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Original Research

Investigations on Recovering Fats from Industrial Wastes by Flotating Separation

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Abstract

Our paper presents the results of research on utilization of after-centrifugal silts (AC-silts) from processing technical fats of animal and vegetable origins. The aim of the research was to compare two methods of fat recovery from AC-silts: dispersed (induced) air flotation (IAF) and hydrogen peroxide-enhanced dispersed air flotation (OxIAF). To realize this task a flotation system was constructed, which enabled complex testing of the method and the determination of parameters essential for the process. The installation of the output up to 10.0 $m^3 \cdot day^{-1}$ was equipped with AC-silt storage-averaging tanks, a flotator, a centrifuge for separating fatty fractions and a set to process after-flotation residuals. The solution permits more than 50% recovery of fats from AC-silts. The residuals, mainly water-protein suspensions, may be considered as substrates to produce material of fertilizer properties.

Keywords: after-centrifugal silts (AC-silts), fat flotation, dispersed (induced) air flotation (IAF), oxidizer enhanced dispersed (induced) air flotation (OxIAF)

Introduction

In recent years the intense development of small technical and oleochemical plant processing side, secondary and waste fats of animal and vegetable origin has made it necessary to work out a method for managing wastes from a product centrifuging process. Terminology defining this type of small factory has been accepted mainly for animal fats on the basis of veterinary directives [1-5]. The secondary processing of technical and side fats of animal and vegetable origin is strictly connected with producing wastewaters and after-centrifugal silts (AC-silts) – the so-called centrifugal shootings [6-8]. The contents of fats, proteins and other substances in these wastes range widely and depend on the quality of the raw material, the way and time of rendering, the phase separation techniques, and on the effectiveness of the applied centrifuges separating a product [9, 10]. Based on the mass balance per year in seven small plants producing animal fats from the raw material of 3rd category using the diaphragmatic technique, the product (fat) yielded at 55-80% (with the use of 200 kg of water steam per 1.0 Mg of raw material on the average), while the volume of after-centrifugal wastewaters (including the processing water and water from the raw material) was at 25-40%, and the volume of AC-silts was up to 5.0% with reference to dry mass of the raw material [11]. Relying on the information gathered from four small plants, the volume of after-centrifugal wastewaters increased even to 60% of the raw material mass for fatty acids of vegetable origin. The volume of AC-silts with residuals mainly from the multi-tonnage refinery process was up to 3% with reference to the used raw material mass [11]. The quality composition of AC-silts showed some homogeneity: proteins and fats dominated in the

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silts from animal fat production, whereas in the silts from vegetable fat production – oils, fatty acids, phosphatides, lecithins and residuals of bleaching clay as well as of oil cakes were generally found [12, 14-16]. Waste soap-stock and fatty silts from cleaning multi-tonnage tanks used in fat industry, which, according to literature, contained app. 0.3-0.5 $m^3 \cdot Mg^{-1}$ of acid waters, are secondary processed in order to recover fatty acids of vegetable origin [9, 14, 15]. AC-silts produced in small oleochemical plants contain mainly solid fractions, e.g. residuals of bleaching clay and oil cakes, sodium or rarely potassium soaps and residual organic substances such as proteins, liquid fatty acids, mono- and diglycerides, oils, phosphatides, etc. [6, 12, 13, 15, 16].

Practical aspects connected with managing AC-silts from these productions have not been completely developed and practically applied. These wastes are usually burnt down or biologically hydrolyzed and used as components for the production of biogas and compost [18-25].

The subject of the present study is an attempt at working out a utilization method of after-centrifugal silts (AC-silts) from processing technical fats of animal and vegetable origins.

