Performance of combination of treatment processes for food industry wastewater depuration

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Abstract

Food industry uses large amounts of water for various purposes, including refrigeration and cleanliness, as raw material, as sterile water for food, transportation, cooking and dissolution auxiliary water etc. In principle the water used in the food industry can be recycled as process water and cooling or boiler feed water. As a consequence of diverse consumption, quantity and composition of wastewater from food industry ranging significantly.The effluent characteristics consist in SST large quantities, several chemical forms of nitrogen, fats and oils, phosphorus, chlorine and organic matter. Generally, BOD_5 and COD of wastewater food industryare10 or even 100 times higher than municipal wastewater. Odours are also a typical problem.

In the present study, a combination of more treatment step processes was investigated at real scalefor wastewater from food industriesby employing a flotation, biological, advanced oxidation and ultrafiltration process.A process data collection was performed and integrated with a characterization of the process effluents in terms of treatability and reusability. In order to evaluate properly the wastewater loading, an analysis course was set. It was examined the efficiency of the pollutants degradation by analysing the parameters concentration of the usual contained organic compounds in effluents: chemical oxygen demand (COD), ammonia, nitrites, nitrates, surfactants, which have been 15 - 20% extra degraded by mixed aeration. COD decrease resulted in the integrated air-ozone aeration process up to 90% compared to only 75% that occurs in a conventional biological activated sludge process. Further membrane MBR ultrafiltration and ozonation entailed a values reduction from another 10 -15%.

1. Introduction

Key resources used by the food-processing industry include the water, raw materials and energy. Traditionally, the food-processing industry has been a large water user. Water is used,throughout all steps of the food production process, as an ingredient, an initial and intermediate cleaning source, an efficient transportation conveyor of raw materials throughout the process, as the principal agent used in sanitizing plant machinery and areas, for peeling, cooking, and cooling. Finally, water is used to clean production equipment between operations. All in all, food processing is a water-intensive operation. Although water uses, always being a part of the food-processing industry, it has become the principal target for pollution prevention, source reduction practices.The food industry is now facing growing pressure to ensure that their company's activities are environmentally sensitive, but there is also increased internal pressure to maintain or increase profitability in the face of fierce competition. The food-processing industry has special concerns about health and safety of consumer.

As a consequence of diverse consumption, the amount and composition of food industry wastewaters varies considerably. Industrial food processing is often recognized as unfriendly to natural environment and considered as a source of numerous potential threats connected with possible environment degradation. Food processing plants are places producing “difficult” wastewater with large total load of organic pollutants like proteins or fats and chemicals used for cleaning and sanitizing processing equipment [Konieczny and Uchman 1997, Morgen-Lewińska 1992 a, Ochrona 1998, Orzeszko 1997, Pezacki 1991]. Characteristics of the effluent consist of large amounts of suspended solids, nitrogen in several chemical forms, fats and oils, phosphorus, chlorides and organic matter (Food and Drink Industries` Federation, 2005). Generally, the BOD_5 (biochemical oxygen demand) and COD (chemical oxygen demand) of food industry wastewater are 10 or even 100 times higher than those of domestic wastewater (EC, 2006). Unpleasant odours are also a typical problem in food industry wastewaters. These odours are usually the result of gases (hydrogen sulphide) produced by the anaerobic decomposition of organic matter (Metcalf & Eddy, 2003).

The disposal of such effluents in the environment will lead to surface and groundwater contamination: increase in COD, eutrophication, ecosystem imbalance and human health risks. Wide range of complex solutions for treatment of wastewater exists in industrial plants. In reference to food industry wastewater, treatment processes have to assure first of all required quality of discharged effluents. Costs analysis, but also possible utilization of substances contained in wastewater are taken into consideration. Plant localization and the water quality impact assessment defining characteristics of wastewater which are led from the processing plant to the municipal sewage system or to surface waters are another important factor while selecting an individual wastewater treatment method (Konieczny and Uchman 1997, Morgen-Lewińska 1992 a). With the exception of some toxic cleaning products, wastewater from food-processing facilities has distinctive characteristics that set it apart from common municipal wastewater managed by public or private WWTPs: is organic, rich in nutrients, biodegradable, nontoxic and can be treated by conventional biological technologies (Tchobanoglous, 1991). Food canning industries generate a large variety of wastewaters that are usually treated in a complex plant. Oils and fats contained in cannery wastewaters are usually removed in conventional treatment plants with flotation devices. Tomato-processing wastewaters generated from food-canning industry are typically considered difficult to biodegrade since they contain seed, skin and high particulate and colloidal fractions. Vegetable washing generates waters with high loads of particulate matter and some dissolved organic matter. It may also contain surfactants. Slaughterhouses generate very strong organic wastewater from body fluids (such as blood and gut contents). This wastewater is frequently contaminated by significant levels of antibiotics and growth hormones from the animals and by a variety of pesticides used to control external parasites (Álvarez et al. 2011, Zhukova et al. 2011). Wastewater from processing food for sale generated from cooking is often rich in organic material and may also contain salt, flavourings, colouring material and acids or alkali. Very significant quantities of oil or fats may also be present. Industrial wastewater characteristics vary not only between the industries that generate them, but also within each industry. These characteristics are also much more diverse than domestic wastewater, which is usually qualitatively and quantitatively similar in its composition.

