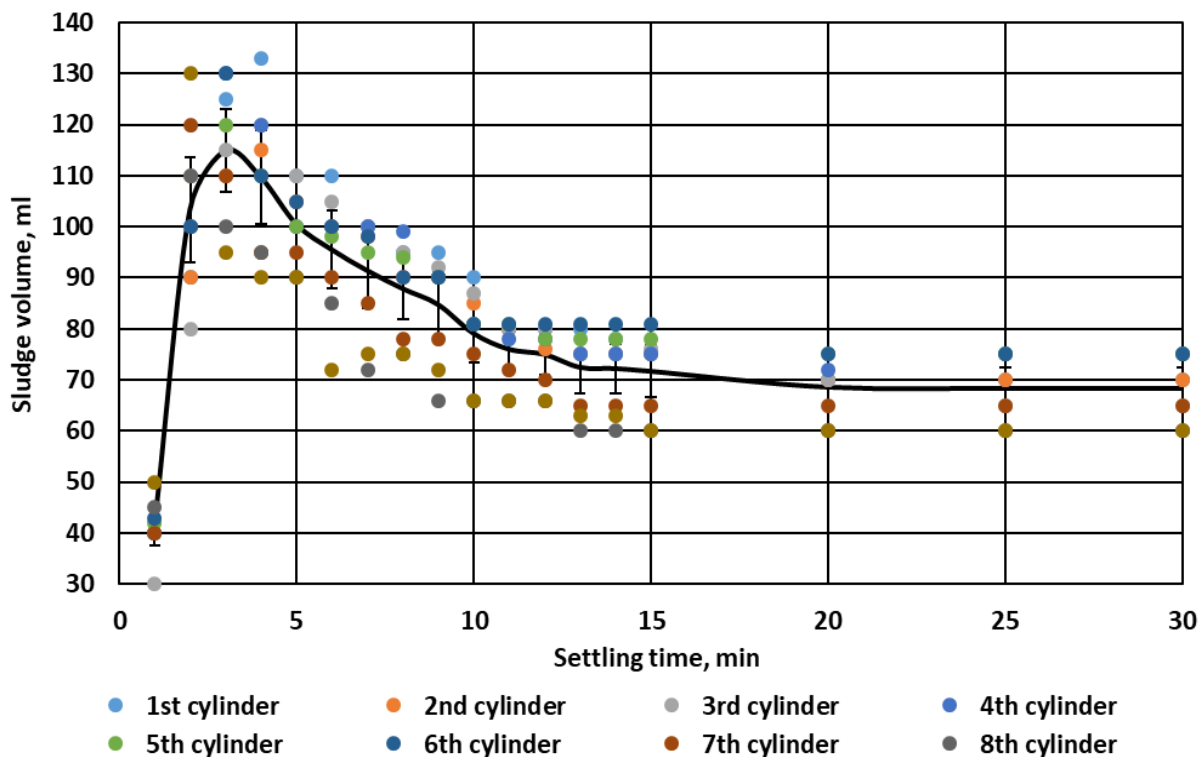


Fig. 6. Dependence of sludge volume on settling time in measuring cylinders

It was also found that the TSS of the mechanical filter wash water at 0.866 ± 0.092 g/L was concentrated in the sludge and amounted to 0.859 ± 0.091 g/L (Fig. 7). The wastewater sludge contained 0.007 ± 0.002 g/l TSS. The distribution of TSS between sewage and sludge was 1:120-125. The average TSS removal efficiency in the measuring cylinders was 99.2%.

