TREATMENT OF INDUSTRIAL EFFLUENT USING LOCALLY MADE ACTIVATED CARBON FROM ANIMAL BONES.

BY

ADEOYE TOYOSI ADERINSOLA

2003 /14928EH

A PROJECT SUBMITTED TO THE DEPARTMENT OF CHEMICAL ENGINEERING

FEDERAL UNIVERSITY OF TECHNOLOGY MINNA, NIGER STATE

IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE AWARD OF BACHELOR DEGREE IN CHEMICAL ENGINEERING (B.ENG)

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DECLARATION

I, Adeoye Toyosi Aderinsola with Reg. number 2003 / 14928EH declare that this project report is my original work and has not been presented else where to the best or my knowledge.

Adeoye

17 - 11 - 2008

Adeoye T.A **Date**

CERTIFICATION

This research project by Adeoye Toyosi Aderinsola. has been examined and certified under the supervision of Engineer M.A Olutoye to be adequate in scope and quality for the partial fulfillment of the requirement for the award of bachelor of Engineering (B.Eng) in Chemical Engineering.

Engr. M.A. Olutoye (Project Supervisor)	22-10-2018 **Date**
Dr. M. O. Edoga **(Head of Department)**	**Date**
External Examiner	**Date**

DEDICATION

This project is dedicated to the most-high God for his protection and guidance throughout the duration of achieving my first degree certificate.

Also to my lovely parents Mr. and Mrs. Adeoye and the entire Adeoye family whose contribution of my educational pursuit cannot be quantified.

ACKNOWLEDGEMENT

My utmost thanks go to God Almighty for his faithfulness over my life by making everything to always work together for good for me. And without whom this project would not have been possible.

I am registering my profound thanks to my supervisor Engr M.A Olutoye, the H.O.D Dr. M.O Edoga, and the entire staffs (both the lecturers and the technical staffs), Mr. Ibikunle and Mr Musa in WAFT Department, Mr.Dirisu and the rest for their contributions to the completion of this project, may God reward your efforts.

My gratitude to my parents Mr and Mrs Adeoye knows no bound for their care and support (both financially and morally) and also for their ceaseless prayer which has led to the success of this work. I also say a big thank you to my siblings Mr. Sunkanmi, Mrs Funmi, Lanre, Sesan, Odunola, Jumoke, Bayo and Shola; you are indeed very wonderful.

I am also saying thanks you to my friends like Charity, Feyi, Bose, Kafayat, Dupe and the rest. And of course this section would be incomplete without making reference to my pals like Kingsley, Picanto de desperado, Momoh, and the rest, God bless you all.

ABSTRACT

This work is aimed at producing activated carbon from animal bones. The bones were carbonized at 400°C and treated with 0.01m H_2SO_4 for activation. The parameters determined in the treated samples were chemical oxygen demand (COD) was 55.57mg/l, biological oxygen demand (BOD) was 56.54mg/l, total dissolved solid (TDS) was 337.50mg/l, total suspended solids (TSS) was 52.50mg/l and total solids (TS) was 430mg/l. the results above suggests that the activated carbon from animal bones can adsorb inorganic and organic matter from industrial waste water up to the threshold limit.

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CHAPTER ONE

1.0 INTRODUCTION

Pollution is generally caused when a change in physical, chemical or biological conditions in the environment affects the quality of human life including effect on the other animals' plants cultural and aesthetic assets.

Pollution is also defined as by MC Graw –Hill dictionary as the destruction or impairment of the purity of the environment. Most of pollution may be characterized as production of excesses resulting from manufacturing or growing more than what to be consumed or discarding by products after use.

Pollution is generally attributed to material substances gases and particulate matter (smoke, stacks, dust)chemical in water or solid wastes (paper, glass, used automobiles)also pollution can be mom material such as excess noise and light(Eckenfelder,1989)

Although pollution and pollution control are usually treated in three categories this: Air, water, and land. Many failures in pollution control have led to in appropriate division of control responsibility, Junk poles and dumps pollute the land. Also industrial waste water poses potential damage to the environment through either direction or indirect chemical reactions. Some industrial waste water is toxic. Some are readily biodegraded and create an immediate oxygen demand.

Industrial waste water can be generally treated by the two, for removal of contaminant with the expectation that the majority of the liquid waste can be recycled. The treatment of organic material present in industrial and municipal waste water has been traditionally accomplished by combing liquid-solid separation techniques and biological processes (Ekenfeider, 1989)

The technology of activated carbon adsorption as an alternative has been applied to remove organic pollutant from waste waters. The reasons for the choice of activated carbon as an adsorbent are of several fields. Carbon has been demonstrated to have good sorption characteristic for most organic compound (Ouano et al, 1989)

1.1 HISTORICAL PERSPECTIVE

Activated carbon first came into prominence through its use as an adsorbent in gas mask in World War 1. However, the decomposition of wood can remove colourings' matter from solution dates back to the fifteenth century. The first commercial application of this property,

2.7 ADSORPTION USING SOLID ADSORBENTS

The purification technique is based on selective removal of poisons impurities from the gas using solid adsorbent commonly used adsorbent include porous materials such as activated carbon silica gel and a host of others. Adsorption must poses high adsorptivity, selectivity, thermal, resistance, and long service life without change in structure and surface property. Adsorption of gaseous impurities is a batch process. The flue gases are passed top-down at a velocity of 0.05 to 0.3m/s. The adsorption is termed a catalyzed gaseous heterogeneous reaction with time the adsorbents lose their adsorptive abilities, due to saturation of their active site by the solute gas, They can be regenerated by passing through them hot water vapour air or inert gas nitrogen.(Odigure, 1998)

2.8 POLICIES AND PAST WORK ON INDUSTEIAL EFFLUENT

Over years several policies has been formulated all over the world to safe guard the environment and many analysis has been carried out on discharge effluence from industrial to minimize the damage of this effluent and also many projects has been dinr on discharge of effluent from industry.