In the present research work, treatability of food processing wastewater from process of cooking tuna, basil tomato and oliveswith COD3500-10000 mg/L was evaluated in a combined system composed of well arranged sequentially: screening, dissolved air flotation DAF, two serial steps of aerobic biological treatment, advanced oxidation process (AOP), MBR ultrafiltration and ozonation. The load may be very low or high in BOD_5, COD, total suspended solids (TSS), pathogenic microorganisms and variable pH. The inorganics (phosphorus and nitrogen) may be absent or present in excess.

2. Materials and Methods

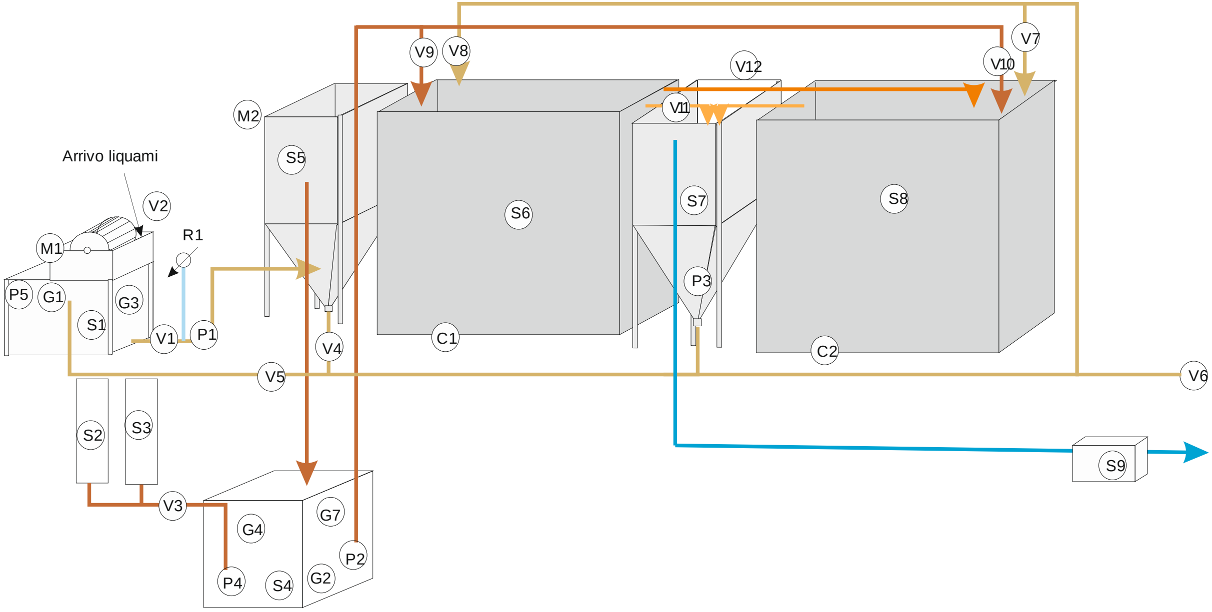
Study area

Present study was conducted in Chiusanico, a municipality in the Province of Imperia in the Italian region Liguria, located about 90 kilometres (56 mi) southwest of Genoa and about 10 kilometres (6 mi) northwest of Imperia.

Full-scale design, setup and description

This paper describes the full-scale installation of the WWTP at the Company of Liguri Food Specialties Spa ("CompagniadelleSpecialitàAlimentariLiguri Spa") in Chiusanico, designed, constructed and installed by GOST Ltd. The WWTP was designed to treat 100 m^3/d of industrial wastewater referred of peak flow rate (60m^3/d daily flow rate average).

Fig.1a. Schematic WWTP of Company of Liguri Food Specialties Spa



The company manufactures various products including tuna canning, basil sauces (aubergine pesto, garlic oil and chilli pesto, tomato asparagus and parmesan pesto, artichoke tomato and mascarpone pesto, olive ricotta and tomato pesto, rocket and lemon pesto), mushrooms, olive, peppers, grilled vegetables, red onion for bruschetta, creamy sauces (of black and green olives, mushrooms, tomato), nut sauces, spicy sauces, parsley sauces, ready made sauces to dress pasta and other food products.

