THE CHEMICAL TREATMENT OF WASTEWATER DISCHARGED FROM SAUSAGE CASING INDUSTRY [4]

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ABSTRACT

This study focused on effluents wastewater treatment from sausage preparation using physical and chemical treatment by coagulation and flocculation processes. Choice of a suitable coagulant for maximum contaminant removal and reduction in costs is the most important factor. The feasibility of using aluminum sulfate, poly aluminum chloride (PAC) and ferric chloride in sausage wastewater treatment has been investigated. Removal of water pollutants discharged from industrial sausage wastewater is required to comply with the environmental standards. The study was conducted using poly aluminum chloride dosage (40-140mg/l), ferric chloride dosage (40- 140mg/l) and alum dosage (100 - 600 mg/l) individually. The efficiency of COD, BOD, TSS, Oil and Grease and TKN removal recorded (98%), (97%), (97%), (95%), (97%) respectively using a dose 140 mg/l of PAC. While using a dose 140 mg/l of ferric chloride recorded (96%), (93.5%), (95.5%), (89.4%), (95.4%), respectively and using a dose 600 mg/l of alum recorded (95.6%),(94.3%), (96.5%), (92%), (95%), respectively.

Keywords: Flocculation, Coagulation, Chemical treatment, Sausage preparation wastewater.

INTRODUCTION

Meat has been and continues to be a central element of diets in developed countries. Processed meat products (sausages, burgers and meat pies) accounts for almost half of the meat being consumed in these countries. Projections suggest that the global consumption of meat will continue to increase moderately over the next 40 years. This increase reflects the

increasing demand for meat and poultry (Kearney, 2010). With increasing market demand, meat processors are driven to invest in research and innovation to remain competitive (Chen *et al*., 2013). Meat processors must meet consumer preferences as one of the keys to developing a successful product (Chen *et al*., 2013). There have been rapidly changing consumer demands in the food industry improved health, safety, quality, convenience, value, experience as well as addressing ethical and environmental issues (Kearney, 2010). Sausage preparation industry is one of it and it's very important due to the increasing demand for fast food but it causes heavy pollution. Animal casings are the oldest form of casings used and are considered to have superior moisture vapor transmission and have a wide range of mechanical properties, depending on the type and preparation of the casing (Savic and Savic, 2002). The process of casings preparation as follows: pre- washing then washing then filling with water then cutting to same length and sectors then salting. Wastewater can be defined as the remaining spent water that has been used by humans in homes, commercial establishments, industries, public institutions, and similar entities for various purposes (Sincero and Sincero, 2003). Wastewater collected in municipal sewer systems is comprised of domestic or 'sanitary' wastewater, industrial wastewater, infiltration and inflow into sewer lines, and storm water runoff (Canter and Harfouche, 2000). In modern water treatment, coagulation and flocculation are still essential steps in the treatment processes. The initial step is simple: the chemical is added to wastewater. This is followed by the second step, where the solution is mixed rapidly in order to make certain that the

chemicals are evenly and homogeneously distributed throughout the wastewater. In the third step, the solution is mixed again, but this time in a slow fashion, to encourage the formation of insoluble solid precipitates, the process known as "coagulation". The final step is the removal of the coagulated particles by way of filtration or decantation (Yılmaz *et al*, 2007). Thus, conventional coagulation practices may provide excellent organic removal if the coagulant dose and pH conditions are adjusted into the optimum range. Organic removal increased with an increasing alum dose and alum doses higher than the normally used for turbidity removal, are needed to obtain the best organic removal. Poly aluminum chlorides, poly aluminum sulfates, or poly aluminum chloro-sulfates, with variable degrees of polymerization, especially the first one are used extensively worldwide during the last decades, with an ever increasing demand. Their properties were intensively examined and have proven to be more efficient in lower dosages, in wider pH, temperature and colloids concentration ranges, than the conventional simpler ones, leading to cost and operative more effective treatment (Sinha *et al*., 2004; Crittenden *et al*., 2005). Polyaluminium chlorides are similar to alum except contain high charge polymeric aluminum species as well as the monomer. Al13 with the formula Al13O4 (OH)24(H2O)127 has been shown to dominate species (Parthasarathy and Buffle, 1985; Bertsch and Thomas, 1986; Bertsch, 1987). The iron salts most commonly used as coagulants include ferric sulfate, ferric chloride and ferrous sulfate. These compounds often produce good coagulation when conditions are too acidic for best results with alum. Sometimes the particles

are best removed under acidic conditions, and also iron compounds give better results (Tripathy and De, 2006).