The parameters to look out for are:

Chemical oxygen demand (COD)

Biological oxygen demand (BOD)

Total solids (TS)

Total suspended solids (TSS)

Total dissolved solids (TDS)

Conductivity e.t.c.

Many bodies like world health organization (WHO) Federal environmental protection agency set standard to meet before discharging any industrial effluent and this project will cover the above areas with the use of activated carbons treat the effluent. In 1991 WHO set standard for this effluent.

TABLE 2.1 SHOWS THE STANDARD FROM THE BODIES.

Parameter	WHO	FEPA	MAX. PERM	UK
BOD	100mg/l	100mg/l	150mg/l	150mg/l
COD	40mg/l	40mg/l	40mg/l	40mg/l
TSS	40-80mg/l	40-80mg/l	30-100mg/l	<400mg/l
TDS	500mg/l	500mg/l	500mg/l	Nrs
TS	580mg/l	580mg/l	580mg/l	Nrs
CONDUCT	750uscm^{-1}	750uscm^{-1}	750uscm^{-1}	
TEMP	21	21	39	<40
PH	7.0 – 8.5	7.0 – 8.5	6.5 – 9.2	6.5 – 9.5

(EHS, 1989)

Where

BOD = Biological oxygen demand.

COD = Chemical oxygen demand.

TSS = Total suspended solids.

TDS = Total dissolved solids.

TS = Total solids.

CONDUCT = Conductivity.

TEMP = Temperature.

WHO = World health organization.

FEDPA = Federal environmental protection agency.

NRS = No regulation set.

MAX PERM = Maximum permit.

EHS = Environmental Health and Safety

CHAPTER THREE

3.0 EXPERIMENTAL PROCEDURES/EXPERIMENT

TABLE 3.1

Material	Quantity
animal bones	1200g
filter papers	24 pieces
Dana effluent	2 litres

TABLE 3.2

Chemicals and reagents	Quantity
Potassium permanganate	60ml
Potassium dichromate	24ml
Sulphuric acid	35ml
Sodium thiosulphate	100ml
Starch solution (indicator)	12ml
Methyl orange (indicator)	
Potassium iodide	36ml
Manganese sulphate	24ml

TABLE 3.3

Equipments/apparatus	Quantity
Measuring cylinder	50ml, 100ml, 1000ml
Desiccator	1
Petri dish	3
Muffle furnace	2
Flat bottom flask	1
Conical flask	5
Stirrer rod	1
Pipette	10ml, 5ml
Burette	3
Electronic pH meter	1
Thermometer	1
Conductivity meter	1

SOURCES OF MATERIALS AND EQUIPMENTS

The animal bones were obtained from Abatoir along Tahir village in Minna on Monday 4th of August, 2008 around 12pm.

The effluent was obtained from Dana pharmaceutical industry Maitumbi Minna on Wednesday 13th of August around 6:30pm. The effluent was discharged at 85°C and was collected when at ambient temperature from the reservoir.

All equipments and apparatus used were from the department of water resources, Aqua culture and fisheries technology (WAFT) laboratory, federal University of technology Minna.

3.3 EXPERIMENTAL PROCEDURES

3.3.1 CARBONIZATION

This is the process of charcoal production from animal bones. The animal bones were washed and dried, after drying; they were placed in three different heating mugs and heated electrically with a digital thermo-controller Muffle furnace at the temperatures of 300°C, 350°C and 400°C each. Within a period of 3 hours in the absence of air after which it was then cooled.

3.3.2 ACTIVATION OF THE CHARCOAL (CARBON)

The cooled charcoal was crushed with mortar and pestle for size reduction after which it was passed through sieves of mesh sizes 300 and 500μm. 100grammes of each of the samples were weighed into three different beakers.

PREPARATION OF REAGENT (0.01M H_2SO_4)

18.39 mole per litre of H_2SO_4 was poured in a container and filled with distilled water up to 1000ml 250ml of the prepared acid was put into three different beakers and 100g of the charcoal was poured into the beakers containing the 250ml of H_2SO_4.

The sieved carbon (charcoal) was impregnated with the prepared H_2SO_4 for a period of 24 hours. The activated charcoal was drained from the chemical. With the aid of stream generating device, stream of water was passed through it. This was done 3 to 4 times. After which they were placed on Petri dishes and was allowed to dry between the temperatures of 30°C -35°C. The charcoal is now activated chemically and ready for use as adsorbent.

3.3.3 PROCEDURE FOR TREATMENT OF EFFLUENT

The columns (burette) were packed up to a height of 20cm with the activated carbon produced after which funnels were used to run the effluent down the packed activated carbon and the resultant water was collected in beakers. Clear water was obtained of which the column with activated carbon that was carbonized at 400°C was the clearest. The effluent was run until clear water of 500ml was obtained each. The water was then kept for the parameters to be determined on them.

3.3.4 DETERMINATION OF CHEMICAL OXYGEN DEMAND (COD)

Chemical oxygen demand was determined by measuring 100ml of the sample using measuring cylinder and mixed with 5ml of potassium permanganate and 1ml of 25% H_2SO_4 was also added and mixed. The solution was heated gently and allowed to boil for about 30minutes, after which it was removed and allowed to cool. 1ml of potassium iodide (KI) was then added and the solution was titrated with sodium thiosulphate until a noticeable pink colour is observed. The procedure was also repeated with distilled water as a blank.

$$\text{COD calculation} = \frac{(\text{blank - vol of } Na_2S_2O_7)}{\text{value obtained x } 0.316 \text{ x } 100}$$

The same procedure is done for both the raw and the treated effluent.

