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RESEARCH ON A POSSIBILITY OF USING AN ELECTROFLOTATION PROCESS FOR WASTE TREATMENT FROM FISH PROCESSING

Some tests were undertaken to determine in what degree the wastes from frozen sea fish processing can be treated using an electroflotation process. On the basis of the investigations performed it has been stated that the best results are obtained during the electroflotation followed by the process of coagulation. Such a combination of processes allowed us to decrease chemical oxygen demand (COD) by 78%, biochemical oxygen demand (BOD_5) by 75% and suspensions by 92%. Effectiveness of the treatment process was connected with maintaining the appropriate reaction of wastes (pH = 6.6–7.0).

1. INTRODUCTION

Wastes from fish processing have a high content of organic impurities, especially proteins and fats. Besides fat from fish processing, there is often fat from canned food processing. It can be found that significant biochemical and chemical oxygen demands [1] are characteristic of the wastes from fish processing. Noxiousness of this kind of wastes for the environment is increased by products of putrid processes taking place in them.

A source of wastes are processing plants of differentiated output. Most of the plants are connected with port areas [1]. Such a location causes higher pollution of port waters and adjacent water regions which have already been contaminanted.

Wastes produced by fish processing vary in the degree of their toxicity. It results from product diversity as well as different technologies of raw material being processed [2].

The data reported by MESSIEH [1] and given in table 1 prove that the content of pollutants in wastes is differentiated. Authors of [3] notice different agents, e.g. sex of fishes, affecting waste composition. Methods of treating the wastewater from fish

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processing are classified according to the quality requirements imposed on the wastewater discharged to public waters (seas, lakes, rivers and canals).

Table 1

Characteristics of effluents from fish processing plants

Type of processing	BOD_5	SS	Oils
	mg/dm^3		
Fish processing			
Dry line, ground fish	100–460	60–290	15–90
Wet line, ground fish	300–1100	160–510	900
Herring	3900–8900	3000–3400	1200–2500
Fish meal processing			
Blood water	80000–120000	15000	3000

Generally, the treatment processes applied, depending on the content of pollutant load, can be specified as follows [2]:

1. In the case of light load of wastes, after sieving relatively large impurities, fish meat suspension containing fat is floated and degraded using biological methods.

2. In the case of heavy load of wastes, coagulation is applied.

Application of coagulation is based on the assumption that water-soluble proteins and emulsion of fat are readily coagulable, if a coagulant is added to effluents. Main coagulants used in the case of water-soluble substances are aluminium and iron salts. Synthetic, high-molecular coagulants are used to make the separation of floccules formed in water during coagulation remarkably quicker.

2. EXPERIMENTAL

In our experiments, wastewater from sea fish processing plant was tested. Samples of wastewater were taken from the equalizing tank. Before entering the tank, large solid wastes, e.g. pieces of fish meat, had been removed. A composition of wastes changed, depending on the conditions, in which a technological process took place. Such changes, i.e. a variation in chemical oxygen demand in the samples taken for over ten weeks, have been shown in figure 1. Wastes from fish processing are turbid and grey in colour. The degree of their transparency changed with time, in the first few hours a bit quicker than in the next tens hours when the changes were almost imperceptibly.

The test equipment is shown in figure 2. A basic element of the system is a rectangular flotation cell of the working capacity of 2 dm^3. The height of the column of liquid was 0.5 m. Inside the cell, close to the bottom, there were placed

Table 2

Characteristics of treated wastes

Indices	Wastes	
	Sample 1	Sample 2
pH	6.4	6.74
Turbidity (mg/dm^3)	47.5	37.0
COD ($mg\ O_2/dm^3$)	1033	700.0
BOD_5 ($mg\ O_2/dm^3$)	957	637
Suspended solids (mg/dm^3)	160	63
Solid residue (mg/dm^3)	944	912
Chlorides (mg/dm^3)	261	260