The aim of this research is treatment for industrial sausage wastewater to comply with the environmental laws.

MATERIAL AND METHODS

Study area:

The Company is located in Alexandria free zone, on 29th Km of Alexandria-Cairo desert highway, 6th km from El Dekhila harbor, 20th km from El Nozha airport, and 30th km from Alexandria airport which is situated in Alexandria, Egypt.

Jar test:

Stock solutions of ferric chloride, alum and poly aluminum chloride were prepared before starting the experiment. The solutions were prepared by dissolving 10g of each substance in distilled water and the solution volumes were completed to 1 liter. Each 1 ml of these stock solutions was equivalent to 10 mg/l when added to 1000 ml of wastewater. They have been prepared in three different concentrations, a conventional jar test apparatus was used in the experiments to coagulate sample of the sausage wastewater by using ferric chloride and alum and poly aluminum chloride. It was carried out as a batch test, accommodating a series of six beakers together with six-spindle steel paddles .Wastewater samples were collected from Sausage Casing Company. Samples were collected, and stored in several polyethylene bottles. Wastewater were mixed homogeneously then, samples were analyzed to

measure pH, T.S.S and COD for representing an initial concentration. After the desired amount of alum, poly Aluminum chloride and ferric chloride was added to the suspension, the beakers were agitated at various mixing time and speed, which consist of rapid mixing (150 rpm) for 1 minute and slow mixing (30 rpm) for 10 minutes to coagulation. Then 4 ppm anionic polymer was added. Then 5 ppm sod. Hypo chlorite was add after the agitation being stopped, the suspension was allowed to settle for 20 minutes. Finally, a sample was withdrawn using a pipette from the top inch of supernatant for pH., total suspended solids and COD and measurements which representing the final concentration. All tests were performed at an ambient temperature in the range of 20-25°C.The study was conducted by varying the experimental parameters, which were poly aluminum chloride dosage (40, 60, 80, 100, 120 and 140 mg/l) Ferric chloride dosage (40, 60, 80, 100, 120 and 140 mg/l) and alum dosage (100, 200,300,400,500 and 600 mg/l).

RESULTS AND DISCUSSION

Sausage preparation waste water analysis: Table 1 shows that wastewater discharged from sausage preparation is not in compliance with the environmental laws in many aspects. COD exceeded the limit set by law 93/ 1962 Decree 44/2000, BOD not comply, and so sausage preparation wastewater must be treated to comply with environmental laws.

Table (1): Analysis of wastewater sample from sausage preparation industry

NO.	ITEMS	Sample (1)	Sample (2)	Sample (3)	Average	Decree 44/2000
1	pH Value	7.78	7.65	7.65	7.69 ±SD	6.5 – 9.2
2	TSS	1732	1680	1900	1770±SD	800
3	VSS	821	857	1202	960 ±SD	--
4	BOD_5	1100	1320	1450	1290±SD	800
5	Soluble BOD_5	610	680	900	730 ±SD	--
6	COD cr	1815	1850	2320	1995±SD	1100
7	PO_4	41	45.32	48.32	44.9±SD	25
8	$N\text{-}NO_3$	29.7	35.65	35.00	33.5±SD	--
9	$N\text{-}NH_3$	21.81	24.98	27.00	24.6±SD	--
10	Oil/Grease	122	120	122	121 ±SD	100
11	TKN	53.7	45.54	38.90	46 ±SD	--

± Standard deviations
TKN: *Total* Kjeldahl *nitrogen*

Treatment with alum:-

The efficiency of COD, BOD, TSS, O&G and TKN removal using alum, was (95.6%), while BOD removal was (94.3%), TSS removal was (96.5%), TKN removal was (95.3%) and O&G removal was (92.14%).