Fig.1b. Schematic WWTP of Company of Liguri Food Specialties Spa

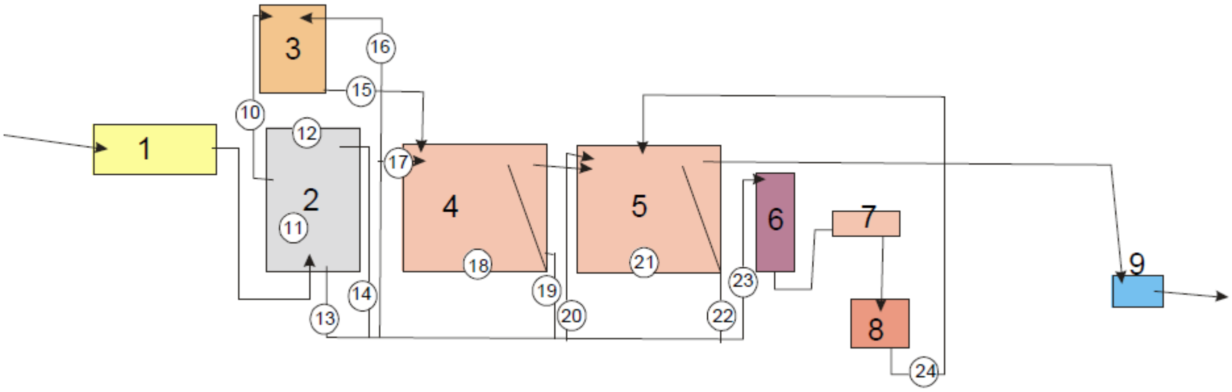


Fig.2. Wastewater

Wastewater resulting from the manufacturing process contains significant amounts of suspended solids (TSS), fats and oils, suspended and dissolved organics (COD, BOD_5), with occasional high salinity (sodium chloride). More than twenty different products are manufactured at the same facility. Produced wastewater, therefore, varies on an hourly, daily and seasonal basis. Cleaning in place is performed with strong chemicals such as detergent, bleach and peracetic acid that can influence downstream wastewater treatment processes. The pH can vary between 3.5 and 5.5, TSS between 2000 mg/L and 5000 mg/L, FOG between 10 and 2000 mg/L, COD between 3000 and 10000 mg/L, BOD_5 between 1400 and 2000 mg/L, TKN between

38.5 and 93.5 mg/L, TP between 23.3 -50.6 mg/L, salinity > 1200 mg/L.

The primary treatment processes are:(1) screening with a bar screen brush able to keep all the solid materials with size more than 0.75 mm (TSS removal 80-90%), (2) flotation - wastewater flows naturally in the flotation tank (removal of 80% TSS and suspended solids, 90% oils and fats, 30% BOD_5), (3) flow equalization in existing tank and pH adjustment.

The secondary treatment of wastewater iscompleted in two series biological tanks (4),(5); after the second tank the removal of COD is 80-90%. Primary and secondary biological treatment methods, aimed to remove suspended solids, BOD_5 and nutrients to some extent. However, to guarantee a safe discharge of the treated effluent, tertiary and disinfection treatments are also necessary. In this sense, first was operated an advanced oxidation method (AOP) in a series chemical – physical plant; the sludge was treated by filterpress. The plant was operated with this system for 3 years but the effluent was not appropriate for discharge into water body or reuse and were added other advanced treatment facilities: membrane MBR filtration and ozonisation.

Fig.3. WWTP ((courtesy of GOST solutions)

Membrane characteristic

The ability of the membrane depends on the size of pores, types of materials, types of wastewater to be treated, solubility and retention time. Retention is observed due to the concentration change between the retentate (a part of solution that cannot cross over the membrane) and permeate (solution after filtration). Permeability, flux, pressure (TMP) and resistance are the parameters that also need to be considered while conducting MBR process. The flow configuration of membrane processes is orthogonal named dead-end filtrations: the wastewater invests the membrane perpendicularly, the mud (retentate) withheld by the membrane is deposited on the membrane itself acting as a filter layer also determining a reduction in the permeate flux due to the increase of the resistance to filtration. Were supplied three MBR modules (Sepra) immersed in the biological tank.To further reduce any mud, the modules have an integrated air distribution system under the fibres through a blower. The air flowing as bubbles along the fibres generates a higher turbulence system around minimizing the biomass storage on the fibres themselves. Also the system allows a greater degradation of refractory organic compounds. Indeed, the high molecular weight that often characterizes these compounds makes waterproof membrane and therefore significantly increases the contact time in the activated sludge tank, favouring the specific microbial consortia development. The hollow fibres are in PP superficially modified to ensure optimal porosity, able to remove all suspended solids, colloids, bacteria and cysts.