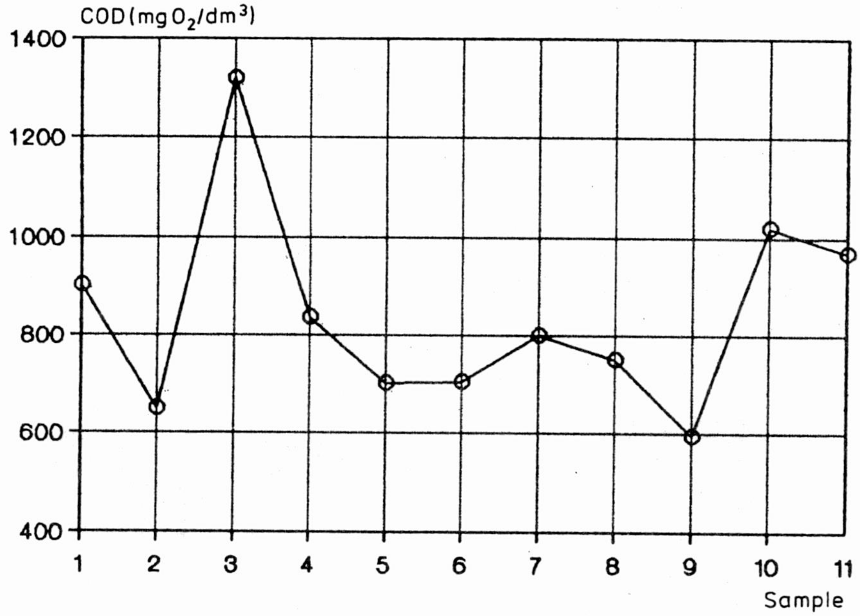

Fig. 1. Variability of chemical oxygen demand (COD) during the work of the fish processing plant

vertically two rectangular electrodes. The dimensions of the electrodes were as follows: 0.1 m in lenght, 0.045 m in height and 0.002 m thick. A gap between electrodes was 0.04 m. The electrodes were made of acid-resisting steel and supplied with direct current with voltage regulation. In some treatment experiments, only electroflotation was applied, while in the remaining experiments separately done coagulation was followed by electroflotation. In the coagulation process, aluminium sulphate ($Al_2(SO_4)_3 \cdot 18\ H_2O$) pure for analysis and polyelectrolyte Rokrysol WF-2 being a modified polyacryloamid of very high polimerization degree were used.

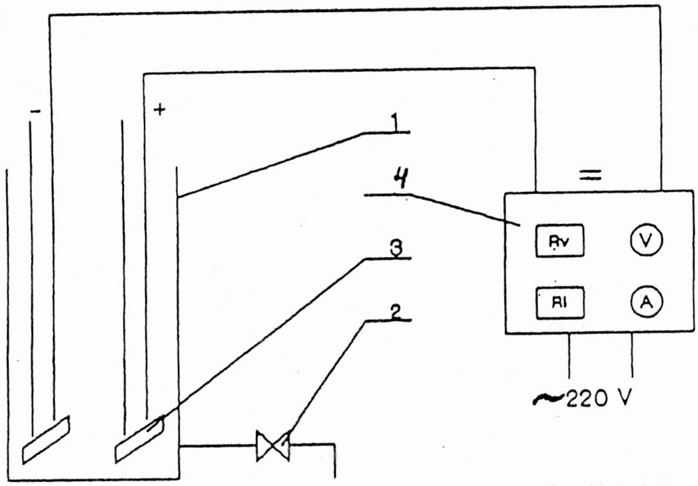

Fig. 2. Scheme of the testing equipment
1 – flotation cell, *2* – sampling, *3* – electrodes, *4* – rectifier

3. RESULTS

We began our research with a series of experiments, in which wastes free of fish meat shreds and other solid substances were treated by electroflotation. The wastes