3.3.5 DETERMINATION OF BIOLOGICAL OXYGEN DEMAND (BOD)

Biological oxygen demand was determined as follows: two BOD bottles were filled with diluted water sample, the bottles were stopped tightly. One of the bottles was placed in the dark for 5days. The dissolved oxygen (DO) of the sample in the other bottle was determined immediately as this:

2ml of manganese sulphate (reagent1) solution was added followed by 2ml alkali iodide (reagent 2) well below the surface of the liquid. The solution was mixed carefully. The precipitate was allowed to settle leaving a clear supernatant above the manganese hydroxide floc. It was shaken again; 2ml of concentrated H_2SO_4 was added by allowing the acid to run down the neck of the bottle. The bottle was shaken until dissolution was complete. 100ml of the solution was then taken and titrated with 0.025N sodium thiosulphate solution to a pale straw yellow colour. 1ml of starch solution was added and the titration continued till the first appearance of blue colour.

After 5 days of keeping the first bottle in the dark, the dissolved oxygen (DO_2) was also determined in the same manner as above BOD calculation

$$D = \frac{\text{ml of titrate } V_1 \text{ x N x 800}}{\text{ml of sample titrate x (ml of bottle 2)(ml of bottle)}}$$

Where N = Normality of thiosulphate solution (0.025N)

BOD = (DO1 – DO2) x The

Where D = dilution factor (percent dilution) (10) D10

3.3.6 DETERMINATION OF TOTAL SUSPENDED SOLIDS (TSS)

Total suspended solids was determined by placing a reweighed filter paper on a holder and washed with 3 x 20ml of water. 100ml of water sample were filtered. The filter was carefully removed and dried for 1hour at 105^0C, cooled in the desiccator and then weighed. Steps were repeated until constant mass was obtained.

$$\text{TSS calculation} = \frac{\text{mass of solid filter x 100}}{\text{volume of sample}}$$

3.3.7 DETERMINATION OF TOTAL DISSOLVED SOLIDS (TDS)

Total dissolved solids was determined by measuring a known volume of water sample into a Petri this and allowed to dry in the oven at a temperature of 105^0C, cooled and placed in a desiccator and then weighed the steps are taken again until constant weight was obtained.

$$\text{TDS calculation} = \frac{\text{mass of residence x 100}}{\text{volume of filtrate}}$$

3.3.8 DETERMINATION OF TOTAL SOLID (TS)

Total solid is determined by adding the total suspended solids and total dissolved solid.

TS = TDS + TSS

3.3.9 DETERMINATION OF TEMPERATURE (T)

Temperature was determined by dipping thermometer in each sample, and values were obtained from the thermometer.

DETERMINATION OF COLOUR

Colour was determined by looking at the samples

3.3.10 DETERMINATION OF CONDUCTIVITY

Conductivity was determined by using a conductivity meter of know cell constant and conductivity cell. The cell constant of the meter was given as 1.2. The cell constant was rinsed with the sample three times and temperature was adjusted to 25^0C + 0.1^0C.

3.3.11 ETERMINATION OF pH

The pH of the samples was determined by using electronic pH meter by dipping the probe of the meter in each sample.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 RESULTS

In this chapter, all the results obtained from the experiment work carried out are characterized.

4.1.1 RESULTS OF SAMPLES USED TO CALCULATE THE PARAMETERS

appearance	cloudy
odour	mild
vol. of effluent	100ml
vol of H2SO4	5.00ml
vol of 0.01 KMnO4	15.00ml
indicator	5drops
with of filter paper	0.402g
with of eva dish	16.19g
with of residue + dish	16.27g
blank	7.84g
vol of sample diluted into 200ml	200ml
dissolved O2 1	43.19ml
dissolved O2 2	20.49
Titre vol. of 0.025N	
$Na_2S_2O_3$	21.16ml

4.2 DISCUSSION OF RESULT

Upon treatment of the industrial effluent, using adsorbent (activated carbon) developed form animal bones that is carbonized at temperature of 300^0C, 350^0C, 400^0C, the characterization parameters reduced in value reasonably as follows: at 300^0C, COD (93.23mg/l), TSS (115mg/l). at 350^0C, COD (71.57mg/l), BOD (81.11mg/l), TS (577mg/l), TDS (497.50mg/l), TSS (80mg/l). At 400^0C, COD (55.57mg/l), BOD (56.54mg/l), TS (430mg/l), TDS (337.50mg/l), TSS (52mg/l). Here, the effect of carbonization on adsorptivity rate is shown. as the temperature of carbonization increases, the adsorption becomes more effective. But higher temperature like 500^0C and above gives ashes which is not desirable.

From a purely theoretical point of view, the rate at which molecules may be adsorbed, other factors being equal will depend on the rate at which the surface of adsorbent particles and speed with which they diffuse into particles after contact. One or the other of these factors may be controlling in any given situation. One way to speed up the mass transfer in either case is to reduce the size of the adsorbent and it can be seen in this project that the reduced particle size of 300 - 500μm contributed to the effective adsorption rate.