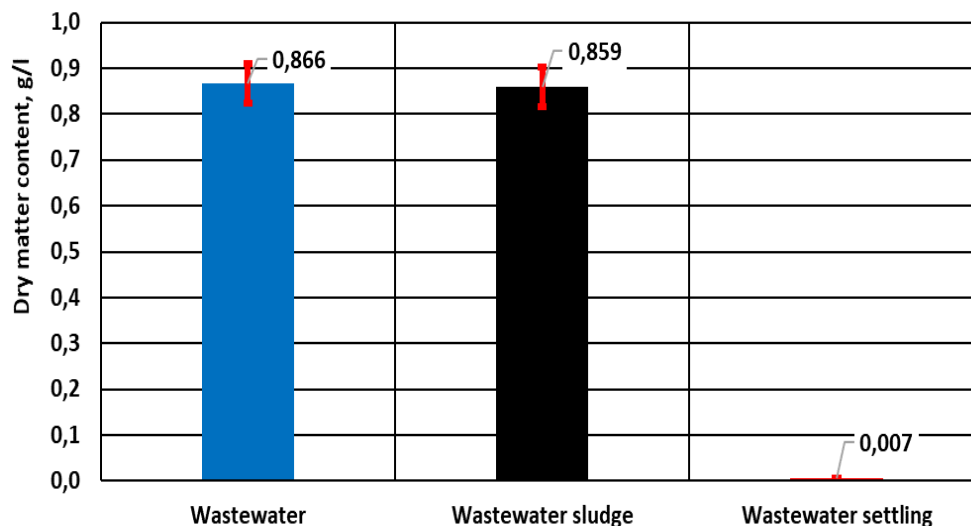


Fig. 7. Distribution of the DM content of mechanical filter wash water as a function of settling time in measuring cylinders

Settling of wastewater in a settling tank

The study of the settling of mechanical filter wastewater in the settling tank during the day showed the TSS content in the settled wastewater after the settling tank at a level of 0.07 ± 0.015 g/l, which is an order of magnitude higher than when settling in measuring cylinders. Such an excess of TSS content in the settled wastewater after the settling tank compared to the settling of mechanical filter wash water in

measuring cylinders is due to the dynamic mode of settling in the settling tank, which operated in a continuous mode. The assessment of the TSS content in the recirculating water after the mechanical filter showed a value of 0.057 ± 0.023 g/l. The TSS content in the sludge from the settling tank was 32.453 ± 0.663 g/l, which is approximately 30 times higher than when settling in measuring cylinders since the settling time significantly exceeded the settling time in measuring cylinders (Fig. 8). This phenomenon is

due to the compaction of sludge under the weight of the sludge and wastewater in the settling tank. The average

value of TSS removal efficiency in the settling tank was 91.9%.

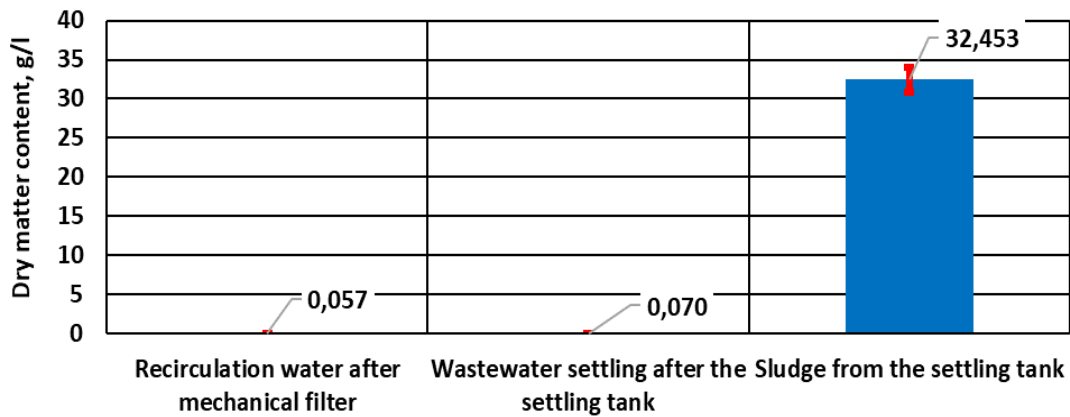


Fig. 8. Distribution of DM content in recirculating water after a mechanical filter, settled wastewater after a settling tank, and sludge from a settling tank after a day of settling

The evaluation of agrochemical parameters of sludge and wastewater after settling in the settling tank for a day showed the results presented in Table 1.