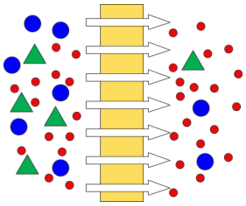
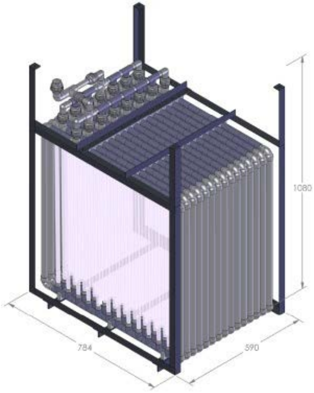


Table 1. Main features of the membranes:

Fibres material	Polypropylene
Porosity	40 – 50%
Pore size	0,1 µm
Outer fibre diameter	0,3 mm
Washing conditions (pH)	7
Washing conditions (temperature)	Tmax = 50 °C
Backwash	SI
Bundle size	Φ 25 x 800 mm
Bundle	1000 fibre
Filtration surface of a module	100 m²
Working pressure	0,1 – 0,5bar
Permeate flowaverage	10 L/ m² h

Fig.4. MBR module



The solid-liquid separation occurred in the aeration tank equipped with MBR submerged hollow fibre membranewith a nominal pore size of 0,01 – 0,1 μm (SepraLtd.). The membrane was operated with an on/off cycle aimed to provide a relaxation time in such a way that in every 2-3 min the permeate discharge was stopped for 15-30 sec for cleaning through backwashing. Membrane fouling was reduced by introducing air at the bottom of the membrane module (scouring) as well as by the on-line backwashing with tap water. The plant was provided with a PLC to control all the automatic control loops of the plant. Membrane bioreactor processes have been widely used to reduce or eliminate not only nutrients and organic pollutants, but also to provide a superior rating for most bulk water quality indicators (Defrance et al., 2000; Hu et al., 2013; Judd and Judd, 2010; Le-Clech et al., 2006; Nguyen et al., 2014; Tadkaew et al., 2011).

Ozone

Ozone is a very powerful oxidant (Redox potential 2,07 V for ozone versus 2,8 V for hydroxyl radical) for water and wastewater treatment, a highly oxidative agent, react directly or via a hydroxyl radical mechanism results into the reduction of organic content with increase of biodegradability of natural organic matter and the efficient inactivation of a wide range of microorganisms (Gottschalk et al., 2000; Takanashi et al., 2002; Xu et al., 2002; Liberti and Notarnicola, 1999). In this sense, ozonation is a recommended technology to be used as an advanced treatment at WWTPs treating various types of food-processing wastewaters as ozone reacts with a wide variety of organic pollutants present in these wastewaters (e.g., phenolic compounds) and it is a clean disinfecting agent leaving no residue after its use. Moreover, Esplugas et al.found ozonation as an economically advantageous technology for the removal of phenol from water by comparison with other classical advanced oxidation methods (O_3/H_2O_2, UV/ H_2O_2, UV/O_3, UV/ H_2O_2/O_3, $Fe^{2+}/H_2O_2$and TiO_2photo catalysis). Consequently, ozonation must be considered as a primary candidate technology for the tertiary treatment of food-processing wastewaters of phenolic nature. Ozonation has also been used to meet discharge requirements for coliform and virus inactivation since the 1970s (Rice et al., 1981). Frequent ozonation for treatment of wastewater and drinking water is due to its ability to oxidize complex organic molecules, phenols, Endocrine Disruptive Chemicals (EDCs) and pharmaceuticals (Zwiener and Frimmel, 2000; Huber et al., 2005; Snyder et al., 2006; Kim and Tanaka, 2010). In combination of microbial disinfection ozonation is an attractive alternative for advanced wastewater treatment (Wert et al., 2007). Recent ozone generation techniques require lower energy consequently; costs are also reduced making the field application of ozonation economically viable (Freire et al., 2001; Jennifer et al., 2010). Accordingly, in this study, the biological degradation and the chemical oxidation by ozone have been studied separately, with an aim of quantifying the COD removal efficiencies. In the 3rdphase, the combined processes consisting of aerobic oxidation and ozonation was carried out to establish the COD removal efficiency achieved by these processes in series. The combined process of ozonation and biological treatment is one of the most promising processes among advanced treatment methods. Ozone gas was produced using an ozone generator previously calibrated. The pure ozone dose was controlled at approximately 20 mgO_3/min for ozonation. The generator produced ozone by the Corona discharge method and was water-cooled. The oxygen was used as a feed gas to this unit and was supplied from the air.