Experimental Procedures

Research on the method was conducted on a system for after-centrifugal silt (AC-silts) treatment (Fig. 1). The set was designed and constructed for daily treating maximum volume up to 10.0 m^3 of AC-silts from animal fat production and from the production of fatty acids of vegetable origin (10.0 $m^3 \cdot day^{-1}$). The essence of the method was based on separating the fatty phase by flotation at the first stage of treatment, and at the second stage, the residual of AC-silts was processed into a preparation with fertilizer properties. To recover fats, two methods of flotation were compared: dispersed (induced) air flotation (IAF) and hydrogen peroxide enhanced flotation (OxIAF). The methods were tested using silts from one- and two-stage serial centrifuging processes in a factory manufacturing technical fats of animal origin and fatty acids of vegetable origin [26]. In the system of the 2-stage product separation, serially set up centrifuges were applied: purifying and classifying, at 6,000 r.p.m. each. The research system consisted of storage-averaging tanks (1) and (2), each with 5.0 m^3 volume, to which AC-silts (also called centrifugal shootings) of vegetable (SS1) and animal (SS2) origins were directed. The tanks (see Fig. 1) were equipped with inner circulation systems (1.1) and (2.1), silt pumps (1.2) and (2.2), frame stirrers (1.3) and (2.3) as well as with heating coil pipes (1.4) and (2.4). The temperature in tanks (1) and (2) was no lower than 50^oC and was kept by means of heat taken from other operations carried out in the plant. Additionally, for long-stored wastes, a 30%-aqueous solution of hydrogen peroxide ($\rho = 1.11\ Mg \cdot m^{-3}$) in the amount of 24.0 $kg \cdot m^{-3} \cdot day^{-1}$ was dosed from the station (8) to block the putrefaction processes. AC-silts were forced by silt pumps (1.2) and (2.2) into the flotator system (3) (of chamber volume 0.5 m^3) equipped with: a circulation mixing system (3.1) with a silt pump (3.2), an air dispersing mechanical stirrer (3.3), an air intake system (3.4) and a flotator outflow system (3.5). In the research on hydrogen peroxide-enhanced flotation, the oxidizer was dosed from the station (8) into the pipelines, forcing AC-silts into a flotator (3). The separated flotates were directed into centrifuges (4) to be dewatered and possibly processed and the residual hydrated phase was directed into a mixer (5) of 1.5 m^3 volume. The mixer contents were kept at a temperature no lower than 50^oC by means of heat taken from other operations conducted in the plant. The mixer set (5) was equipped with a vertical frame stirrer (5.1), an aeration system (5.2) built into the bottom of the tank (4 Pfleiderer Water System aerating membrane disc diffusers) type of disc diameter D = 240 mm and diameters of membrane pores d = 120 μm), and an inner circulation system (5.3) with a silt pump (5.4). A pipe reactor (6) dosing a 60%-orthophosphoric acid from the station (10) at the first stage of the process producing fertilizer preparation was installed on the outer mixing circulation system. After averaging the acid concentration in a whole tank volume (at $70\text{-}75^oC$), the amount of 18.0-20.0 $kg \cdot m^{-3}$ of the aqueous 30% hydrogen peroxide solution was introduced from the station (9) within 30 minutes.

The first stage took 6.0 hours for each type of silt. The second stage was also realized in the mixer (5) after circulation mixing and aeration were disconnected. At this stage, burnt lime from a bunker (7) was applied with the use of a screw feeder (7.1) and directed into a mixer (5) in doses permitting the reaction at pH no lower than 8.0. The production of the fertilizer product was carried out at continuous mixing of the mass. After bulk consistence of the fertilizer product was achieved the process was stopped and the mixer contents were poured out onto a hopper of a screw feeder (11) and directed into a storage tank for further ripening. To control the reaction, pH-meters were installed at the inlet of the pipe reactor (pH1) and in the mixer (5) (pH2) (with a bayonet electrode). At the final stage, the ready raw material of the fertilizing preparation from the mixer (5) was directed to the volume providing its further ripening. In the case of treating wastes from vegetable fat production, the water separated on centrifuges was drained into the sewage system for its further biological treatment. Hydrogen peroxide was dosed to the mass in tanks (1) and (2) only for wastewater and silt putrefaction (mainly those of long storage time – more than 48.0 hours). Then the flotation process was not conducted and the streams flowed directly into the mixer (5) or, most often, to the waste incinerating plant. Such cases were found only in emergencies.

The flotator system separating fats provided the optimum recovery of these fractions at batch operation of the plant. It was achieved due to a method of the flotate outflow by using the system of vertical and serial outflow canals (3.5 in Fig. 1). Such a solution permitted exact determination of the volume of the flotated and concentrated fats. Depending on the contents of fats and other substances, in particular silts, the process of phases separation was carried out individually for each type of AC silt. If the content of fatty fractions of favorable use parameters (of the low value of peroxide number) in raw silts was significant, the flotate was processed again. This variant was realized most frequently and limited fat derivatives in the after-flotation residuals (particularly for fats of animal origin) to a maximum degree.