Table 1. Agrochemical parameters of sludge and wastewater after settling in the settling tank for a day (for initial moisture)

Name of indicators	Units of measurement	Sludge	Settled wastewater
Organic matter (C)	%	0.04±0.004	–
Mass fraction of total nitrogen (N)	%	0.25±0.003	0.17±0.02
Mass fraction of ammonia nitrogen (NH ₄)	%	0.11±0.0001	0.06±0.01
Mass fraction of total phosphorus (P ₂ O ₅)	%	0.06±0.0005	0.001±0.0001
Mass fraction of total potassium (K ₂ O)	%	0.02±0.002	0.007±0.001
Mass fraction of total calcium (CaO)	%	0.1±0.001	0.005±0.0008
Salt extract	pH	5.93±0.05	6.22±0.02

The results of the agrochemical parameters of the sludge indicate the possibility of using the sludge after settling in the settling tank as an organic fertilizer for vegetable crops when diluted with water in a ratio of 1:4.

Sludge settling using measuring cylinders

After settling in the settling tank for a day, the sludge was further settled in a measuring cylinder. It was found that the sludge volume continued to decrease for 15 days (Fig. 9).

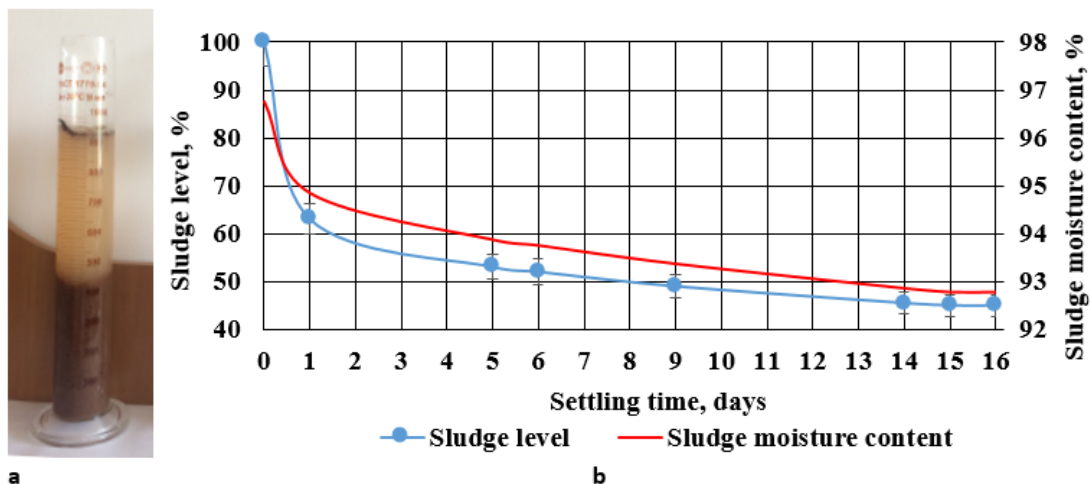


Fig. 9. General view of the sludge after settling (a) and the dependence of the sludge volume and its estimated moisture content on the settling time (b)

During the first day, the sludge level as a percentage of the current value of the sludge volume to the initial value decreased by up to 35-38%. The maximum value of the sludge level reduction was 45%. Based on the sludge level data, the dependence of the calculated sludge moisture content on the settling time was determined. It was found that when the sludge was settled for 15 days, its estimated moisture content was about 92.8%.

Settling of sludge in the settling tank

Settling the sludge directly in the settling tank for 15 days allowed obtaining a differential and integral distribution of the results of determining the moisture content of the sludge (Fig. 10).

