Waste water treatment unit

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Abstract

A wastewater treatment plant to treat both the sanitary and industrial effluent originated from process, utilities and offsite units of the refinery is described.

The purpose is to obtain at the end of the treatment plant, a water quality that is in compliance with contractual requirements and relevant environmental regulations.

1- First treatment (pretreatment)

- Primary de-oiling
- Equalization
- Neutralization
- Secondary de-oiling

2- Second treatment (Biological)

- The mechanism of BOD removal
- Biological flocculation
- Nutrient requirements
- Nitrification
- De-nitrification
- Effect of temperature
- Effect of pH

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Introduction

The wastewater treatment plant to treat both the sanitary and industrial effluent originated from process, utilities and offsite units of the refinery in order to obtain at the end of the treatment plant, a water quality that is in compliance with contractual requirements and relevant environment regulations and our treatment unit fulfill this target according to the analysis of final discharge which was drainage in Nubaria channel.

Function of the unit

The wastewater treatment plant processes sanitary and industrial effluents originated in process, utilities and offsite system of the refinery outgoing water quality is in compliance with governing environmental regulations.

Description of flow

Waste water originated from the different refinery areas can be divide into five groups as described below:

- **Hydrocarbon wastes**
  a) hydrocarbon process equipment drainage originated from process unit
- **Oil and suspended solids contaminated waters**
  a) De-Salter effluent
  b) Tank bottom and miscellaneous drainage
  c) Oily storm water from paved areas
  d) Accidentally polluted storm water
- **Organic contaminated non oily waters**

a) Sour water stripper effluent
b) Spent caustic treatment effluent
c) Gas wash tower effluent (CCR plat forming unit)
d) Vent gas washing from penex

- **Sanitary sewer water**

- **Non contaminated water**
  a) Cooling water blow down
  b) Boiler blow down
  c) waste heat boiler blow down
  d) Neutralized chemical; sewer
  e) Sulfur solidification drainage
  f) Raw water filter backwash