In order to estimate the effectiveness of the fats separation process, fats quality and protein content by the subject method in the averaged samples of the raw AC-silts (points A and B in Fig. 1) in the flotate (point C1 Fig. 1), in residues after separating the flotate (point C2 Fig. 1) and in the produced preparation which has fertilizer properties (point D Fig. 1), the following indicators were determined in accordance with the applications given in Polish standards [27]: reaction (PN-90/C-04540/01), total phosphorus (PN-91/C-04537/09), total nitrogen (PN-73/C-04576/12), ammonia nitrogen (PN-C-04576-4:1994 as well as PN-73/C-04576/03 and 05), and the contents of fatty substances (PN-87/C-04288.04). Routine analyses were made in raw silts in order to determine the level of the peroxide value and to state the presence of *Salmonella sp.*, with the use of tests and methods described in the RapidChek® *Salmonella sp.* user's manual and they were confirmed by other methods given in items [28. a, b].

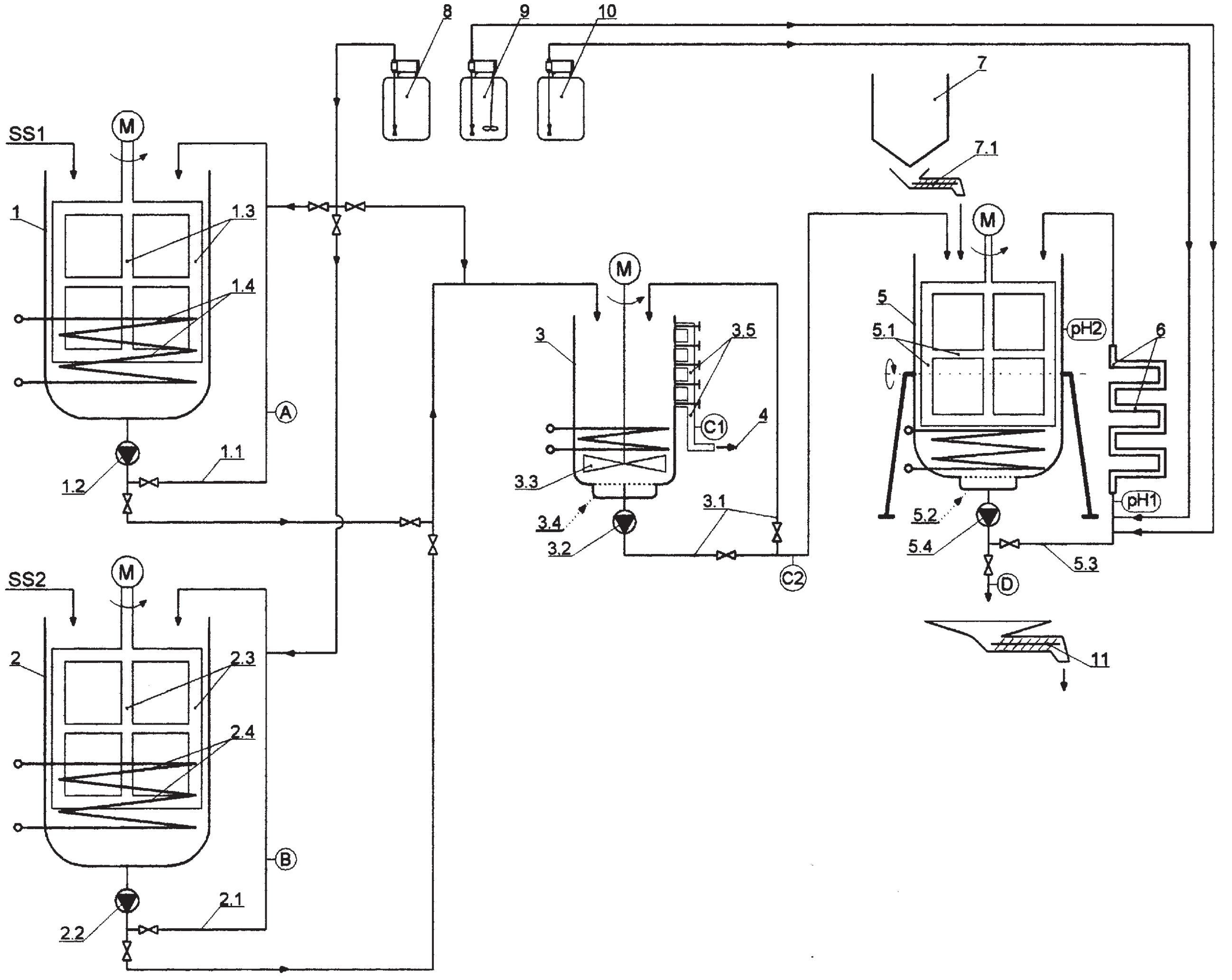

Fig. 1. Flow diagram of the installation for utilization of after-centrifugal silts (AC-silts) from secondary animal and vegetable fat production.

SS1 and SS2 – raw after-centrifugal silts from production of secondary vegetable and animal fats, 1 and 2) storage wastewaters from production of vegetable and animal fats, 1.1 and 2.1) inner circulation pipelines, 1.2 and 2.2) silt pumps, 1.3 and 2.3) frame stirrers, 1.4 and 2.4) silt pumps, 3) flotator, 3.1) flotator circulation mixing pipeline, 3.2) silt pump, 3.3) mechanical stirrer, 3.4) air intake system, 3.5) flotate outflow system, 4) centrifuges, 5) fertilizing preparation mixer, 5.1) frame stirrer, 5.2) aeration system, 5.3) circulation mixing system pipeline, 5.4) silt pump, 6) pipe reactor, 7) burnt lime bunker, 7.1) screw feeder, 8 and 9) hydrogen peroxide dosing stations, 10) orthophosphoric acid dosing station, 11) screw feeder, pH1 and pH2) pH-meters, (A, B, C1, C2 and D) – points of sampling, respectively: averaged AC-silts from production of: A) vegetable; B) animal fats; C1, C2) after flotation and D) fertilizing preparation.