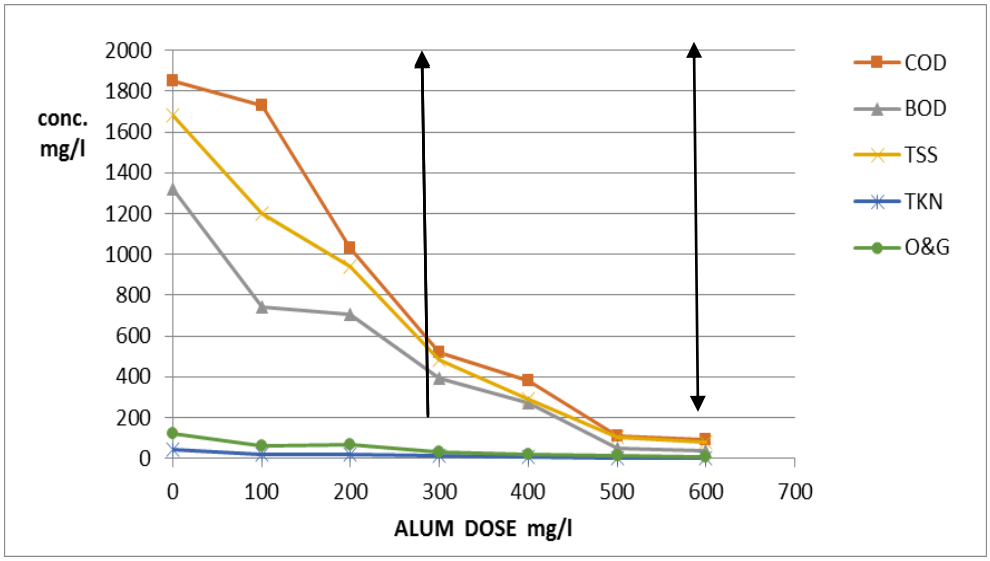

Fig (1): Water pollutants as a function of Alum dose (mg/l)

The obtained results were in agreement with Saatci *et al.*, 2001 who reported that the efficiency of COD removal was 92.11% and the efficiency of oil & grease removal was 92.99% for Vegetable oil industry. Also, results showed an agreement with the results reported by Ghaly *et al.*, 2006 for greasy waste water where using aluminum sulfate as coagulant achieved an efficiency of total solid (90 %).

Treatment with ferric chloride:-

The efficiency of COD, BOD, TSS, O&G and TKN removal using ferric chloride was as follows: was (96%) while, BOD removal was (93.5%), TSS removal was (95.5%), TKN removal was (95.43%) and O & G removal was (89.43%).