Description of flow scheme in the waste water treatment unit

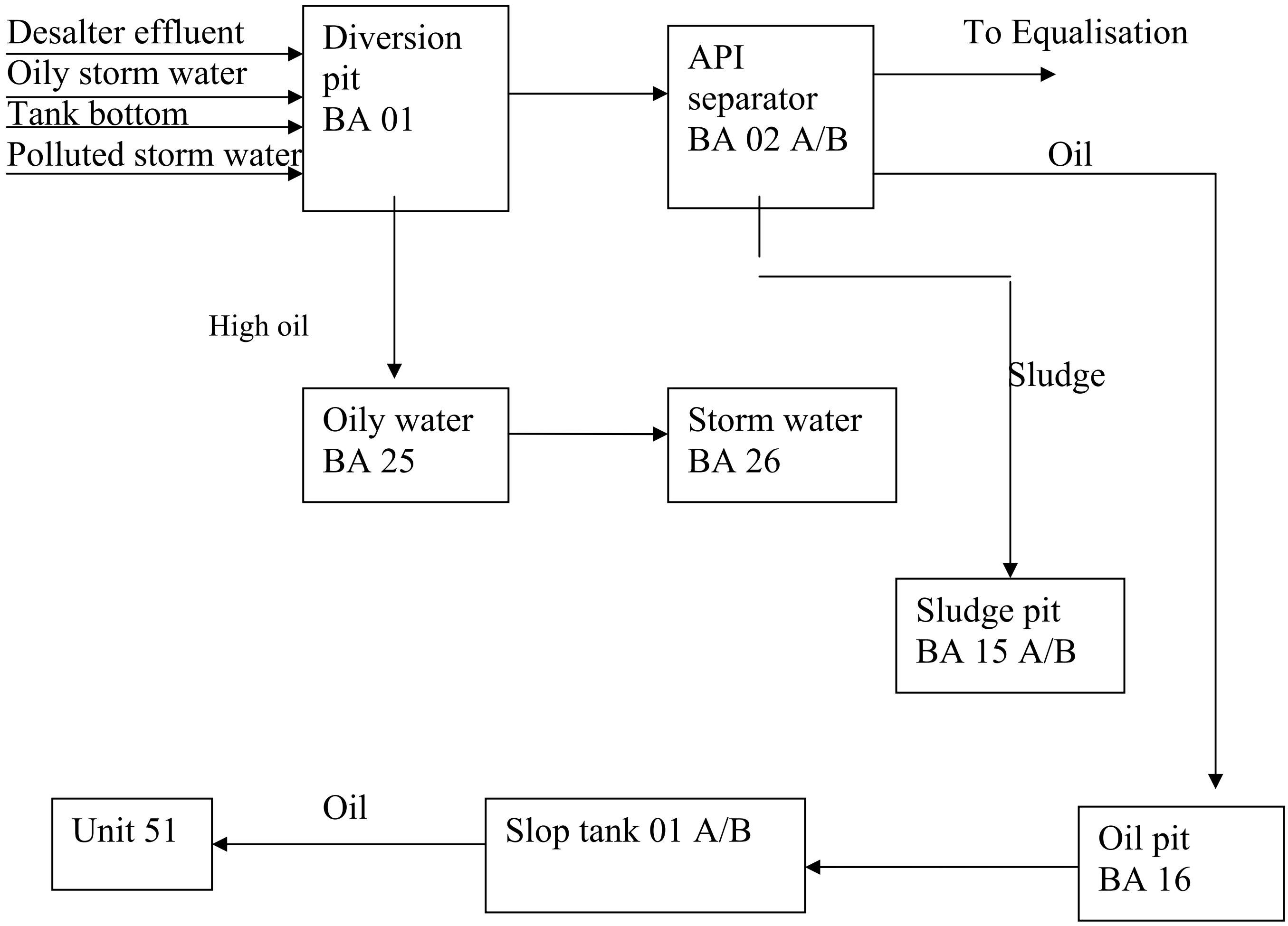


Figure 1

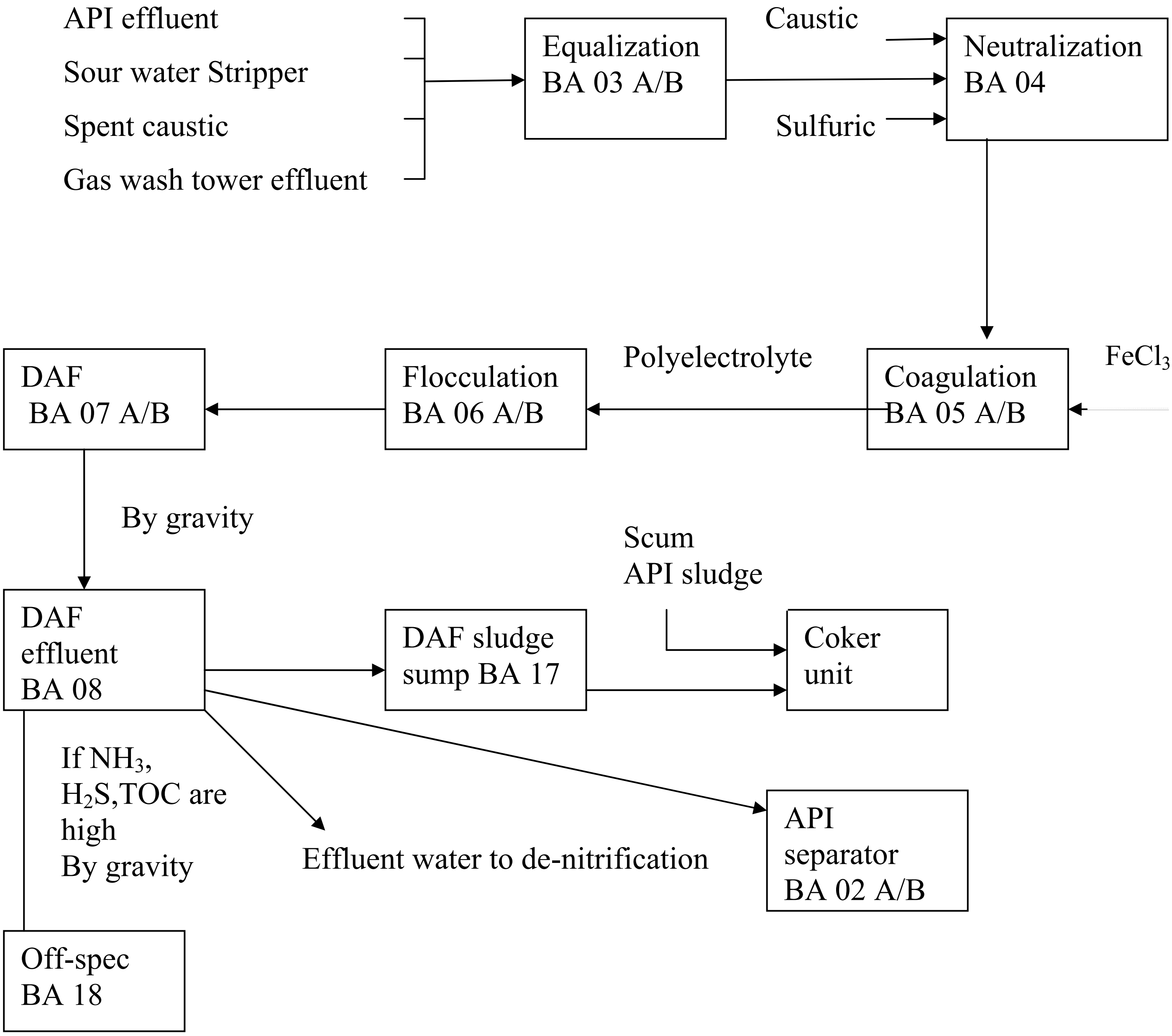

API effluent
Sour water Stripper
Spent caustic
Gas wash tower effluent
Equalization BA 03 A/B
Caustic
Sulfuric
Neutralization BA 04
DAF BA 07 A/B
Flocculation BA 06 A/B
Polyelectrolyte
Coagulation BA 05 A/B
$FeCl_3$
By gravity
Scum
API sludge
DAF effluent BA 08
DAF sludge sump BA 17
Coker unit
If NH_3, H_2S,TOC are high
By gravity
Effluent water to de-nitrification
API separator BA 02 A/B
Off-spec BA 18