The separated flotate was assessed by determining: peroxide value (PN-88/C-04288.10) and (PN-ISO: 3960:1996); acid value (PN-88/C-04288.06) and (PN-ISO 660:1998), and protein contents (PN-87/C-04288.14). Basic parameters of the fertilizing preparation were estimated by analyzing humidity (PN-EN 12048:1999), reaction (PN-EN 13037:2002), organic substance contents (PN-EN 13039:2002), total nitrogen (PN-78/C-87013.03) and (PN-93/C-87085), total phosphorus (PN-89/C-87030.17), and total calcium (PN-EN 13466:2003).

Results and Discussion

The problem of after-centrifugal silts (AC-silts) secondary processing is found in small technical and oleochemical plants which belong to a category of small and middle companies. Raw materials used in these plants are mainly wastes from multi-tonnage vegetable fat industry such as: oils, soap-stock, after-refining acids, fats from separators and discoloring sorbents, after-flotation fats, wastes from storage tank cleaning and AC-silts [6, 8]. After-centrifugal silts from extracting raw rapeseed oil used for the production of bio-fuels are often applied as raw materials [29]. In the secondary processing, meat industry largely uses pork, beef, and poultry fats [3, 8, 30]. Technical and oleochemical plants generally process low risk materials of the so-called 3rd category in accordance with veterinary directives [1-5]. The contents of the processed material depend on its origin as well as the time and method of storage, and also on the techniques applied for obtaining them. The processed secondary fatty substances are used as technical greases, among others, in the production of: esters, refined fatty acids, soaps, detergents, and in the processes of fodder enriching, etc. [6-8, 23, 29]. The amount and the contents of AC-silts are determined by product (fat) separation techniques and by the type and origin of a raw material. In case of animal-originated fats, the amount of silts makes a significant volume fraction in the general balance of the processed masses, and managing it is a real problem. One- and especially two-stage centrifuging leads to the formation of hydrated AC silts of

Table 1. Exemplary composition of AC-silts from the production of animal fats.