Sample collection

Samples were collected in plastic bottles from the effluent channel and transferred to the laboratory, preserved and stored for further analytical determinations and study. Biological activity such as microbial respiration, chemical activity such as precipitation or pH change, and physical activity such as aeration or high temperature must be kept to a minimum. Methods of preservation include cooling, pH control, and chemical addition. The length of time that a constituent in wastewater will remain stable is related to the character of the component and the preservation method used (APHA, 2005). The influent and effluent samples were collected regularly, one time per month, to investigate the system performance, during its evolution: after installation and start-upand during MBR filtration and ozonisation test.The water quality parameters including BOD_5, COD, E.Coli, TSS, TKN, NH_4^+-N, NO_3^--N, total phosphorus TP, pH values and temperature T°C were determined according to standard methods (APHA, 2005). Influent flow rate and effluent flow rate were monitored continuously by the online real-time systems.

Long-term monitoring. The long-term sampling round was carried out for a period of 5 years (2004 - 2009) to collect data for calculation (detailed is listed in Table 2). The incoming influent and outlet effluent were collected 3 h composite samples with refrigerated samplers both in the context of long-term sampling, to measure COD, TKN, NH_4^+, NO_3^-, NO_2^-, TP, and Surfactants. Other registered online data has been the filtration flow rate of MBR membranes.

Analysis

Physicochemical parameters

To measure NH_4^+, NO_3^-, NO_2^- and COD parameters were used photochemical commercial test kits (Hach Lange GmbH, Düsseldorf, Germany) LCK type. The parameters determinations were done according to the standard methods of analysis of wastewater and water, (APHA et al., 2005). The pH measurements were done using digital pH meter (Hanna Instruments, Italy). The spectrophotometric analysis was done using XION 500 Dr Lange spectrophotometer (Hach Lange, Italy). Total Nitrogen / ammonia /nitrite/nitrate were measured using the kit Dr Lange LCK238/LCK303/LCK342/LCK339 respectively. Total phosphorus was measured using the kit Dr Lange LCK348. Surfactants Non-ionic / Anionic / Cationic were measured using the kit Dr Lange LCK333/LCK 332 / LCK331 respectively.

Table 2. Long term monitoring on WWTP using screening, flotation, equalisation –neutralisation, biological treatment, 1st phase AOP

	Parameter	pH	MLSS (mg/L)	COD (mg/L)	Pt (mg/L)	$N\text{-}NH_4$ (mg/L)	$N\text{-}NO_2$ (mg/L)	$N\text{-}NO_3$ (mg/L)	Tt (mg/L)
10.10.01 (Lab test)	**Influent**	3,52	2271	3480	20,8	68,1	0,144	0,972	16,78
	Influent after sedim	3,52	346	1020	2,75	58,71	<0,6	3,31	2,149
07.08.03	**Influent**	5,10	2468	1465	7,48	40,7	0,248	1,341	19,22
	Effluent chim-phys	7,04	140	319	0,14	23,58	<0,6	5,76	3,04
9.03.04	**Influent**	5,20	1466	2359	28,3	4,07	0,614	0,171	8,32
	Effluent (conv)	6,50	80	1016	0,412	1,98	0,215	1,53	1.968
26.06.04	**Influent**	4,28	2361	3478	36,44	0,936	0,153	0,363	12,41
	Effluent (conv)	6,40	72	758	4,91	0,344	0,289	1,44	2.72
10.08.04	**Influent**	5,11	2455	1543	28,72	35,68	0,179	0,218	24,36
	Effluent (conv)	6,70	68	167	2,1	1,72	0,184	0,790	10,11
31.08.04	**Influent**	4,92	2010	2019	3,25	22,17	0,336	0,336	9,39
	Effluent (conv)	7,10	79	165	0,175	1,31	0,159	0,988	2,405
23.11.04	**Influent**	5,55	1876	8735	55,71	1,281	0,414	1,12	17,35
	Effluent (conv)	7,20	75	1187	11,48	0.621	0,298	1,32	3,43
18.02.05	**Influent**	4,88	1353	2431	48,36	66,29	0,512	0,17	36,21
	Effluent (conv)	7,33	67	351	2,71	15,91	0,291	1,24	5,20
01.02.08	**Influent**	5,46	1968	5360	17,9	83,6	0,329	2,46	28,17
	Effluent (conv)	6,01	77	1038	1,234	57,8	0,664	2.59	6,91

Microbiological parameters

The samples were also examined for microbiological content including total coliforms, faecal coliforms, and E.Coli, after being kept at 37 °C for 48 h, using the method of Most Probable Number (APHA, 2005).