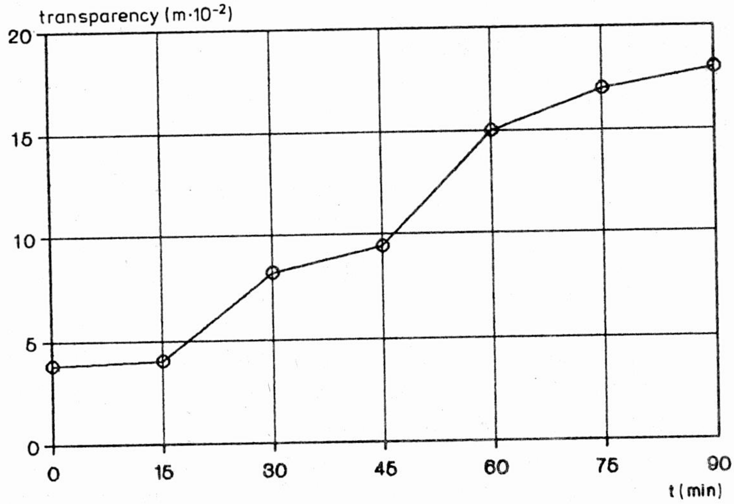

Fig. 3. Changes in waste transparency during the electroflotation process

introduced into the flotation cell were very turbid. Their reaction was basic (pH ranged from 7.4 to 7.6).

In this series of experiments, the influence of electroflotation time on waste transparency was examined. Some results of experiments are shown in figure 3. The transparency was determined basing on the measurement of the height of a column of liquid at which a black cross on a white background showing through the liquid disappeared. During electroflotation with the increase in the foam layer thickness, the transparency of the treated wastes increased. It was a foam of a good stability. Only in few cases the problems with very intense foaming of wastes arised and the foam formed was unstable. It was caused by the presence of detergents used for equipment washing. Another feature of wastes, whose variability was determined during the electroflotation, was chemical oxygen demand. Simultaneous changes of the transparency and chemical oxygen demand during the electroflotation are presented in figure 4.

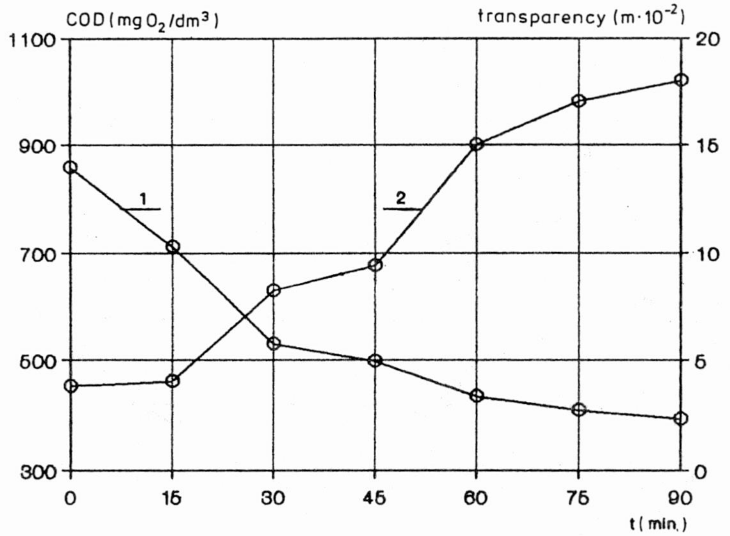

Fig. 4. Changes in chemical oxygen demand *1* and wastes transparency *2* during the electroflotation process

The measurement of the reaction of wastes, performed at the same time (the experiments in figure 4), proved that the value of pH increased steadily from 7.4 up to 8.8. Experiments were carried out at the direct current of voltage of 20 V and the density of 42 A/m^2. Long time of the process as well as rather slight decrease in the chemical oxygen demand (up to 44% of initial content) cannot be regarded as satisfactory, the more so as is was connected with high energy consumption (6 kWh/m^3 of wastes).

A high level of chemical oxygen demand after termination of electroflotation could prove that there arose the difficulties with direct removal of proteins, which were highly dispersed in water. Because of that reason in the next series of experiments, the coagulation done separately was followed by the electroflotation. The experiments carried out proved that the prolonged time of coagulation (over 30 minutes) did not cause an increase in the efficiency of the electroflotation applied for the waste treatment. Wastes treated in the coagulation process for 30 min increased their transparency from the initial value of 0.038 m in the way shown in table 3.