Product separation system[a)]	Water content [%]	Fat contents[b)] [%]	Mineral substances[b, c)] [%]	Protein contents[b, d)] [%]
One-stage system	88.1 – 96.7	45.8 – 67.8	-	22.9 – 29.3
Two-stage system	66.3 – 81.7	52.7 – 72.2	-	22.6 – 40.4

[a)] based on analyses made in 7 small technical fat production plants; [b)] with reference to dry mass; [c)] foreign substances – introduced during primary processing; [d)] determined acc. to PN-87/C-04288.14 and presented with reference to dry mass.

Table 2. Exemplary composition of AC-silts from the production of vegetable fats.

Product separation system[a)]	Water content [%]	Fat contents[b)] [%]	Mineral substances[b, c)] [%]	Protein contents[b, d)] [%]
One-stage system	93.8 – 97.3	79.6 – 85.9	0.2 – 3.8	1.5 – 2.7
Two-stage system	89.3 – 93.7	83.0 – 93.6	2.1 – 5.3	2.2 – 4.4

[a)] based on analyses made in 4 small oleochemical plants processing wastes from multi-tonnage fat industry (mainly: soap-stock, after-refining silts and flotates from the processing wastewater treatment); [b)] with reference to dry mass; [c)] foreign substances introduced during original processing (bleach soil residuals mainly) – determined acc. to PN-EN ISO 15301:2002, [d)] determined acc. to PN-87/C-04288.14 and presented with reference to dry mass.

Table 3. Exemplary composition of AC-silts from the production of raw rapeseed extracted oil.

Product separation system[a)]	Water content [%]	Oil contents[b)] [%]	Content of silts[b, c)] [%]	Total content of the other substances[b, d)] [%]
One-stage system	47.8 – 54.8	18.7 – 29.2	0.3 – 0.7	27.4 – 31.7
Two-stage system	30.7 – 41.4	28.5 – 39.5	0.4 – 1.1	29.9 – 38.9

[a)] based on analyses made in 3 small oleochemical plants extracting raw plant oil; [b)] with reference to dry mass; [c)] determined acc. to PN-EN ISO 15301:2002 (oilseed cake mainly); [d)] total amount of substances determined gravimetrically in the so called lecithin waters – after separation of fats and after vacuum water evaporation at temperature of 65-68°C.

high level of mass emulsifying. The emulsification level of the waste AC-silts depends on the type of separators used and is higher and more stable for higher rotations of centrifuges. Two-stage centrifuging permits the separation of after-centrifugal wastewaters from silts and provides higher effectiveness of fat recovery [19, 26]. This problem has already been discussed in the introduction to the present paper and is illustrated in Tables 1-3.

The basic problem concerning direct utilization of AC silts produced in secondary processing of animal fat deals with the contents of oleosubstances and protein mixtures. As far as AC-silts of vegetable origin are concerned, the problem also applies to phosphatides and lecithins – particularly from separation of raw extracted oil. So far, these substances have been treated as wastes in small technical and oleochemical plants and therefore ought to be utilized. To manage them reasonably, it is necessary to separate efficiently particular phases such as fats and water-protein in case of animal fats, or fats from water-phosphatide emulsion in case of vegetable originated silts. As it was stated on the basis of the analyses, AC-silts from the two-stage centrifuging were characterized by lower water fraction and, at the same time, showed a relatively higher level of fat and protein concentrations and of the content of the other substances. The comparison of the two flotation techniques: dispersed (induced) air flotation (IAF) and hydrogen peroxide enhanced flotation (OxIAF) made it possible to estimate the usability of these methods for practical fat recovery. In the first solution, fat recovery by dispersed air flotation exceeded 50% of effectiveness for each type of AC silt (Table 4). In the solution with the use of hydrogen peroxide-enhanced flotation in the vol-

Table 4. Exemplary parameters of fatty phase separated from AC-silts with the use of dispersed (induced) air flotation (IAF).