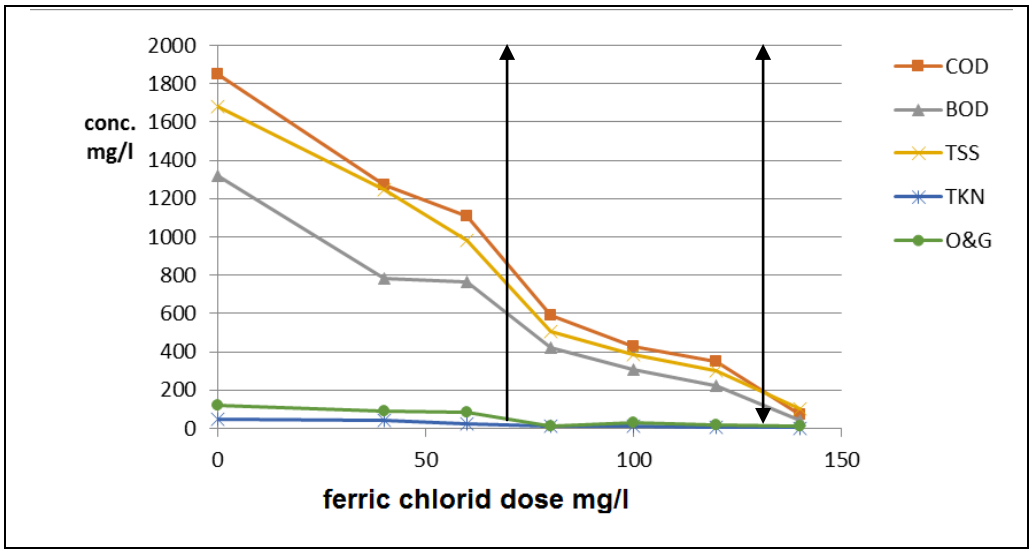

Fig (2): Water pollutants as a function of ferric dose (mg/l)

The obtained results were in agreement with Saatci *et al.*, 2001 who reported that the efficiency of COD removal was 96.25 % and the efficiency of oil & grease removal was 96.11%for Vegetable oil industry. Also, results showed an agreement with Moghaddam *et al.*, 2010 who mentioned that using a dose (140 mg/l) of ferric Chloride as coagulant achieved an efficiency of removed dye was 96.3 %. Also, results showed an agreement with the result reported by Ghaly *et al.*, 2006 for greasy waste water by using a dose 140 mg/l of ferric chloride as coagulant achieved efficiency of total solid (88 %). Also, results showed an agreement with Lianga *et al.*, 2009 for molasses waste water by using dose (3.5 g/l) of ferric chloride as coagulant the efficiency of COD removal achieved (86 %).

Poly aluminum Chloride (PAC):

The efficiency of COD , BOD , TSS , O&G and TKN removal using poly aluminum chloride was as follows: COD (98%) while, BOD removal was (97.6%), TSS removal was (97.6%), TKN removal was (97.47%) and O & G removal was (95.17%).

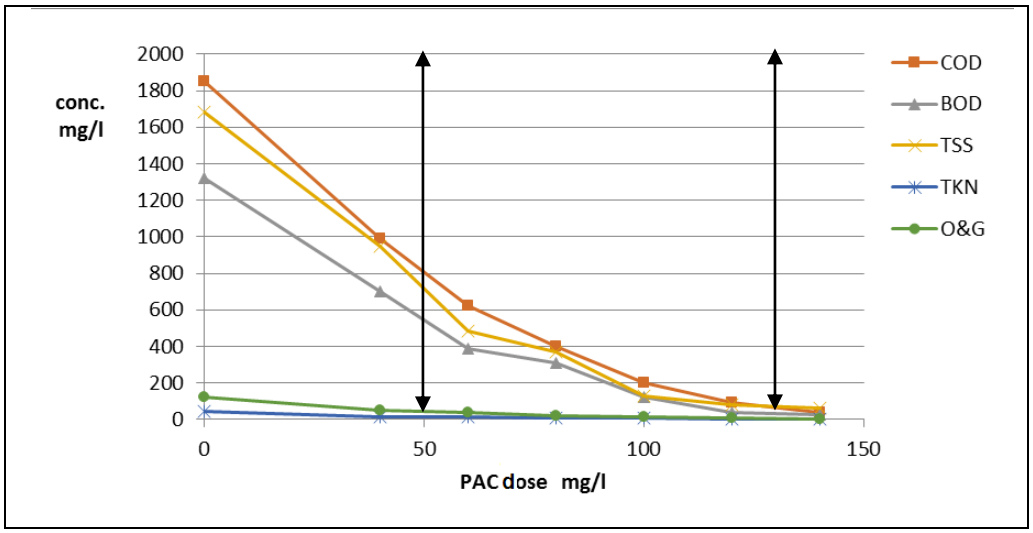

Fig (3): Concentration of water pollutants with PAC dose (mg/l)

The obtained results were in agreement with Sabur *et al.*, 2012 who reported that the efficiency of COD removal was (90.17 %) and the efficiency of turbidity removal was achieved (93.47%) for textile industry. Also, results showed an agreement with Kadhum *et al.*, 2011 who mentioned that the efficiency of COD removal was (91.12 %) and the efficiency of turbidity removal was achieved (93.13%) for pulp and paper industry. Also, results were in agreement with Kumar *et al.*, 2011 who mentioned that efficiency of COD removal achieved (84 %) for pulp and paper industry.