CHAPTER FIVE

5.0 CONCLUSION

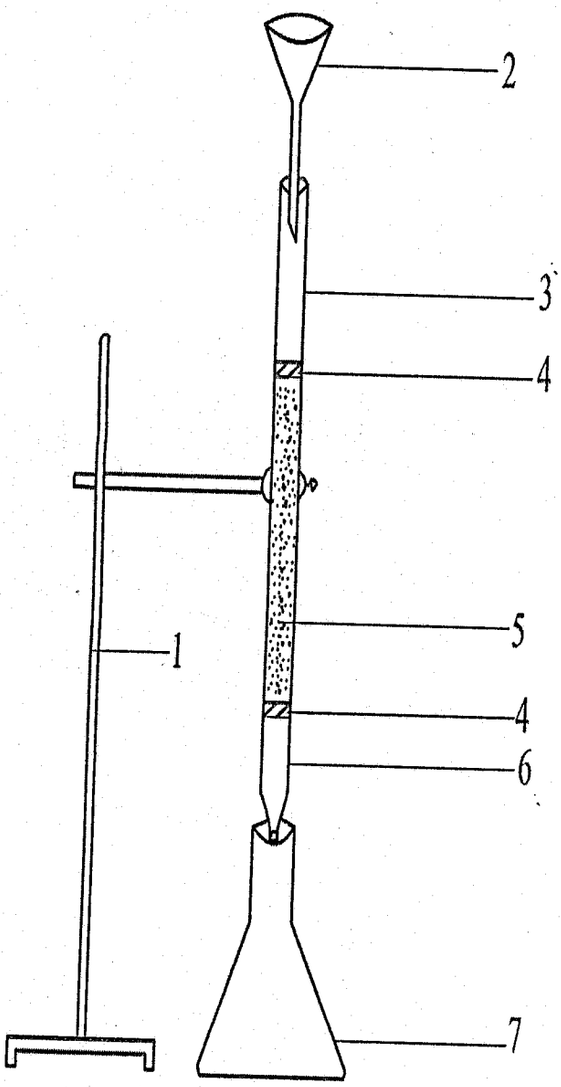
The treatment of industrial effluent has been successfully carried out using activated carbon from animal bones of 300 and 500μm particle size. The COD was gotten to be 55.5mg/l, BOD 56.54mg/l, TDS 377.50mg/l, TSS 52.50mg/l, TS 430.0mg/l. for activated carbon that was carbonized at a temperature of 400^0C.

These values are comparable to a reduction of about 51% from the standard set by world health organization (WHO) for the discharge of the industrial effluent.

5.1 RECOMMENDATION

For more efficiency and further improvement of this work, the following are recommenced:

- To avoid contamination of the effluent sample, the experiment should be carried out immediately and unexposed.
- Provisions should be made for storage of samples with proper labeling to avoid mixing up of samples.
- Prolonged exposure of activated carbon to higher temperature may lead to rearrangement and shrinkage of the particle size resulting in more constructed micro porousity leading to formation of activated carbon of lower adsorption capacity. (Abdusalam, 2003).



1. retor stand
2. funnel
3. industrial waste
4. cotton wool
5. activated carbon
6. burette
7. conical flask containing treated water