3. Results and discussion

Temperature

Basically, wastewater temperature is a key factor that can affect biological processes for wastewater treatment, especially biological nitrification/denitrification processes. During the present study, influent wastewater temperatures varied from 10.0°C to 27.0°C depending on the season of the year. Refereed of the influent temperature variability the effect on the performance from this study was not clearly observed. The ambient temperature during the winter season reached - 5°C. The expected results showed matched with the interpretation of (Halling- Sørensen and Jørgensen, 1993) that the attached-growth systems have an advantage in withstanding lower temperatures. Consequently, the establishment and growth of microorganisms in this system could tolerate the variation of temperature.

pH

Fig. 5shows the average of the pH, based on samples of the influent and effluent flow. Furthermore, it was found that variations occurred during the experiment in each phase. pH value is also one of the important factors that has a significant impact on the growth rate of nitrifying bacteria (B. Halling-Sørensen and Jørgensen, 1993) in particular, and on biological treatment processes as a whole. During the experimental operation, the variation of pH in biological tanks was not significant, and remained within an appropriate range for biological treatment processes. Thus, the adjustment of pH was necessary only in accumulation tank.

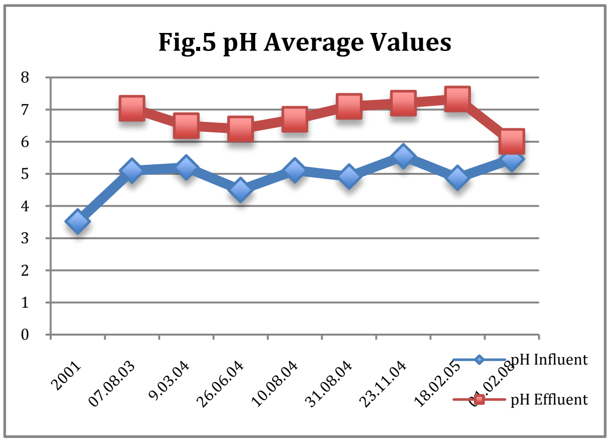


Fig.5 pH Average Values

COD removal

Results of COD removal efficiency in WWTP during the experiment period in the influent and final effluent during the 1st phase treatment are presented in Fig.6. The results indicated that the concentrations of COD in the effluent in the 3rd phase were all lower than 2nd phase and lower than 1st phase. Despite the wide range of COD concentration in the influent, from 1500 to 10000 mg/L, with an average value of 4750 mg/L, the combined system showed significant performance in organic carbon removal in particularly in the 2ndand 3rdphase when was used ozone and filtration with MBR. The COD removal efficiency in the 1stphase was 70–80%. The removal efficiency increased in the 2ndphase when additional ultrafiltration membrane MBR entailed a reduction of the studied parameters values by an additional 10 to 15%.It can be seen that the average efficiency of COD removal is approximately 90% compared to only 75% that it notes in1st phase.In the 2nd phase were installed 3 MBR modules: two modules in the first aeration tank (1) and one module in the aeration tank (2). The results of removal are showed in Fig.7.

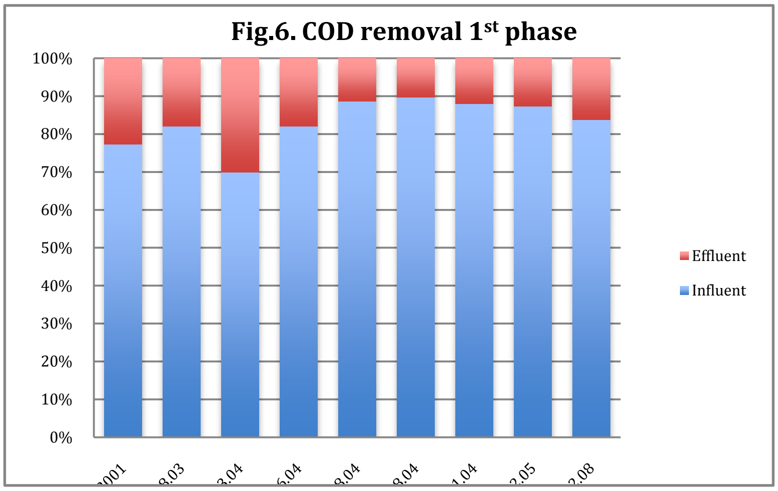


Fig.6. COD removal 1st phase

Table 4. Average parameters values after MBR installation

	Parameter	pH	COD (mg/l)	Nt (mg/l)	Pt (mg/l)	$N\text{-}NH_4$ (mg/l)	$N\text{-}NO_2$ (mg/l)	$N\text{-}NO_3$ (mg/l)	Tt (mg/l)
25.07.12	**Influent**	4,70	8416	78,3	31,36	68,2	0,018	0,417	17,22
	Effluent after MBR	7,90	416	8,72	2,48	2,23	0,282	2.09	2,347
09.09.12	**Influent**	5,20	4479	56,28	26,47	53,44	0,173	0,233	18,11
	Effluent after MBR	7,06	308	11,43	1.37	1,036	0,314	6,72	0.872
27.02.13	**Influent**	5,60	5708	68,28	28.2	58,23	0,155	1,715	14,31
	Effluent after MBR	7,06	323	7,49	3.22	3,47	0,434	8,16	1,475