Figure 2

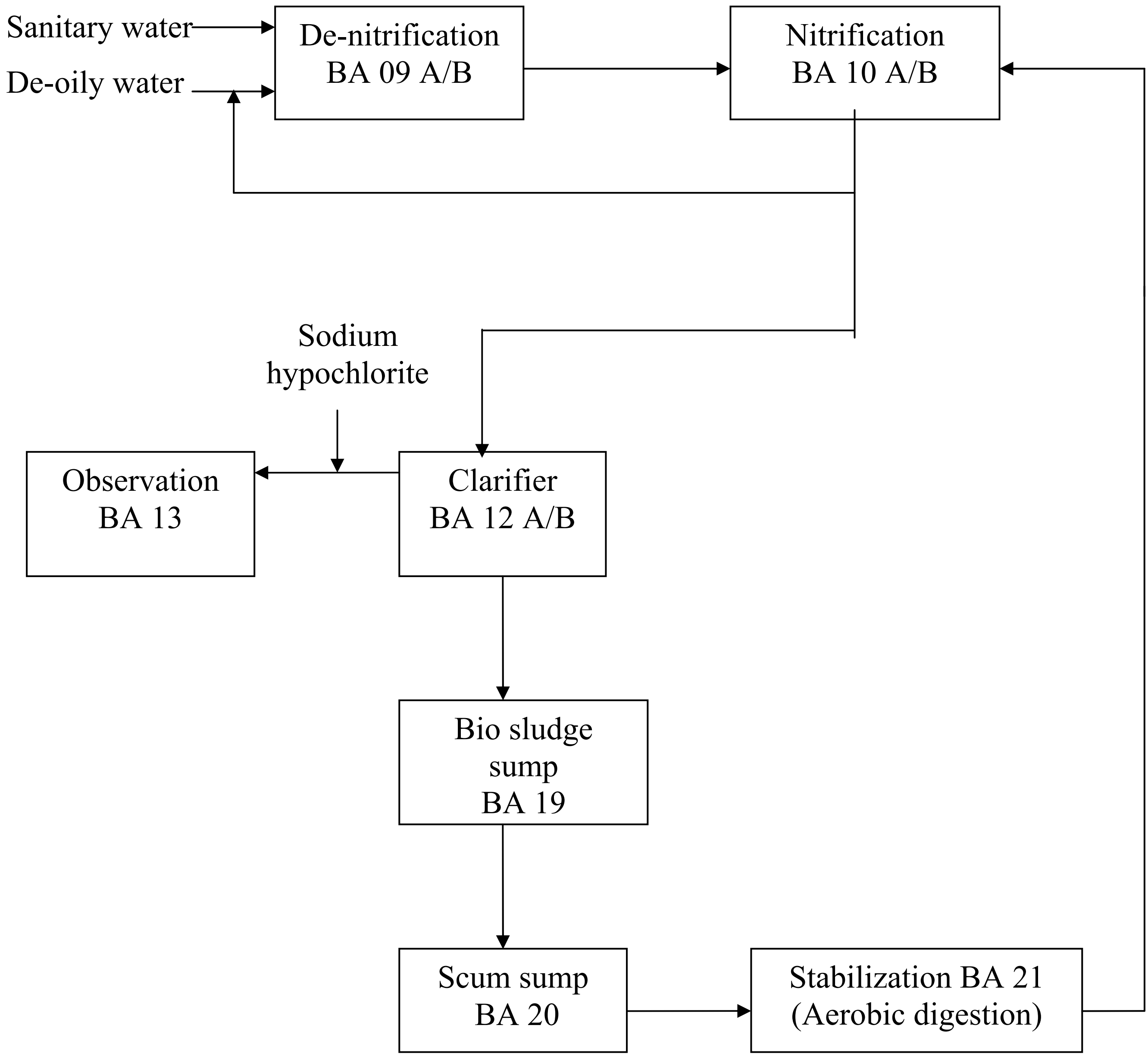


Figure 3

Chemicals used :

- Caustic Soda used to adjust the pH
- Sulfuric acid used to adjust the pH
- Ferric chloride used as a coagulant reagent
- Polyelectrolyte Emulsion used as flocculation reagent
- Tri sodium phosphate as a nutrient reagent
- Sodium Hypochlorite as a disinfection reagent
- Urea as a nutrient reagent

<u>Flow rates of the streams:</u>

American petroleum institute separator (API inlet)

The influent flow rate is (140 m^3/hr) divided as

- Oily sewer 30 m^3/hr
- De-Salter 44 m^3/hr
- Stripped water 65 m^3/hr
- Spent caustic 1 m^3/hr

American petroleum institute separator (API outlet)

The effluent flow rate is (140 m^3/hr) divided as

- Sludge 0.8 m^3/hr
- Effluent to Equalization 139.2 m^3/hr

Dissolved air flotation (DAF inlet)

The influent flow rate is (139.2 m^3/hr) divided as

- Effluent from Equalization (139.2 m^3/hr)

Dissolved air flotation Dissolved air flotation (DAF outlet)

- Sludge 1.2 m^3/hr
- Effluent to Biological 138 m^3/hr
- Bio-sludge recycle 140 m^3/hr

Biological inlet

- Influent from DAF outlet135 m^3/hr
- Bio-sludge recycle from clarifier140 m^3/hr
- Unit 55 (Sanitary)3 m^3/hr

Biological outlet

- Effluent to clarifier 270 m^3/hr

Clarifier inlet

- Effluent from Biological outlet 270 m^3/hr

Clarifier outlet

- Bio-sludge recycle to biological 140 m^3/hr
- Effluent to discharge 130 m^3/hr

Final Discharge

- Effluent from discharge to Nubaria channel 130 m^3/hr

<u>Process theory</u>

Treatment of waste water include the following steps

a) **Pretreatment**
   - Primary de-oiling
   - Equalization
   - Neutralization
   - Secondary de-oiling

b) **Biological treatment**
   - The mechanism of BOD removal
   - Biological flocculation
   - Nutrient requirements
   - Nitrification
   - De-nitrification
   - Effect of temperature

- Effect of pH
- Toxicity

c) Tertiary treatment

- Sedimentation
- Chlorination

d) Treatment of sludge

- Digestion
- Thickening
- Dewatering
- Other types of treatment
    a) Composting
    b) Pyrolsis
    c) Gasification
    d) Anaerobic digestion

e) Deviation from normal operation and troubleshooting measures are described

1- Pretreatment

Treatment is given to some water streams prior to the waste water treatment as retention ponds are often provided to avoid overloading the waste water plant with storm water, De-oiling is provided for removal free oil before the effluent stream is treated Inside the plant.