CONCLUSION

The focus of this paper was to select the best coagulant and the good dose to investigate the potential use of coagulation process for the removal BOD, COD, O & G, TKN and TSS from industrial effluents sausage casing wastewater using ferric chloride, alum and poly aluminum chloride was investigated. The experiments conducted confirm the significant effect of coagulant dosage on coagulation process. Under optimal conditions of process parameters, in this work alum, poly aluminum chloride (PAC) and ferric chloride were used to coagulate the suspended solid in the wastewater it was found that the behavior of coagulant may change from wastewater to another according to many factors including kind of coagulant and different constituents of wastewater. The efficiency of COD, BOD, TSS, O & G and TKN removal was achieved by using poly aluminum chloride by (98%), (97%), (97%), (95%), (97%) respectively. It can be deduced that, increasing the coagulant dosage increasing the efficiency of coagulant in removal. Alum is one of the common and cheapest coagulants used to the treatment purpose.

REFERENCES

APHA, (1992): Standard Methods for the Examination of Water and Wastewater. 18th ed.

Bertsch, P. M. (1987): Conditions for Al (13) Polymer Formation in Partially Neutralized Aluminum Solutions. Soil Science Society of America Journal 51, pp. 825-828.

Bertsch, P. M and Thomas, G. W. (1986): Characterization of Hydroxy-Aluminium solution by aluminum 27 Nuclear Magnetic Resonance Spectroscopy, Soil Science Society of America Journal 50, pp. 825:828.

Canter, L. W. and Harfouche, N. (2000): Sources and Characteristics. In: Wastewater Treatment. D. H. F, Liu and B. G, Liptak (Editors). Lewis Publishers, New York, New York. pp. 114-142.

Chen, Q.; Anders S. (2013): Measuring consumer resistance to a new food technology; a choice experiment in meat packaging. Food Quality and Preference 28:419-428.

Crittenden, J. C.; Trussel, R. R. and D.W. Howe, K.J., Tchobanoglous, G., and (Eds).,(2005): Coagulation, mixing and flocculation, in: Water Treatment: Principles and Design, second ed., John Wiley and Sons, New Jersey, 643-779.

Ghaly, A. E.; Snow, A. and Faber, B. E. (2006): Treatments of grease filter wash water by chemical coagulation. Canadian Bio systems Engineering/Le genie des Bio systems au Canada 48, 6.13-6.22.

Kadhum, M. Shabeeb, Hayder, A., Abdul Bari, Hayder, and Abdul Bari, (2011): Treatment Of Pulp And Paper Mill Wastewater By Poly-Aluminum- Silicate-Chloride (Pasic) Through Coagulation-Flocculation Process, Al-Qadisiya Journal For Engineering Sciences 4(4), pp. 546-555.

Kearney, J. (2010): Review; Food consumption trends and drivers. Philosophical Transitions of the Royal Society B 365:2793-2807.

Kumar, P.; Teng, T. T.; Chand, S. and Kailas, L. (2011): Wastewater, Treatment of Paper and Pulp Mill Effluent by Coagulation, International Journal of Civil and Environmental Engineering 3, 3.

Lianga, Z.; Wang, Y.; Zhoub, Y. and Liu, H. (2009): Coagulation removal of melanoidins from biologically treated molasses wastewater using ferric chloride, Chemical Engineering Journal 152, pp. 88–94.

Moghaddam, S. S.; Moghaddam; Alavi, A. R. and Arami, M. (2010): Decolonization of an Acidic Dye from Synthetic Wastewater by Sludge of Water Treatment Plant, Iran Journal of Environment Health Science Engineering 7(5), 437-442.