No.	Recovery of fats from silts [%]	Contents of fats in flotate phase [%]	Contents of mineral substances[a)] [%]	Acid value [mg KOH/g]	Peroxide value[a, b)] [meq/kg]
1	51.8 – 79.4	56.8 – 65.4	–	28.9 – 69.6	8.7 – 21.7
2	57.4 – 82.0	63.2 – 74.3	–	33.3 – 78.4	5.8 – 19.6
3	62.9 – 86.7	60.4 – 77.4	–	28.7 – 80.6	8.3 – 28.9
4	72.6 – 92.8	71.5 – 81.6	–	17.6 – 58.0	11.9 – 30.4
5	79.8 – 94.6	58.6 – 79.2	0.0 – 3.4	53.9 – 89.5	38.6 – 56.4
6	66.4 – 81.3	60.4 – 79.3	0.0 – 0.3	> 100	30.5 – 51.8
7	75.7 – 88.7	79.7 – 84.8	0.1 – 0.3	3.1 – 11.8[c)]	3.9 – 11.8

where: No. indicates silts formed as a result of processing: 1) unsalted fatback, 2) jowl fats, 3) leaf fat, 4) poultry fats and vegetable fats, 5) the 1st stage wastewater pretreatment flotate, 6) soap-stock for fatty acid production 7) from production of extracted raw rapeseed oil; [a)] in phase of the separated flotate; [b)] meq/kg – peroxide value expressed in milliequivalents of active oxygen in 1.0 kg of fat, acc. to PN-ISO 3960:1996; [c)] as the oil acidity determined acc. to PN-ISO 729:1999.

Table 5. Exemplary parameters of the fatty phase separated from AC-silts with the use of hydrogen peroxide-enhanced dispersed (induced) air flotation (OxIAF).

No.	Recovery of fats from silts [%]	Contents of fats in flotate phase [%]	Contents of mineral substances[a)] [%]	Acid value[a)] [mg KOH/g]	Peroxide value[a)] [meq/kg]
1	70.4 – 92.1	67.9 – 83.1	–	27.7 – 70.1	38.7 – 53.0
2	73.3 – 91.6	70.7 – 79.5	–	31.4 – 75.9	26.4 – 41.6
3	78.4 – 93.9	71.5 – 79.9	–	28.5 – 76.9	22.0 – 53.8
4	80.9 – 94.8	74.6 – 82.8	–	15.3 – 59.4	33.4 – 74.9
5	83.5 – 96.7	69.9 – 81.0	0.2 – 4.2	> 100	50.2 – 72.7
6	83.5 – 92.8	66.8 – 83.6	0.1 – 0.5	> 100	60.3 – 87.5
7	80.9 – 95.2	88.7 – 93.4	0.0 – 0.1	> 100	10.2 – 37.9

where: number indicates silts formed as a result of processing: 1) salted fatback, 2) jowl fats, 3) leaf fat, 4) poultry and vegetable fats, 5) the 1st stage wastewater pretreatment flotate, 6) soap-stock for fatty acid production, 7) from production of extracted rapeseed oil; [a)] in phase of the separated flotate.

ume of 1.2-1.9 kg·m^{-3} of the silts, the effectiveness of fat recovery exceeded 70% (Table 5). However, the use of this compound to support flotation resulted in a significant increase in the peroxide contents in the flotate (Table 5). Since the applied parameters (a value of peroxide number) are more favorable, it seems that the solution with the dispersed air stream flotation is more reasonable to implement in practice. A flotate obtained in this solution can be recycled to recover fatty substances. However, the solution with hydrogen peroxide-enhanced flotation (Ox-EIAF) can be used to a limited degree, especially for silts of a long storage time. Then, after preliminary biological hydrolysis, the contents of tanks (1) or (2) can be directed into a mixer (5) (see Fig. 1), where they are transformed into fertilizing preparations provided that the fat contents are low. However, this tendency requires further research on the fertilizing usability of such a preparation.

Auto-hydrolysis of protein substances with releasing ammonium and hydrogen sulfide, which takes place while storing silts of animal origin in particular, is a serious problem in the management of the discussed AC silts. Under these conditions, an increase is observable in both soluble COD and BOD (COD$_D$ and BOD$_{5(D)}$) with reference to the total ones (COD$_T$ and BOD$_{5(T)}$) as the storage time elapses and the processes of biodegradation develops. The decay of proteinous substances and their partial mineralization are a result of those complex processes. Under these conditions, processes of biological hydrolysis of fats proceed, leading to an increase in the acid value. This issue is presented in Figures 2-4 for the stored raw AC-silts.