FIGURE 1: SET UP OF APPARATUS FOR TREATMENT OF INDUSTRIAL WASTE WATER WITH ACTIVATED CARBON

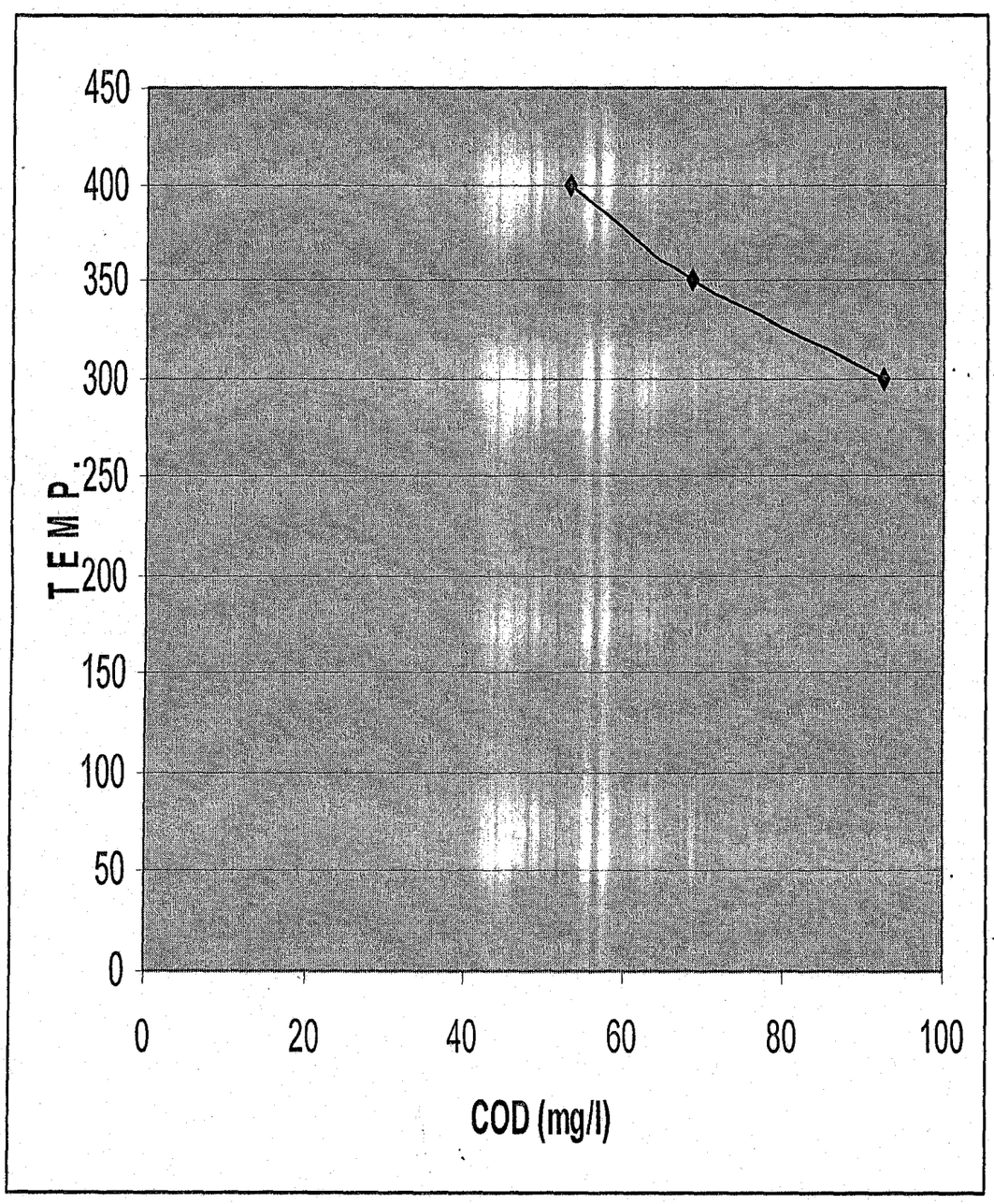


FIG 2: GRAPH OF TEMPERATURE OF CARBONIZATION AGAINST COD

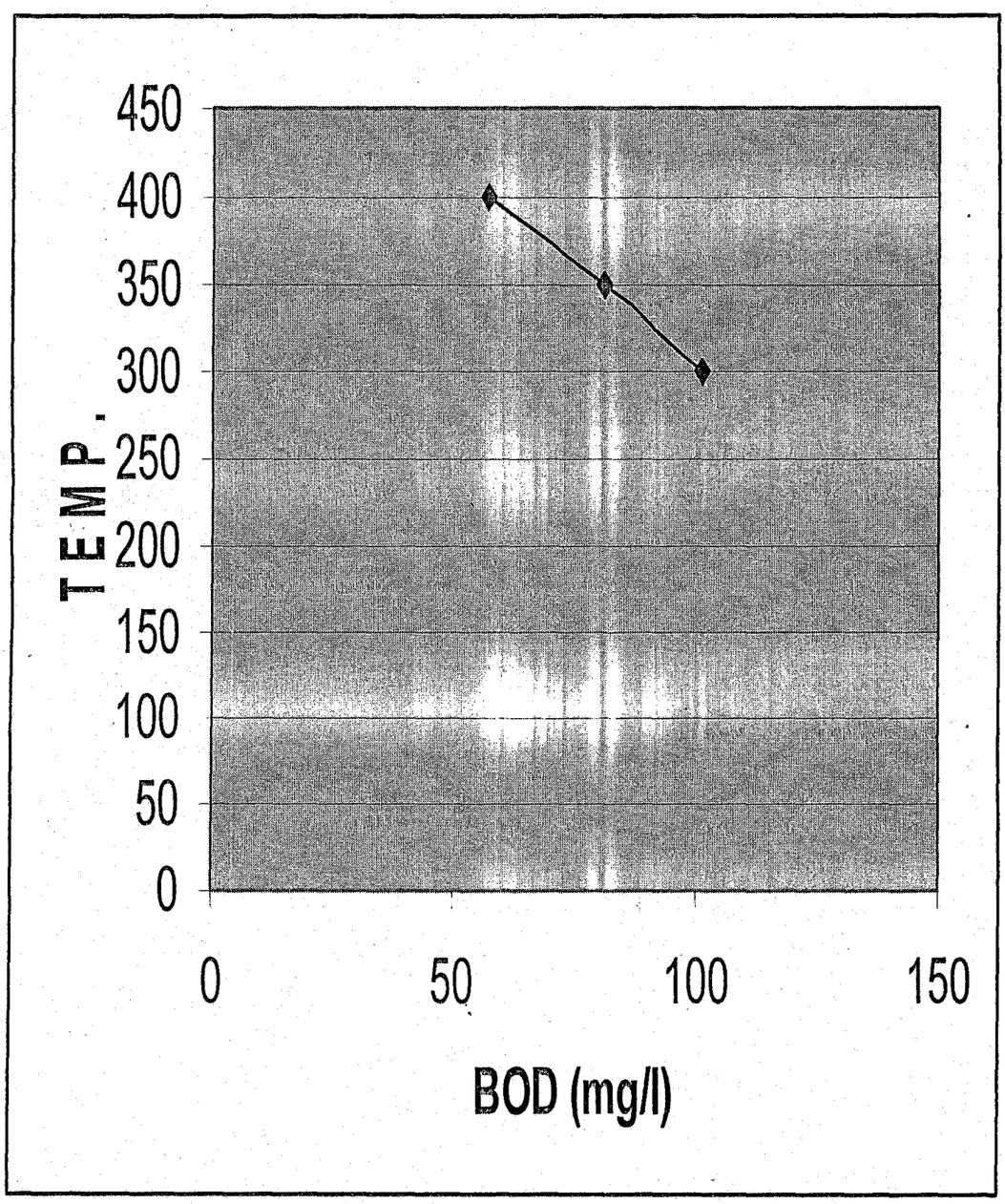