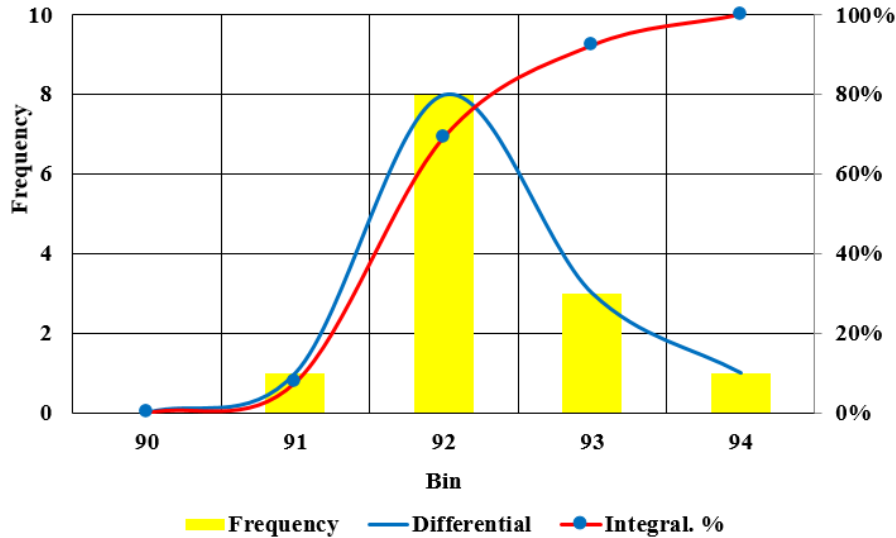


Fig. 10. Distribution of sludge moisture content after settling in a settling tank for 15 days

It was found that a sludge moisture content of 92% could be obtained after settling the sludge for 15 days, with a probability of 69.23%. As for the sludge moisture content of 93%, it can be obtained after settling the sludge for 15 days with a probability of 92.31%. No sludge sample with

more than 94% moisture content was obtained during the study. These data indicate the possibility of further anaerobic digestion of the resulting sludge to produce biogas and use it to increase the energy autonomy of an aquafarm.

Table 2. Agrochemical parameters of sludge and wastewater after settling in a settling tank for 15 days (for initial moisture)

Name of indicators	Units of measurement	Sludge	Settled wastewater
Organic matter (C)	%	1.95±0.05	–
Mass fraction of total nitrogen (N)	%	0.28±0.01	0.05±0.01
Mass fraction of total phosphorus (P ₂ O ₅)	%	0.28±0.03	0.02±0.003
Mass fraction of total potassium (K ₂ O)	%	0.01±0.002	0.009±0.001
Mass fraction of total calcium (CaO)	%	0.26±0.03	0.008±0.001
Salt extract	pH	5.55±0.01	6.59±0.05

Engineering methodology for calculating parameters of the process of preparation of aquaculture wastewater sludge for biogas fermentation

Studies have shown the feasibility of creating a system for settling mechanical filter wash water based on two settling tanks: the first one is for settling mechanical filter wash water; the second one is for settling the sediment obtained at the first settling stage. The sediment obtained at the first settling stage can be returned to the RSA system in the case of effective operation of the biological treatment system for recirculating water. It is obvious that the working volume of the first settling tank can be determined by the expression:

$$V_1 = q \cdot t_1, \quad (2)$$

where V is the working volume of the first settling tank, l; t_1 is the retention time of the mechanical filter wastewater in the first settling tank, min; q is the volume of the mechanical filter wastewater, l/min.

The annual yield of sedimentation during the settling of the wastewater wash water of mechanical filters in the first settling tank will be:

$$Q_1 = \frac{1440 \cdot 365}{1000} (1 - k_1) q, \quad (3)$$

where Q_1 is the volume of sedimentation from the first settling tank, l/min; 1440 min/day is the number of minutes in one day; 365 days/year is the number of days in one year;

1000 l/m³ is the number of minutes in one day; k_1 is the sediment yield coefficient from the first settling tank, rel. units. The annual sediment yield when settling the wastewater wash water of mechanical filters in the first settling tank will be:

$$Q_2 = \frac{1440 \cdot 365}{1000} k_1 \cdot q, \quad (4)$$

where Q_2 is the volume of sediment from the first settling tank, l/min. The working volume of the second settling tank (for settling the sediment obtained at the first settling stage) can be determined by the expression:

$$V_2 = \frac{1440}{1000} t_2 \cdot k_1 \cdot q, \quad (5)$$

where V_2 is the working volume of the second settling tank, l; t_2 is the retention time of the sludge from the first settling tank in the second settling tank, days.