Table 3

Effect of coagulants on the changes in waste transparency

Waste	pH		Transparency after 30 min (m)
	Initial value	After 30 min	
Raw waste	7.4	7.4	0.057
Waste with addition of 0.1 g of $Al_2(SO_4)_3/dm^3$	7.4	6.8	0.092
Waste with addition of 0.1 g of $Al_2(SO_4)_3/dm^3$, 0.1 g of WF-2/dm^3	7.4	6.8	0.223

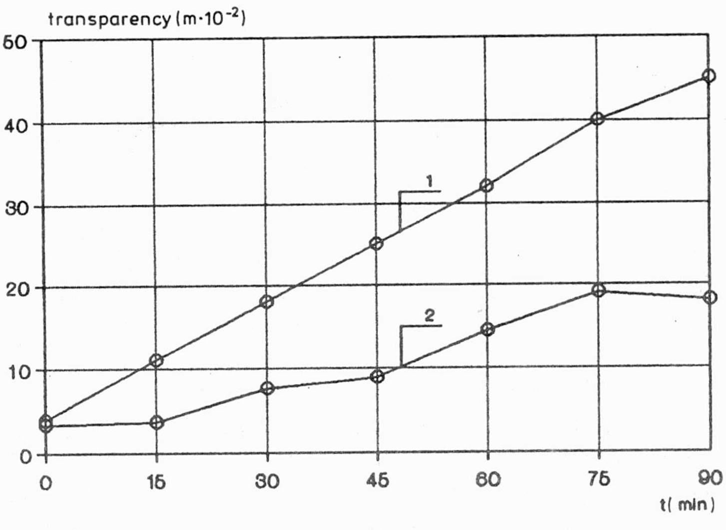

Fig. 5. Changes in waste transparency during the electroflotation process
1 – wastes treated by coagulation with $Al_2(SO_4)_3$, *2* – wastes without coagulation treatment

The results obtained revealed that application of such additives as aluminium sulphate and polyelectrolytes, which intensified the treatment, was justified. The comparison of the changes in waste transparency during electroflotation in the presence of coagulants and without them is shown in figure 5.

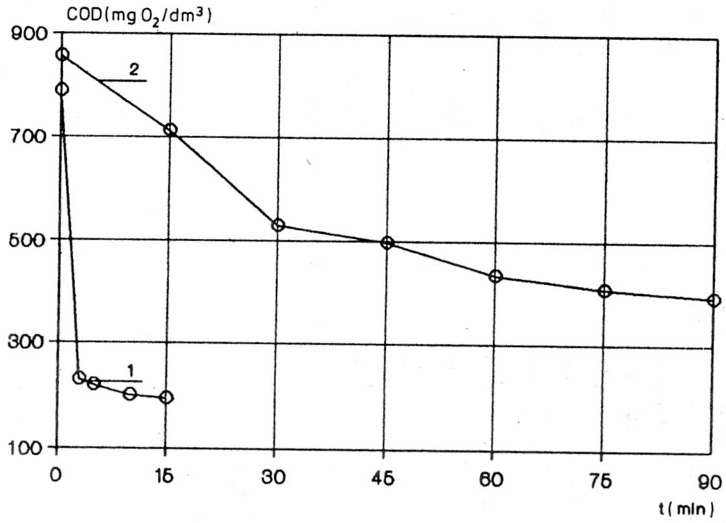

Fig. 6. Changes in chemical oxygen demand during the electroflotation process
1 – wastes treated by coagulation, *2* – wastes without coagulation treatment

The comparison of the chemical oxygen demand of wastes during electroflotation also pointed out how important the previous coagulation was for the efficiency of the former process. In figure 6, the process proceeding with and without coagulants is presented. Two significant differences are evident. The first refers to the rate of achieving an attainable level of waste treatment. Shortening of the time of electroflotation led to several times lower electrical energy consumption.