FIG 3: GRAPH OF TEMPERATURE OF CARBONIZATION AGAINST BOD

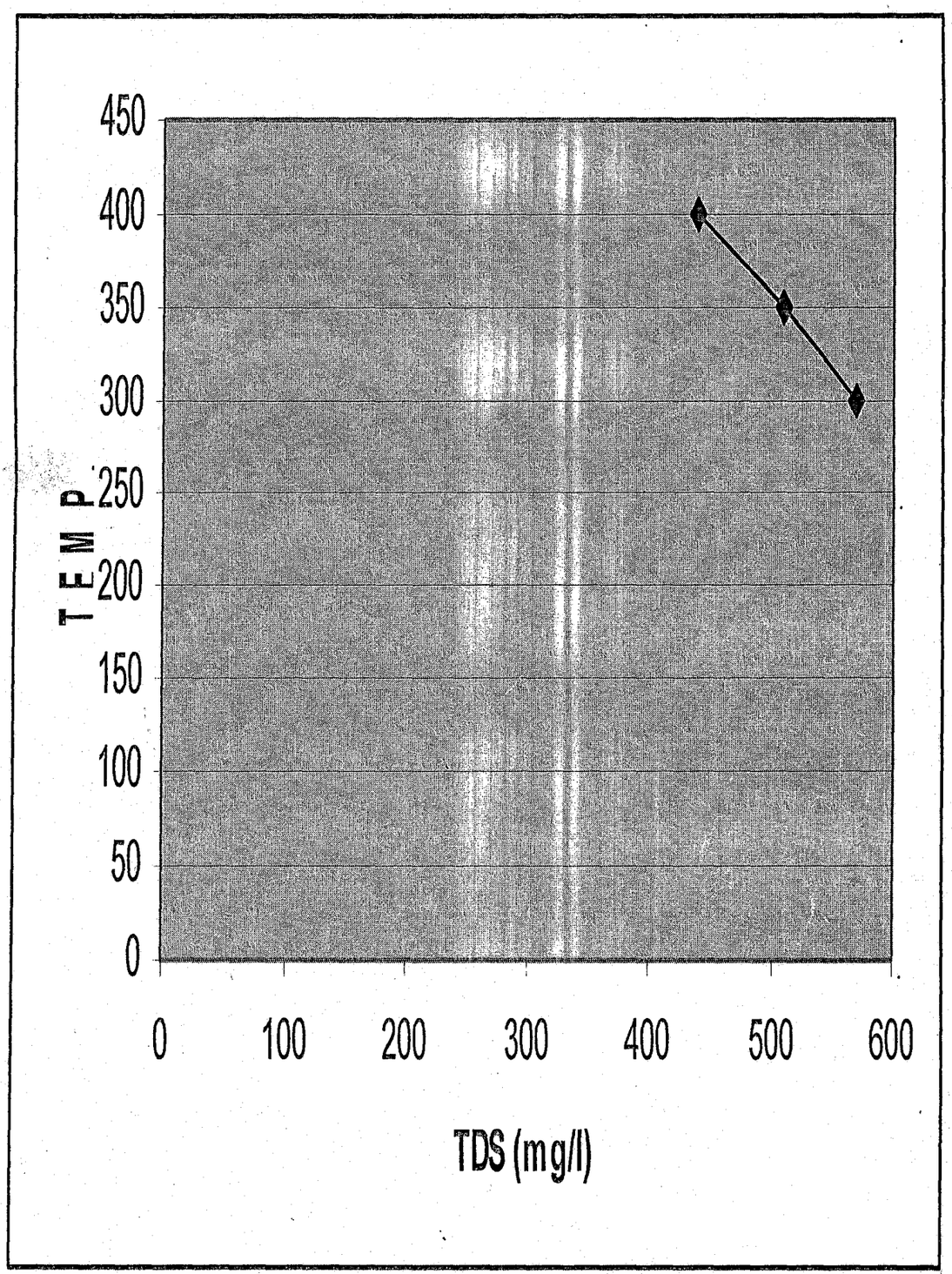


FIG 4: GRAPH OF TEMPERATURE OF CARBONIZATION AGAINST TDS

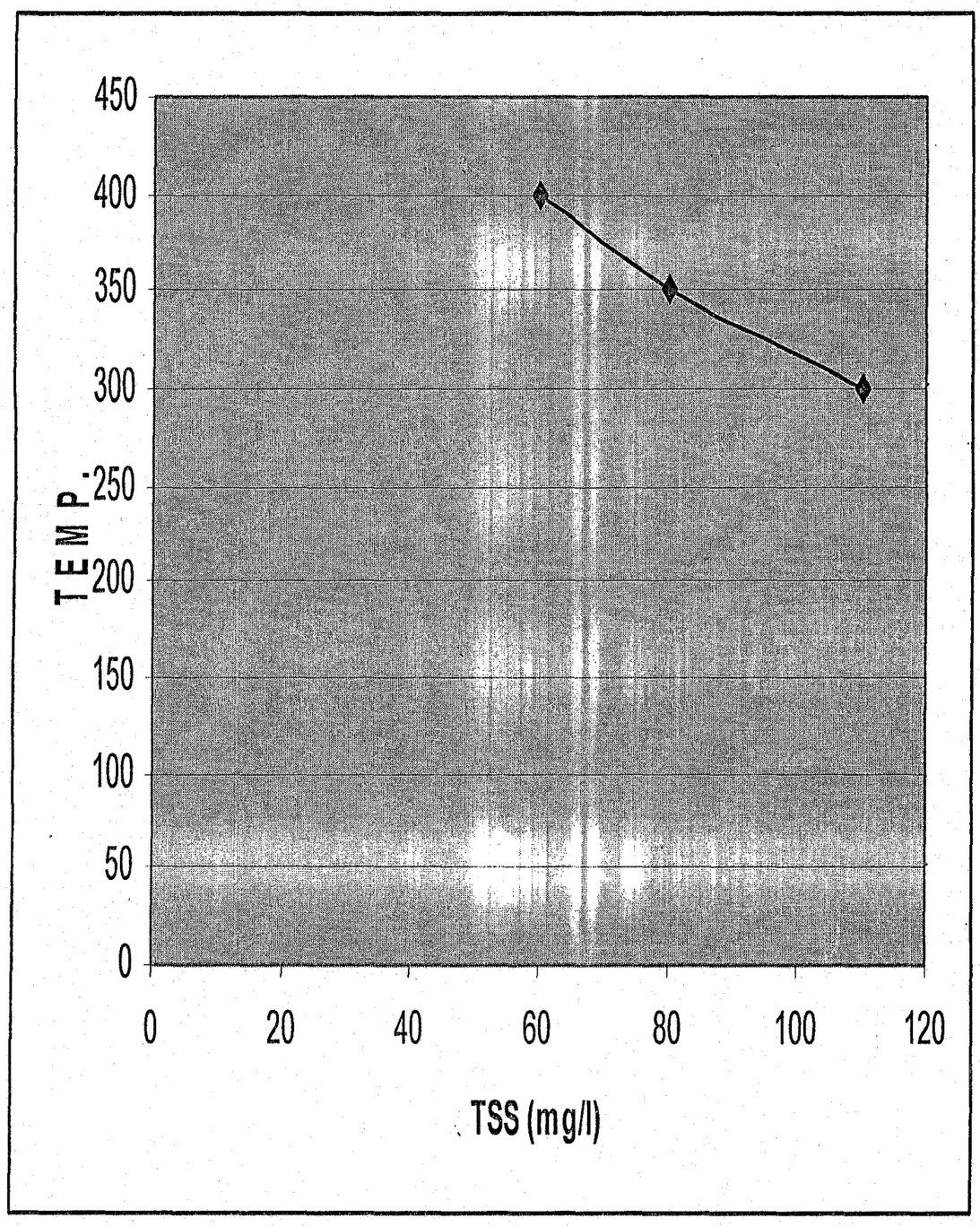


FIG 5: GRAPH OF TEMPERATURE OF CARBONIZATION AGAINST TSS