Studies have established that the retention time of the wastewater wash water of mechanical filters in the first settling tank to achieve the maximum level of sedimentation should be at least $t_1=15$ minutes, the sediment yield coefficient from the first settling tank $k_1=0,07$ rel. units, the retention time of the sediment from the first settling tank in the second settling tank to achieve the maximum level of sedimentation should be at least $t_2=15$ days, and the sediment yield coefficient from the second settling tank $k_2=0,45$ rel. units.

The annual yield of sediment when settling the sediment obtained at the first stage of settling in the second settling tank will be:

$$Q_3 = \frac{1440 \cdot 365}{1000} (1 - k_2) q \cdot k_1, \quad (6)$$

where Q_3 is the volume of sediment from the second settling tank, l/min; k_2 is the coefficient of sediment yield from the second settling tank, rel. units.

The annual sediment yield when settling the sediment obtained at the first stage of settling in the second settling tank will be:

$$Q_4 = \frac{1440 \cdot 365}{1000} k_1 \cdot k_2 \cdot q, \quad (7)$$

where Q_4 is the volume of sludge from the second settling tank, l/min.

The working volume of the biogas reactor (for the fermentation of sludge obtained at the second settling stage) can be determined by the expression:

$$V_3 = \frac{1440}{1000} k_1 k_2 q t_3 \quad (8)$$

where V_3 is the working volume of the third settling tank, l; t_3 is the retention time of the sludge in the biogas reactor, days.

The annual biomethane yield can be determined by the expression:

$$V_{CH_4} = 365 \gamma \cdot V_3, \quad (9)$$

where V_{CH_4} is the annual yield of biomethane, m³/year; γ is the specific yield of biomethane in the biogas reactor, m³ CH₄/m³ CH₄ per day.

The annual electricity production based on the obtained biomethane can be determined by the expression:

$$W_{EL} = 0.278 V_{CH_4} \cdot Q_{CH_4} \frac{k_E}{100} \left(1 - \frac{k_{CCE}}{100} \right), \quad (10)$$

where W_{EL} is the annual electricity production, kWh/year; 0.278 kWh/MJ is the conversion factor of MJ to kWh; Q_{CH_4} is the calorific value of biomethane, MJ/m³ CH₄; k_E – the efficiency of electricity production by a cogeneration (gas internal combustion engine with an electric generator) plant, %; k_{CCE} – the coefficient of electricity consumption for the internal needs of a biogas plant, %.

An example of calculating the volume of settling tanks, sludge yield and indicators of the biotechnological process is given in Fig. 11.

The calculation shown in this figure demonstrates that with the volume of wastewater wash water of mechanical filters $Q_1=3$ l/min and in the case of returning the sediment from both settling tanks to the RAS system, in the case of efficient operation of the biological treatment system of circulated water, the amount of sediment that requires further disposal is 49,7 m³/year. This is about 3% of the total volume of wastewater wash water of mechanical filters.

The sediment from settling tanks can be used in hydroponics systems for growing vegetable crops or for irrigation when growing field crops, and the sediment after two-stage settling can be used for the production of biomethane and electricity based on it. Thus, the feasibility of creating a settling system based on two settling tanks has been established: the first one is for settling wastewater wash water of mechanical filters; second - for settling the sediment obtained at the first stage of settling, which will allow reducing the amount of sediment for further disposal to 3% of the amount of wastewater flushing water from mechanical filters.