Taking account of the results presented, next experiments were carried out. They allowed a broader analysis of the efficiency of waste treatment by means of the electroflotation method. Results of these experiments are given in table 4.

The time of coagulation in all cases was 15 min, and the time of electroflotation did not exceed 10 min. Voltage of direct current conveyed to electrodes was regulated and did not differ from 0.5 A. This allowed us to decrease the electrical energy consumption to the value lower than 1 kWh/1 m^3 of wastes. The addition of polyelectrolyte to the wastes in experiments described in table 4 was 0.02 g/dm^3, while the additions of aluminium sulphate to wastes I and II as well as to waste III were 0.125 g/dm^3 and 0.175 g/dm^3, respectively.

Table 4

Indices of pollution before and after treatment in the process of electroflotation

Indices	Experiment I			Experiment II			Experiment III		
	Before treatment	After treatment	Treatment efficiency %	Before treatment	After treatment	Treatment efficiency %	Before treatment	After treatment	Treatment efficiency %
pH	6.74	6.75	–	7.15	6.7	–	6.97	6.8	–
Turbidity (mg/dm^3)	37.0	0.5	96.6	60.0	0.6	99.0	–	–	–
COD ($mg\ O_2/dm^3$)	700	258	63.1	720	160	77.8	981	259	73.6
BOD_5($mg\ O_2/dm^3$)	637	252	60.4	702	170	75.8	804	242	70.0
Extractable ether (mg/dm^3)	31.0	11.6	62.6	29.5	6.1	79.3	113.0	9.0	92.0
Suspended solids (mg/dm^3)	63.0	17.0	73.0	134.0	11.0	91.8	94.0	11.6	87.6

4. CONCLUSIONS

1. Research on the possibility of applying the electroflotation to the treatment of wastes from fish processing has given a positive result.

2. During investigations it has been established that for an effective electroflotation, previous coagulation of wastewater is necessary.

3. Our investigations have proved that the effectiveness of both processes: coagulation and electroflotation in the treatment of wastes from fish processing plants is strongly dependent on the pH adjustment. In the wastes treated by using the polyelectrolyte Rokrysol WF-2 and aluminium sulphate the value of pH ranged between 6.6 and 7.0.

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BADANIA NAD MOŻLIWOŚCIĄ ZASTOSOWANIA PROCESU ELEKTROFLOTACJI DO OCZYSZCZANIA ŚCIEKÓW Z PRZETWÓRSTWA RYB

Podjęto próbę określenia, w jakim stopniu można oczyścić ścieki pochodzące z przerobu mrożonych ryb morskich, wykorzystując do tego proces elektroflotacji. W wyniku badań stwierdzono, że najlepsze efekty daje elektroflotacja połączona z poprzedzającą ją koagulacją. Takie połączenie procesów sprawiło, że chemiczne zapotrzebowanie tlenu w ściekach zmniejszyło się o 78%, pięciodniowe biochemiczne zapotrzebowanie tlenu o 75%, a zawartość zawiesin o 92%. Skuteczność procesu oczyszczania związana była z utrzymywaniem właściwego odczynu ścieków (pH = 6,6–7,0).

ИССЛЕДОВАНИЯ ВОЗМОЖНОСТИ ПРИМЕНЕНИЯ ПРОЦЕССА ЭЛЕКТРОФЛОТАЦИИ ДЛЯ ОЧИСТКИ СТОЧНЫХ ВОД ИЗ РЫБОЗАВОДОВ

Предпринят опыт определения, в какой степени можно с помощью электрофлотации очистить сточные воды, происходящие из переработки мороженной рыбы. В результате исследований было установлено, что наилучшие эффекты дает электрофлотация вместе с коагуляцией. Такое соединение процессов вызвало 78-процентное понижение в сточных водах химической потребности в кислороде, 75-процентное понижение пятидневной биохимической потребности в кислороде, а содержание суспензей понизилось на 92%. Эффективность процесса очистки была связана с удерживанием соответствующей реакции сточных вод (pH = 6,6–7,0).