THE CHEMICAL TREATMENT FOR INDUSTRIAL WASTE WATER FROM CASING SAUSAGE INDUSTRY

Submitted By

Mohamed Asef Abdel Hamied Kariem

B.Sc. of Science (Chemistry/Physics), Faculty of Science, Ain Shams University, 2004

Diploma in Environmental Sciences, Institute of Environmental Studies & Research,

Ain Shams University, 2011

A thesis submitted in Partial Fulfillment
Of
The Requirement for the Master Degree
In
Environmental Sciences

Department of Environmental Basic Sciences

Institute of Environmental Studies and Research

Ain Shams University

2017

THE CHEMICAL TREATMENT FOR INDUSTRIAL WASTE WATER FROM CASING SAUSAGE INDUSTRY

Submitted By

Mohamed Asef Abdel Hamied Kariem

B.Sc. of Science (Chemistry/Physics), Faculty of Science, Ain Shams University, 2004

Diploma in Environmental Sciences, Institute of Environmental Studies & Research,

Ain Shams University, 2011

A thesis submitted in Partial Fulfillment
Of
The Requirement for the Master Degree
In
Environmental Sciences
Department of Environmental Basic Sciences

Under The Supervision of:

1-Dr. Taha Abdel Azim Mohamed Abdel Razek

Associate Prof., Department of Environmental Basic Sciences
Institute of Environmental Studies & Research
Ain Shams University

2-Dr. Ahmed Shafik El-Gendy

Associate Prof., Department of Environmental Engineering Sciences
Institute of Environmental Studies & Research
Ain Shams University

2017

APPROVAL SHEET

THE CHEMICAL TREATMENT FOR INDUSTRIAL WASTE WATER FROM CASING SAUSAGE INDUSTRY

Submitted By

Mohamed Asef Abdel Hamied Kariem

B.Sc. of Science (Chemistry/Physics), Faculty of Science, Ain Shams University, 2004

Diploma in Environmental Sciences, Institute of Environmental Studies & Research, Ain Shams University, 2011

A thesis submitted in Partial Fulfillment

Of

The Requirement for the Master Degree

In

Environmental Sciences

Department of Environmental Basic Sciences

This thesis Towards a Master Degree in Environmental Sciences

Has been Approved by:

Name Signature

1-Prof. Dr. Tarek Ismail Sabry

Prof. of Sanitary Engineering
Faculty of Engineering
Ain Shams University

2-Prof. Dr. Mostafa Mohamed Hassan Khalil

Prof. of Analytical and Inorganic Chemistry
Faculty of Science
Ain Shams University

3-Prof. Dr. Taha Abd El Azeem Mohamed Abd El Razek

Prof. of Environmental Analytical Chemistry and Head of
Department of Environmental Basic Sciences
Institute of Environmental Studies and Research
Ain Shams University

4-Dr. Ahmed Shafik El-Gendy

Assistant Prof., Department of Environmental Engineering Sciences
Institute of Environmental Studies & Research
Ain Shams University

Giving

To my Supporters

To my Family

To everyone all over the world

I hope this Effort will be Useful to Them

ACKNOLEDGMENT

I would like to express my deepest gratitude to my supervision committee. ***Prof. Taha Abdel Azim M. A. Razek*** *and* ***Dr. Ahmed Shafik A. El Gendy*** *for their support, continuous encouragement, helpful advice, and valuable suggestions*

Sincere appreciation and deep gratitude to ***Dr. Farouk Abdel Aziz*** *for his continuous encouragement and giving all possible help and facilities throughout this work.*

Deep thanks and gratitude are extended to ***Prof. Mohamed Hanafy Mahmoud*** *Environmental & Infra Structural Studies Cairo University faculty of engineering for his continuous encouragement.*