Parthasarathy, N. and Buffle, N. (1985): Study of polymeric Aluminum (III) Hydroxide of solution for Application in waste water treatment properties of the polymer and optimal condition of preparation, Water Research 19(1), pp. 25-36.

Saatci, Y.; Hasar. H. and Cici, M. (2001): Treatability of Vegetable Oil Industry Effluents through Physical-Chemical Methods, Fresenius Environmental Bulletin 10(12).

Sabur, M. M.; Khan, A. A. and Safiullah, S. (2012): Treatment of Textile Wastewater by Coagulation Precipitation Method, Journal of Scientific Research 4 (3), pp. 623-633.

Savic, Z. and Savic, I. (2002): Sausage Casings. 1st Edition. Austria: Victus. p. 354.

Sincero, A. P. and Sincero, G. A. (2003): Physical-Chemical Treatment of Waste and Wastewater. CRC Press, New York, New York.

Sinha, S.; Yoon, Y.; Amy, G. and Yoon, J. (2004): Determining the effectiveness of conventional and alternative coagulants through effective characterization schemes, Chemosphere 57, pp. 1115-1122.

Tripathy, T. and De, B. R. (2006): Flocculation: A New Way to Treat the Waste Water, Journal of Physical Sciences, 10, pp. 93-127.

Ylmaz, A. E.; Boncukcuoğlu, R. and Kocakerim, M. M. (2007): A Quantitative Comparison between Electrocoagulation and Chemical Coagulation for Boron Removal from Boron-Containing Solution. Journal of Hazardous Materials 149, pp. 475-48.

المعالجة الكيميائية للمخلفات السائلة الناتجة عن صناعة أعداد أغلفة السجق

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المستخلص

تعد صناعة تجهيز الأمعاء من الصناعات العريقة وكذلك تُعد من الصناعات المنتشرة عالمياً اليوم حيث بانتشار الوجبات السريعة عالميا أدى ذلك لزيادة الطلب عليها والحجم الشاسع لتلك الصناعة العالمية والمهمة ولكن تكمن المشكلة في هذا المشروع في المخلفات التي تنتج عن تلك الصناعة. لذلك تعني هذه الدراسة بمعالجة المخلفات السائلة الناتجة عن صناعة تجهيز الأمعاء باستخدام طرق المعالجة الفيزيائية والكيميائية واختيار المروبات المناسبة وكذلك الجرعات المناسبة لإزالة الملوثات. وتتناول الدراسة كذلك مقارنة استخدام المروبات المختلفة (عديد كلوريد الالمنيوم بجرعات (٤٠ – ١٤٠ ملجم / لتر) لتكون نسبة إزالة الملوثات كالتالي الاكسجين الكيميائي المستهلك والاكسجين الحيوي الممتص والعوالق الصلبة الكلية و(الزيوت والشحوم) وكالدال نيتروجين ٩٨% و٩٧% و٩٧% و٩٥%و٩٧% على الترتيب. بينما كانت مع كبريتات الألومنيوم بجرعات (١٠٠ – ٦٠٠ ملجم / لتر) لتكون نسبة إزالة الملوثات كالتالي الاكسجين الكيميائي المستهلك والاكسجين الحيوي الممتص والعوالق الصلبة الكلية و(الزيوت والشحوم) وكالدال نيتروجين ٩٥,٦% و٩٤,٣% و٩٦,٥% و٩٢%و٩٥% على الترتيب. بينما مع كلوريد الحديديك بجرعات (٤٠ – ١٤٠ ملجم / لتر) لتكون نسبة إزالة الملوثات كالتالي الاكسجين الكيميائي المستهلك والاكسجين الحيوي الممتص والعوالق الصلبة الكلية و(الزيوت والشحوم) وكلدال نيتروجين ٩٦% و٩٣,٥% و٩٥,٥% و٩٢% و٩٥% على الترتيب) بالإضافة الى مادة محفزة كمساعد في عملية الترويب. واتضح من النتائج أن الجرعة المثلى للمعالجة هي (١٤٠ ملجم / لتر) من عديد كلوريد الالمنيوم.