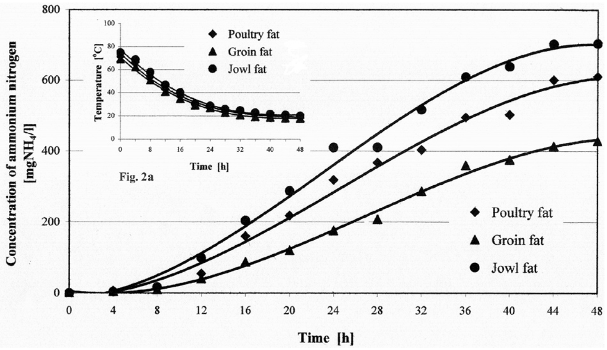

Fig. 2. The ammonium nitrogen concentration and the fat temperature (Fig. 2a) as a function of storage time of AC-silts from the production of technical fats of animal origin with the change of the ambient temperature.

The management of fats recovered from AC-silts is not a technical issue on condition that material of favorable use parameters is obtained. However, for small manufactured quantities in small technical plants it makes a big problem connected with a long storage time of AC-silts. This results in an increase in the acid and peroxide values and in the variations of the above discussed COD and BOD values. It was found that the addition of hydrogen peroxide to the stored waste material (particularly in cases of batch production and frequent changes of raw material) at least partially blocks putrefaction processes and biological hydrolysis of fatty compounds due to its bacterio- and fungistatic as well as bacterio- and fungitoxic activities [31]. However, the application of this compound results in producing fats of low quality (a high peroxide value) and, therefore, only their energetic application may be taken into account.

As far as the technological aspect of processing is concerned, in order to obtain a fertilizer from the substances found in the discussed wastes, it was necessary to defat them and to eliminate micropathogens, if they occurred. This solution was tested by conducting experiments at the second stage of AC silts. After introducing orthophosphoric acid and maintaining the medium reaction at 70-75°C, the solid phase is transformed into the liquid one (suspended proteins in particular) and sanitation with hydrogen peroxide takes place. The addition

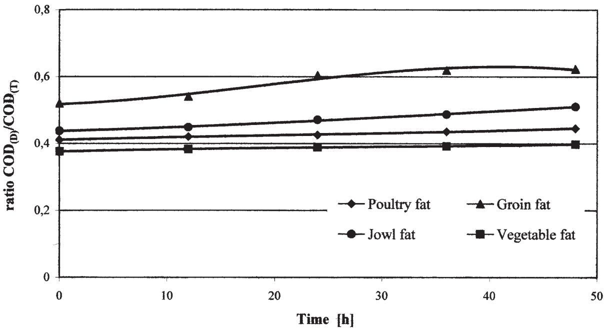

Fig. 3. The COD$_D$/COD$_T$ ratio as a function of storage time of AC silts from manufacturing technical fats of animal or vegetable origin.

The raw silts BOD$_{5(T)}$ concentration (time = 0.0 h) was for (fats of the following origins): poultry, jowl, groin, vegetable, respectively: 84010, 97560, 92020 and 68950 mgO$_2$/L. Changes of the COD$_D$/COD$_T$ ratio as a function of the changing environment temperature are presented in Fig. 2a.

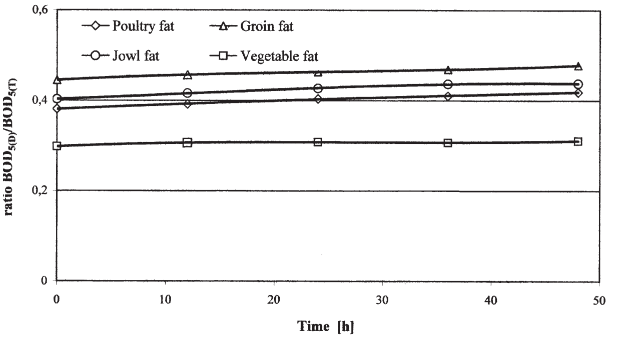

Fig. 4. The BOD$_{5(D)}$/BOD$_{5(T)}$ ratio as a function of storage time of AC silts from manufacturing technical fats of animal or vegetable origin.

The BOD$_{5(T)}$ concentration for raw silts (time = 0.0 h) was for fats (of the following origins): poultry, jowl, groin, vegetable origins, respectively: 38660, 47610, 42990 and 20540 mgO$_2$/L. Changes of the BOD$_{5(D)}$/BOD$_{5(T)}$ ratio as a function of the environment temperature are presented in Fig. 2a.