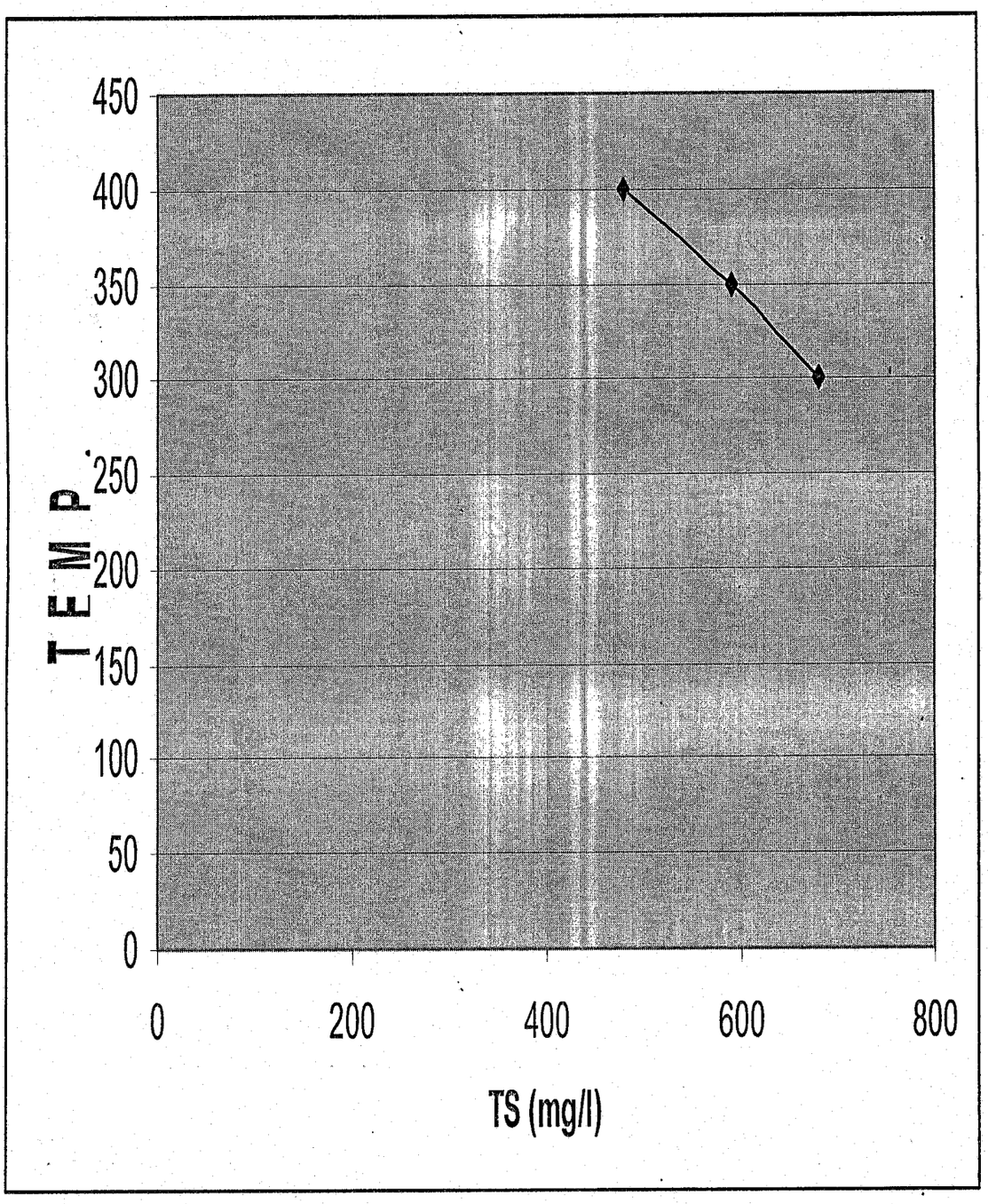


FIG 6: GRAPH OF TEMPERATURE OF CARBONIZATION AGAINST TS

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APPENDIX

Here, the calculations of the results are outlined and detailed.