The results of the study of settling the wastewater from mechanical filters using RAS during the cultivation of *Clarias gariepinus* confirmed the possibility of carrying out this process with high efficiency and using simple equipment. It should also be noted that the efficiency of wastewater settling can be ensured, provided that the sludge and settled wastewater are further utilized. This review of scientific publications also focuses on the efficiency of settling the wastewater from mechanical filters during the cultivation of tilapia, shrimps, rainbow trout, and the use of other RAS. The use of mechanical filters for settling wastewater and the resulting sludge using measuring cylinders and experimental settling tanks showed a significant difference in the

results obtained. This is due to the dynamic mode of sedimentation in the settling tank, which operated in a continuous mode, as well as the compaction of the sludge under the influence of the weight of the sludge and wastewater

in the settling tank. This should be taken into account when using different types of decanters for settling studies, as the results obtained will be only preliminary in comparison with the use of settling tanks.

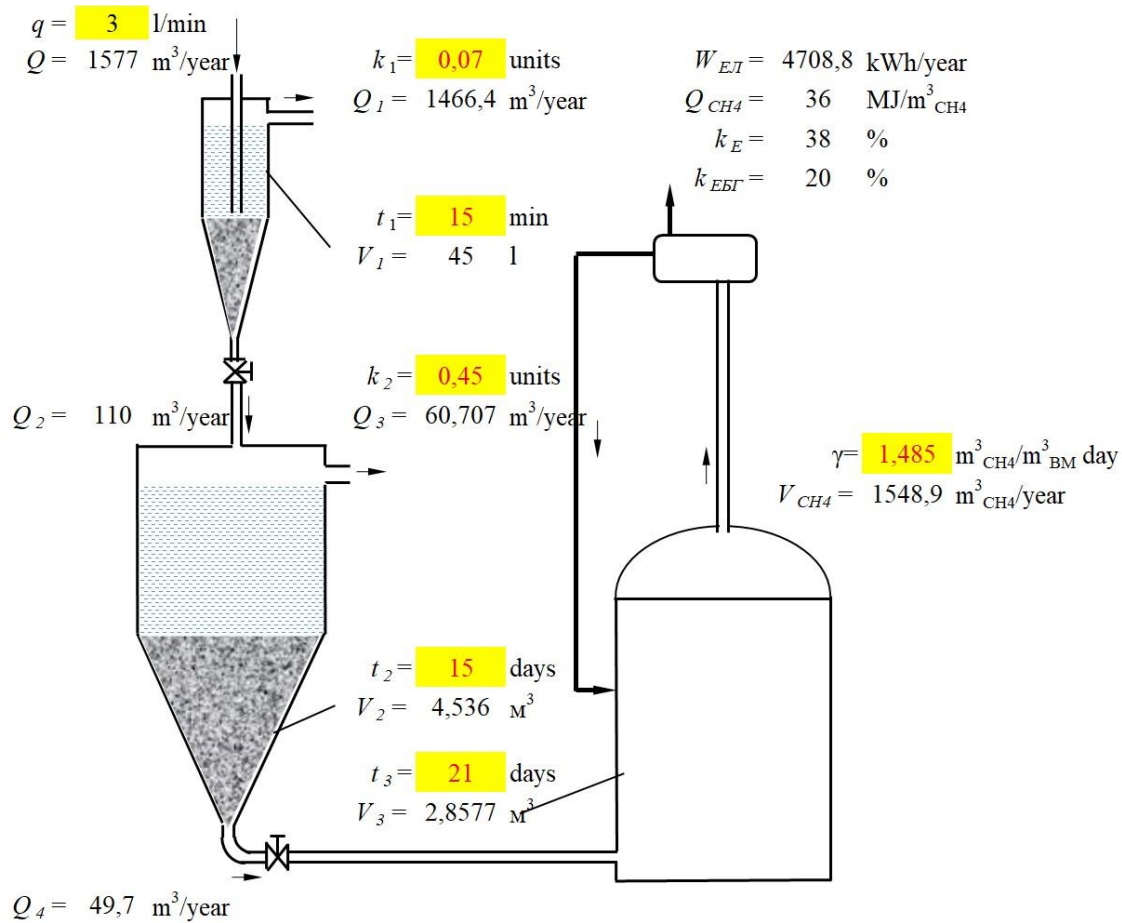


Fig. 11. Scheme and indicators of the biotechnological process of processing wastewater wash water of mechanical filters