Table 6. Exemplary contents of the material of fertilizer properties as a product defatting of AC silts from production of technical fats of animal origin.

Item	Parameter[a]	Unit[b]	Contents[c]
1	Humidity	%	17.7 – 32.9
2	Organic substance contents	%·kg^{-1} d.m.	18.9 – 27.8
3	Total nitrogen	% N·kg^{-1} d.m.	2.9 – 6.9
4	Total phosphorus	% P·kg^{-1} d.m.	10.4 – 15.3
5	Total calcium	% Ca·kg^{-1} d.m.	19.7 – 29.9

[a] after 10 days of ripening; [b] d.m. – dry mass; [c] the contents obtained for 9 samples of different proportions of the reagents.

of burnt lime results in obtaining a solid final substance characterized by a considerable fraction of the products, mainly of the probable reactions [32, 33]: $2H_3PO_4 + CaO_{(s)} \rightarrow Ca(H_2PO_4)_{2(s)} + H_2O$, $H_3PO_4 + CaO_{(s)} \rightarrow CaHPO_{4(s)} + H_2O$ and $2H_3PO_4 + 3CaO_{(s)} \rightarrow Ca_3(PO_4)_{2(s)} + 3H_2O$. This method may be also useful to process the long-stored AC-silts. Ammonium nitrogen, produced as a result of spontaneous protein hydrolysis, can be fixed during the material processing according to the following reactions: $H_3PO_4 + NH_4^+ \rightarrow NH_4H_2PO_4 + H^+$, $H_3PO_4 + 2NH_4^+ \rightarrow (NH_4)_2HPO_4 + 2H^+$, $H_3PO_4 + 3NH_4^+ \rightarrow (NH_4)_3PO_4 + 3H^+$ and $H_3PO_4 + NH_4^+ + Ca(OH)_2 \rightarrow CaNH_4PO_4 + H^+ + 2H_2O$, leading to the formation of ammonium phosphates. The method based on the use of orthophosphoric acid and burnt lime makes it possible to regulate C:N:P:Ca ratios with reference to the required final parameters of the fertilizing material. An exemplary, basic content of the preparation is listed in Table 6.

In the obtained organic-mineral product, a well-known process called ripening takes place as time goes on, which results in setting the mass of the preparation and in the occurrence of the final features of the product. In the last stage of the process, the bulk or semi-liquid (depending on technical conditions of the process) material of the obtained preparation is directed to open tanks, where it ripens and its final composition is stabilized.

Conclusion

The presented method of managing AC-silts of animal or vegetable origin is an alternative to currently used methods of their management, i.e. anaerobic decomposition into biogas or as a component in composting processes. The method may contribute to replacing a conventional two-stage elimination used in utilization plants, i.e. a preliminary decay in Hartmann's reactors and final thermal degradation. Fats separated from AC silts can be used in the oleo-chemical industry, e.g. as technical fatty acids for producing detergents, etc. Protein residues can be processed into calcium organophosphate preparations of fertilizer properties. The pretreated water phase can be directed for full aerobic or anaerobic biological wastewater treatment. The practical application of this solution may minimize waste produced at the source and significantly reduce fat losses.

References

1. Regulation of the Minister of Agriculture and Village Development of 12 June 2003, on the list of low, high and special risk materials (Polish Journal of Laws, 2003, no. 106, item 1001).
2. Regulation of the Minister of Agriculture and Village Development of 8 October 2003, on veterinary terms concerning inedible animal products and materials of low, high and special risk (Polish Journal of Laws, 2003, no 180, item 1767).
3. Regulation (EC) No. 1774/2002 of the European Parliament and of the Council of 3 October 2002, laying down the health rules concerning animal by-products not intended for human consumption.
4. Regulation of the Minister of Agriculture and Village Development of 7 December 2003, on the list of low, high and special risk materials (Polish Journal of Laws, 2004, no. 269, item 2676).
5. Commission Regulation (EC) No. 95/2005 of January 2005, implementing Regulation (EC) No 1774/2002 of the European Parliament and of the Council, as regards means of disposal or uses of animal by-products and amending its Annex VI as regards biogas transformation and processing of rendered fats.
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