CALCULATION OF COD

$$\text{COD} = \frac{\text{value obtained x } 0.316 \text{ x } 1000}{\text{volume of sample}}$$

$$\text{COD for } CA_1 = \frac{29.21 \text{ x } 0.316 \text{ x } 1000}{100}$$

$$= 92.30 mg/l$$

$$\text{COD for } CB_1 = \frac{34.60 \text{ x } 0.316 \text{ x } 1000}{100}$$

$$= 109.30 mg/l$$

$$\text{COD for } CC_1 = \frac{27.60 \text{ x } 0.316 \text{ x } 1000}{100}$$

$$= 87.20 mg/l$$

$$\text{COD for } CD_1 = \frac{26.6 \text{ x } 0.316 \text{ x } 1000}{100}$$

$$= 84.10 mg/l$$

$$\text{COD for } CA_2 = \frac{20.11 \text{ x } 0.316 \text{ x } 1000}{100}$$

$$= 63.60 mg/l$$

$$\text{COD for } CB_2 = \frac{30.13 \text{ x } 0.316 \text{ x } 1000}{100}$$

$$= 95.20 mg/l$$

$$\text{COD for } CC_2 = \frac{18.69 \times 0.316 \times 1000}{100}$$

$$= 59.14 mg/l$$

$$\text{COD for } CB_2 = \frac{21.62 \times 0.316 \times 1000}{100}$$

$$= 68.34 mg/l$$

$$\text{COD for } CA_3 = \frac{14.92 \times 0.316 \times 1000}{100}$$

$$= 47.23 mg/l$$

$$\text{COD for } CB_3 = \frac{27.24 \times 0.316 \times 1000}{100}$$

$$= 86.15 mg/l$$

$$\text{COD for } CC_3 = \frac{11.36 \times 0.316 \times 1000}{100}$$

$$= 35.90 mg/l$$

$$\text{COD for } CD_3 = \frac{16.78 \times 0.316 \times 1000}{100}$$

$$= 53.00 mg/l$$

$$\text{For Raw Sample} = \frac{38.64 \times 0.316 \times 1000}{100}$$

$$= 122.10 mg/l$$

CALCULATIONS FOR TSS

$$\text{TSS} = \frac{\text{mass of solid filter x 1000}}{\text{volume of sample}}$$

$$\text{For TSS } CA_1 = \frac{11 \times 1000}{100}$$

$$= 110 mg/l$$

$$\text{For TSS } CB_1 = \frac{18 \times 1000}{100}$$

$$= 180 mg/l$$

$$\text{For TSS } CC_1 = \frac{9 \times 1000}{100}$$

$$= 90 mg/l$$

$$\text{For TSS } CD_1 = \frac{8 \times 1000}{100}$$

$$= 80 mg/l$$

$$\text{For TSS } CA_2 = \frac{8 \times 1000}{100}$$

$$= 80 mg/l$$

$$\text{For TSS } CB_2 = \frac{12 \times 1000}{100}$$

$$= 120 mg/l$$

$$\text{For TSS } CC_2 = \frac{7 \times 1000}{100}$$

$$= 70 mg/l$$

For TSS $CD_2 = \frac{5 \times 1000}{100}$

$= 50mg/l$

For TSS $CA_3 = 6\frac{8 \times 1000}{100}$

$= 60mg/l$

For TSS $CB_3 = \frac{6 \times 1000}{100}$

$= 60mg/l$

For TSS $CC_3 = \frac{5 \times 1000}{100}$

$= 50mg/l$

For TSS $CD_3 = \frac{4 \times 1000}{100}$

$= 40mg/l$

For Raw Sample $= \frac{27 \times 1000}{100}$

$= 270mg/l$

CALCULATIONS FOR TDS

$$\text{TDS} = \frac{\text{mass of residue} \times 1000}{\text{volume of filtrate}}$$

For TDS $CA_1 = \frac{57 \times 1000}{100}$

$= 570 mg/l$

For TDS $CB_1 = \frac{63 \times 1000}{100}$

$= 630 mg/l$

For TDS $CC_1 = \frac{52 \times 1000}{100}$

$= 520 mg/l$

For TDS $CD_1 = \frac{52 \times 1000}{100}$

$= 520 mg/l$

For TDS $CA_2 = \frac{51 \times 1000}{100}$

$= 510 mg/l$

For TDS $CB_2 = \frac{54 \times 1000}{100}$

$= 540 mg/l$

For TDS $CC_2 = \frac{48 \times 1000}{100}$

$= 480 mg/l$

For TDS $CD_2 = \frac{46 \times 1000}{100}$

$= 460 mg/l$

For TDS $CA_3 = \frac{44 \times 1000}{100}$

$= 440 mg/l$

For TDS $CB_3 = \frac{42 \times 1000}{100}$

$= 420 mg/l$

For TDS $CC_3 = \frac{35 \times 1000}{100}$

$= 350 mg/l$

For TDS $CD_3 = \frac{30 \times 1000}{100}$

$= 300 mg/l$

For Raw Sample $= \frac{78 \times 1000}{100} = 780 mg/l$

CALCULATIONS FOR TOTAL SOLIDS (TS)

TS = TDS + TSS

TS for CA_1 = 570 + 110 = 680mg/l

TS for CB_1 = 630 + 180 = 810mg/l

TS for CC_1 = 520 + 90 = 610mg/l

TS for CD_1 = 520 + 80 = 520mg/l

TS for CA_2 = 510 + 80 = 590mg/l

TS for CB_2 = 540 + 120 = 660mg/l

TS for CC_2 = 480 + 70 = 550mg/l

TS for CD_2 = 480 + 50 = 510mg/l

TS for CA_3 = 440 + 60 = 500mg/l

TS for CB_3 = 420 + 60 = 480mg/l

TS for CC_3 = 350 + 50 = 400mg/l

TS for CD_3 = 300 + 40 = 340mg/l

For Raw Sample = 780 + 270 = 1050mg/l