The TSS content in the settled wastewater after the settling tank was found to be $0.07 \pm 0.015 \text{ g/l}$, while the TSS content in the recirculating water after the mechanical filter was $0.057 \pm 0.023 \text{ g/l}$. Thus, the wastewater settling after the settling tank corresponds with a slight excess to the recirculation water after the mechanical filter. This situation allows the settling tank to be used to replace the mechanical filter for RAS during the cultivation of *Clarias gariepinus*. Replacing the mechanical filter with a settling tank will make it possible to remove only sludge from the RAS, the amount of which, based on the analysis of settling in measuring cylinders, will be no more than 7% of the amount of waste wash water from mechanical filters. Given that the TSS content in the sludge obtained in the settling tank was $32.453 \pm 0.663 \text{ g/l}$, which is approximately 30 times higher than when settling in measuring cylinders, the amount of sludge that will need to be disposed of will be drastically reduced. This will significantly reduce the environmental impact. However, on the other hand, replacing the mechanical filter with a settling tank is only possible for RAS

with small volumes of recycled water. For comparison, similar results were obtained by the authors of [11, 16].

Studies have shown the feasibility of creating a settling system based on two settling tanks: the first one for settling the waste wash water from mechanical filters; the second one - for settling the sludge obtained at the first stage of sedimentation. The sludge obtained at the first stage of sedimentation can be returned to the RAS system in case of efficient operation of the biological purification system of recycled water.

The introduction of anaerobic digestion for biogas production is often hindered by the lack of sufficient energy and economic efficiency [17]. I have shown in my previous study [18] that in the vast majority of cases, this is due to insufficient biomass preparation for anaerobic digestion. It is known that the biogas produced is only sufficient to maintain the required anaerobic digestion temperature when the biomass moisture content is 96%, and the optimum biomass moisture content is 90-92%. Studies have shown that it is possible to achieve a given concentration of TSS in the biomass for further anaerobic digestion by using two

settling tanks, one for settling the mechanical filter rinse water and the other for settling the resulting sludge from the first settling stage. Such a two-stage settling of the mechanical filter flush water in the RSA during the cultivation of *Clarias gariepinus* made it possible to obtain a sludge moisture content of 92% for 15 days with a probability of 69.23%, which is the level of the sludge entering the anaerobic digestion process. As for the sludge moisture content of 93%, it can be achieved with a probability of 92.31%. Thus, the moisture content of the biomass is acceptable for starting the anaerobic digestion process in the RSA.

Conclusions

1. The results of studies on the settling of wastewater from mechanical filters using RAS during the cultivation of sharptooth catfish confirmed the possibility of carrying out this process with high efficiency and using simple equipment in case of further utilization of sludge and settled wastewater.
2. The TSS content in the settled wastewater after the settling tank was 0.07 ± 0.015 g/l, while the TSS content in the recirculating water after the mechanical filter was 0.057 ± 0.023 g/l, which allows the use of the settling tank to replace the mechanical filter for RAS during the cultivation of sharptooth catfish. Such a replacement will make it possible to remove only the sludge from the settling tank from the RAS, the amount of which, based on the analysis of settling in measuring cylinders, will be no more than 7% of the amount of mechanical filter wash water.
3. It was found that the average value of TSS removal efficiency in the measuring cylinders was 99.2%, and in the settling tank - 91.9%. This indicates the feasibility of creating a settling system based on two settling tanks: the first one for settling the waste wash water of mechanical filters; the second one - for sedimentation of sludge obtained at the first stage of sedimentation, which will significantly reduce the amount of sludge for further utilization by anaerobic digestion to produce biogas.
4. It was found that the sludge after settling in the lagoon can be used as an organic fertiliser for vegetable crops when diluted with water in a ratio of 1:4.
5. The biogas yield for a typical RSA system was determined on the basis of the methodology for calculating the parameters of the process of preparing aquaculture wastewater sludge for methane digestion, with a methane yield of 1 m^3 per 1 m^3 of wastewater.

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