Table 3. Values of parameters after MBR installation

PARAMETER	U.M	Influent	Aeration Tank (1)	Aeration Tank (2)	Effluent (1) from MBR (1)	Effluent (2) from MBR (1)	Effluent (3) MBR from (2)	Italian Standards for Water Body
pH	mg/L	5,32	6,42	7,22	7,4	7,32	7,77	5,5 - 9,5
SST (after 40 min)	mg/L	2247	175	100	0	0	0	≤ 80
COD	mg/L	8416	5103	634	816	849	163	≤ 160
T P	mg/L	25,5	29,2	9,79	6,81	7,61	3,67	≤ 10
N-NH4	mg/L	54,4	18,9	0,843	0	0	0,826	≤ 15
C6H5OH	mg/l	high	high	3,45	5,27	5,46	1,76	≤ 0,5
Tt	mg/L	high	6,6	5,5	1,64	2,26	0,826	≤ 2

The integrated aeration process air-ozone has led to COD decrease up to 90%.After the 2nd phase the pollutants removal doesn't fit the standards to body water discharge for COD and E.Coli and after careful consideration were installed two ozone generators, one for each tank.

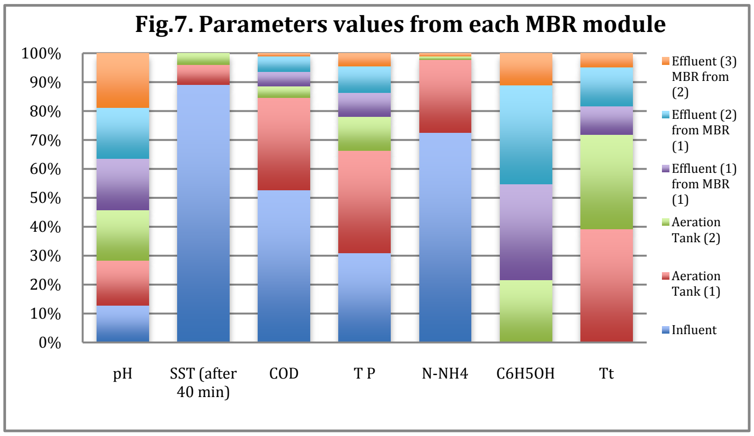


Fig.7. Parameters values from each MBR module

Nutrient removal. The integrated Biological/MBR/Ozone system was designed to incorporate biological nutrient removal along with organic removal. The long-term experimental result of the full-scale system showed excellent nutrient removal efficiency throughout varying influent concentrations, regardless of internal recycling ratios. The removal of TKN and TP was in the range of 60–85%, and 50 –99 %, respectively. These high removal efficiencies were comparable to those reported in other studies. The removal rates of TKN and TP showed a decreasing trend.