Finally, I am deeply grateful and thankful to the great help of my family

ABSTRACT

Sausage preparation industry consumes large amounts of water in washing the raw and final products also final products that generates large amount of polluted water contains protein which have impact on environment. Pollution aspects related to the sausage preparation industry effluents are characterized by higher concentration of suspended solids. Large volumes of wastewater are generated during the process. Different conventional physicochemical treatments have been used to treat the wastewater. Removal of pollutants produced by industrial plants is required for reuse of water and meet environmental standards. The pollutants in the sausage wastewater have variable concentration of suspended solids, dissolved solids, chemical oxygen demand and Biochemical oxygen demand. This waste water can cause serious environmental problems due to their large amount of suspended solids, and high chemical oxygen demand. So, they have to be removed before being discharged into the environment. Limits for pollutants in wastewater vary depending on the type of receiving water body. The parameters that should be monitored and/or inspected are biochemical oxygen demand BOD, chemical oxygen demand COD, pH, temperature, total suspended solids TSS, and total dissolved solids TDS. The problem of sausage preparation wastewater utilization may be solved with different techniques without reuse or recycle treated wastewater. Different conventional physicochemical treatments have been used to treat the wastewater such as coagulation with mineral coagulants and organic coagulants, then precipitation. Choice of a suitable coagulant to optimize contaminant removal and reduction in costs is the most important factor. The feasibility of using aluminum sulfate, poly aluminum chloride 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 removal efficiency of COD, BOD, TSS, O&G and TKN recorded (98%), (97%), (97%), (95%), (97%) respectively using a dose of 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.

Content

Title	page
Acknowledgment	vii
Abstract	vii
Content	vii
CHAPTER (1)	1
1. Introduction	1
1.1 General	1
1.2 Sausage preparation industry	1
1.3 Objective	3
1.4 Process selection	4
Study area	5
CHAPTER (2)	6
Literature Review	6
2.1 Introduction	6

2.2 Coagulation and flocculation	7
2.3 Mechanisms of coagulation process	9
2.3.1 Double-layer compression	9
2.3.2 Adsorption and charge neutralization	10
2.4 The chemicals used	15
2.4 .1 Aluminum Sulphate (Alum)	15
2.4.2 Ferric chloride	16
2.4.3 Polymers	17
2.4.4 Polyacrylamides	18
2.4.5 Polyaluminum Chloride (PAC)	18
2.5 Effect of pH on coagulation	19
2.6 Optimum coagulant dosage	20
2.7 peoples know the coagulation	21
2.8 Steps of coagulation process	22
2.9 Mechanism of polymer coagulation	34
Aim of Work	46
CHAPTER (3)	47
Material and Methods	47
3.1 Material	47
3.2 Methods	47
3.2.1. Phase I Jar test	47
Collecting samples	47
3.2.2. Phase II The full plant	49
3.3.2.1. waste water characteristics	49
3.3.2.2. Sequence of operation	50
3.4. Full scale treatment plant	53
3.4.1. Treatment processes	53

3.4.1.1. Screening	53
3.4.1.2. Flow Equalization	53
3.4.1.3. Sedimentation	54
3.4.1.4. Equalization tank	55
3.4.1.5. Rapid mix basin.	56
3.4.1.6. Flocculation tank.	56
3.4.1.7. V- shape.	57
3.4.1.8. Drying Bed (Sludge dewatering unit)	57
Operating system suggested	60
CHAPTER 4	61
Results and Discussions	61
Results	61
(A) The Results with Jar test	61
Ferric Dose Sample (1)	61
Sample (2) Fe cl3	62
Sample (3) Fe cl3	62
Alum Dose	63
Sample (1) Alum	63
Sample (2) Alum	64
Sample (3) Alum	64
PAC dose	65
Sample (1) PAC	65
Sample (2) PAC	66
Sample (3) PAC	67
(b) The full scale results (The limits of Decree 44/2000)	68
Discussions	68
4.1.1. Treatment with ferric chloride: Sample (1)	69

4.1.2. Treatment with ferric chloride: Sample (2)	71
4.1.3. Treatment with ferric chloride: Sample (3)	72
4.2.1. Treatment with alum: Sample (1)	74
4.2.2. Treatment with alum: Sample (2)	76
4.2.3. Treatment with alum: Sample (3)	78
4.3.1. Poly aluminum Chloride (PAC): Sample (1)	79
4.3.2. Poly aluminum Chloride (PAC):Sample (2)	81
4.3.3. Poly aluminum Chloride (PAC): Sample (3)	82
Full scale results assessment	84
CHAPTER 5	86
Conclusion	86
Summary	87
Reference	91
المستخلص	١
الملخص العربي	٢