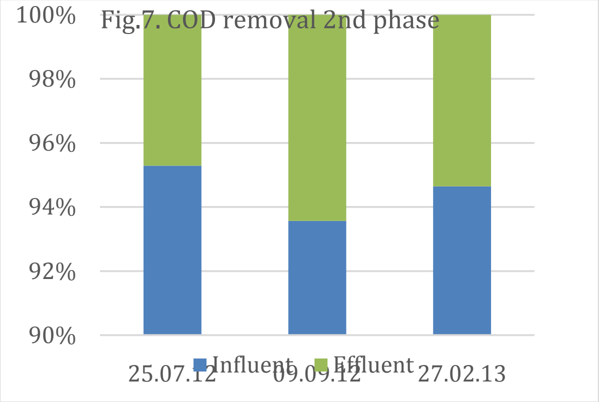


Fig.7. COD removal 2nd phase

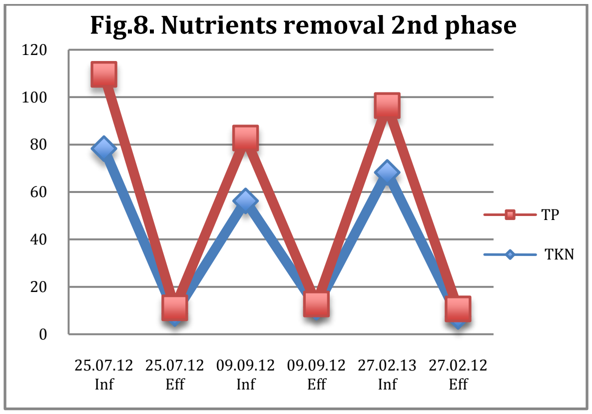


Fig.8. Nutrients removal 2nd phase

TKNremoval efficiency was around 70% but levels changed due to influent fluctuations. Basically, almost all TKN was found as NH_4^+. The average NH_4^+ removal was around 59 - 60 %. The pH was maintained within a range of neutrality (mean of 7.00).

Physicochemical characteristics of ozonized effluents

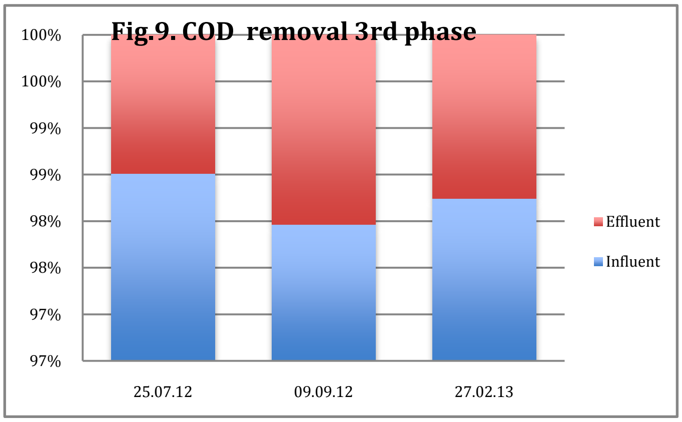


Fig.9. COD removal 3rd phase

Ozonation experiments were performed in the two-aeration tank. The applied ozone doses were 20 mg O_3/L of O_3, while the ozonation process run together with the aeration time. The efficiency of ozonation to upgrade the effluents quality was strongly depended upon the supplied ozone dose. Higher ozonation periods did not significantly affect the physicochemical properties of the effluent (Petala et al., 2006, 2008; Kim and Tanaka, 2010. The chemical oxidation was accomplished by two mechanisms, a molecular ozone reaction (direct oxidation) and a hydroxyl radical reaction mechanism (indirect oxidation). In general, the first mechanism was dominating during acidic conditions, while the latter was the main mechanism under alkaline conditions (Gottschalk et al., 2000). Beltran et al. (1999) observed lower removal rates of total nitrogen, about 15%, during the ozonation treatment of municipal wastewater, while Paraskeva and Graham (2005) verified total nitrogen removal up to 20%, during ozonation of a secondary effluent with ozone doses exceeding 18 mg O_3/L. In general, the most significant factors for the removal of certain pollutants by ozonation depend on the quality of wastewater, the ozone dose and exposure time. After ozonation in the aeration tank using 20 mg O_3/L of ozone the COD removal was about 10-15%. The effect of ozone on the COD effluent properties was showed in Figs. 9. It can be seen that ozonation led to the reduction in the COD value, in other words, it brought about the mineralization of some of its contents during the treatment step itself by bringing about the oxidation of some of the pollutants. Beltran et al. (1999) have reported 33.7% COD removal after 5 h of ozone treatment, which can be attributed to fact that COD reduction obtained in the treatment step will be dependent on the effluent characteristics and the operating conditions in terms of ozone flow rate, time of ozone treatment and the type of reactor used for ozonation. The ozonation of organic compounds in water usually produces oxygenated organic products and low molecular weight organic acids that are relatively easily biodegradable (Gilbert, 1987; Contreras et al., 2003).

4. Conclusions

The objectives of this study were to evaluate practical possibilities to obtain an effluent suitable for the discharge into surface bodies and, alsocan be recycled as process water and cooling or boiler feed water after a combination of more treatment step processes for wastewater from food industry by employing a flotation, biological treatment, advanced oxidation,MBR microfiltration and ozonisation process. A process data collection was performed and integrated with a characterization of the process effluents in terms of treatability and reusability. In order to evaluate properly the wastewater loading, an analysis course was set. It was examined the efficiency of the pollutants degradation by analysing the parameters concentration of the usual contained organic compounds in effluents: COD, ammonia, nitrites, nitrates, surfactants, which have been 15-20% extra degraded by mixed aeration. COD decrease resulted in the integrated air-ozone aeration process up to 90% compared to only 75% that occurs in a conventional biological activated sludge process. Further more, membrane MBR ultrafiltration entailed a values reduction from another 10 -15%.

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