List of Figures

Title	page
Fig. 1 A map for the industrial area in Alexandria	5
Fig. 2 Mechanism of Coagulation (Gregory, 2006)	9
Fig. 3 schematic representation of bridging model	12
Fig. 4: Steps of coagulation process	23
Fig. 5: Reaction Schematics of Coagulation	25
Fig. 6: Stepwise Conversion of the Tri-Positive Al	27
Fig.7: Concentrations of Monomeric hydrolysis products	31
Fig. 8: Proportions (mole fractions) dissolved hydrolysis	31
Fig. 9: Mechanism of polymer coagulation	34
Fig 10: Jar test apparatus	48
Fig 11: sample photo of jar test	48
Fig 12: Flow diagram for the plant	51
Fig 13: drowning for the plant	52
Fig (14) Screening	53
Fig (15) Flow Equalization	54
Fig (16) Sedimentation	55
Fig (17) Equalization tank	55
Fig (18) Rapid mix basin.	56
Fig (19) Sedimentation tank	56
Fig (20) V- shape	57
Fig (21) Drying Bed (Sludge dewatering unit)	57
Fig (22) Sample (1) a with ferric chloride dose(mg/l)	69
Fig (23) Sample (1) b with ferric chloride dose(mg/l)	70
Fig (24) Sample (2) a with ferric chloride dose(mg/l)	71
Fig (25) Sample (2) b with ferric chloride dose(mg/l)	72
Fig (26) Sample (3) a with ferric chloride dose(mg/l)	73

Fig (27) Sample (3) b with ferric chloride dose(mg/l)	73
Fig (28) Sample (1) a with alum dose (mg/l)	74
Fig (29) Sample (1) b with alum dose (mg/l)	75
Fig (30) Sample (2) a with alum dose (mg/l)	76
Fig (31) Sample (2) b with alum dose (mg/l)	77
Fig (32) Sample (3) a with alum dose (mg/l)	78
Fig (33) Sample (3) b with alum dose (mg/l)	79
Fig (34) Sample (1) a with PAC dose (mg/l)	80
Fig (35) Sample (1) b with PAC dose (mg/l)	80
Fig (36) Sample (2) a with PAC dose (mg/l)	81
Fig (37) Sample (2) b with PAC dose (mg/l)	82
Fig (38) Sample (3) a with PAC dose (mg/l)	83
Fig (39) Sample (3) b with PAC dose (mg/l)	83

List of table

Title	page
Table (1) Inorganic chemicals for coagulation	15
Table (2) Optimum pH Values for Metallic	20
Table (3) sample (1) a with ferric dose	61
Table (4) sample (1) b with ferric dose	61
Table (5) sample (2) a with ferric dose	62
Table (6) sample (2) b with ferric dose	62
Table (7) sample (3) a with ferric dose	62
Table (8) sample (3) b with ferric dose	63
Table (9) sample (1) a with alum dose	63
Table (10) sample (1) b with alum dose	63
Table (11) sample (2) a with alum dose	64
Table (12) sample (2) b with alum dose	64

Table (13) sample (3) a with alum dose	64
Table (14) sample (3) b with alum dose	65
Table (15) sample (1) a with PAC dose	65
Table (16) sample (1) b with PAC dose	66
Table (17) sample (2) a with PAC dose	66
Table (18) sample (2) b with PAC dose	66
Table (19) sample (3) a with PAC dose	67
Table (20) sample (3) b with PAC dose	67
Table (21) The full scale plant results	68

ABBREVIATIONS: The following abbreviations are used in this thesis:

Abbreviation	Illustration
BC	Before Christ
BOD	Biochemical oxygen demand
^{o}C	Centigrade
COD	Chemical oxygen demand
EC	Electrical conductivity
m3 /d	Cubic meter per day
m3/m2/d	Cubic meter per square meter per day
mg/l	Milligram per liter
DO	Dissolved Oxygen
EEAA	Egyptian Environmental Affairs Agency
PH	Hydrogen Ion Concentration
WTP	West Treatment Plant
WHO	World Health Organization

ml /l	Milliliter per liter
Min	Minute
Ppm	Part per million
R%	Removal percent
rpm	Recycle per minute
RWW	Raw wastewater
SS	Suspended solids
TDS	Total dissolved solids
TS	Total solids
TSS	Total suspended solids
µS/cm	Micro Siemens Per Centimeter
Zp	zeta potential

CHAPTER
(1)
1. Introduction

1.1 Genral

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**).

1.2 Sausage preparation industry

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 follow; 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