- **Primary de-oiling**

  An API separator is a gravity settling basin for the separation of free oil from waste water, and is basically a holdup basin which reduces waste water velocity and provides holdup time to allow the oil to the surface, where it is removed by skimming, Oil content (max. 1000 to 10000 ppmw) of the influent water from

API separator and could be 50 to 100 ppm w of the effluent water from API Separator, API separator will not separate soluble substances, will not break Emulsion and not remove soluble BOD.

- **Equalization**

Equalization is used to overcome the operation problems caused by flow rate variation to improve the performance of the downstream process, and to reduce the size and cost of downstream treatment facilities and also to dampen concentration of the influent waste water.

- **Neutralization**

Neutralization and pH control is essential for effective operation of the air flotation and biological process, There is a constant feedback mechanism to rest the controls in order to maintain steady pH condition of 7-8 by adjusts the stroke of the injection pumps of both caustic and sulfuric acid.

- **Secondary de-oiling**

Dissolved air – flotation (DAF) remove free oil and non dissolved solids from water by floating them to the surface with small air bubbles which precipitate from solution. DAF can produce an effluent with an oil content of < 15 ppm w if flocculating chemicals are used, DAF can not remove soluble BOD or other soluble components. DAF consists of pressurizing the waste water flow with air and then releasing it to atmospheric pressure when the pressure on the waste water is reduced the dissolved air in excess of saturation at atmospheric pressure is released in extremely fine bubbles, The gas bubbles raise toward the surface the controlled turbulence in the inlet compartment causes contact between the solids. The floc- forming properties of the material or by the chemicals that have been added to induce or aid in the development of buoyant forces, Inorganic chemicals such as (alum, activated silica, ferric chloride) aid The flotation process by promoting flocculation Increasing floc size facilities the entrapment of rising air bubbles

Factors affecting the design of flotation systems

a) The feed solids concentration
b) Quantity of air used
c) Liquid loading rate
d) Particle rinse velocity

2- Biological treatment

- **The mechanism of BOD removal**

There are two basic phenomena occur to explain removing of organic from the solution.

i. Oxygen is consumed by the organism for energy
ii new cell mass in synthesized

Initial BOD_5 removed is accomplished by one or more mechanisms, Depending on the physical and chemical properties of the organic matter.

These mechanisms are

a) Removal of suspended matter by their enmeshment in the Biological flow

b) Removal of colloidal material by physiochemical adsorption on the biological floc.
c) A bio-adsorption of soluble organic matter by the microorganisms

Amount of immediate removal of soluble BOD_5 is directly proportional to:

a) The concentration of sludge present
b) The sludge age
c) The chemical characteristics of the soluble organic matter

- **Biological flocculation**

One of the factors essential to the performance of the activated sludge process is effective flocculation of the sludge with subsequent rapid settling and compaction of the floc, The maintenance of aerobic conditions with an available carbon source stimulates the growth of fungi and other filamentous forms resulting in so- called bulking sludge Failure to maintain oxygen in the aeration system can result in diffuse non settling floes because of the high for production anaerobic conditions The maintenance of aerobic conditions in the aeration tank followed by an anaerobic period in the final clarifier appears to promote growth of facultative bacteria which are effective in the removal of BOD and produce high-density flocs and to limit the growth of filamentous organisms.

a. Nutrient requirements

In all biological waste treatment system for microorganism to have all the necessary elements to build protoplasm, All microorganisms required the basic elements (carbon nitrogen phosphorus and sulfur together with certain trace elements such as potassium calcium zinc magnesium iron manganese copper and cobalt) most of these elements are normally available in the treatment plant influent Nitrogen and phosphorus waste will stimulate fungal rather than any Bacteria.

Much research has this basis 11.8 %wt (N) 5.2 %wt (P) Other researches have been this ratio 100:5:1 for BOD: N: P this ratio can be used on either a mass or concentration basis

b. Nitrification

Nitrification results from the oxidation of ammonia by Nitrosomonas to nitrite and the subsequent oxidation of the nitrite to nitrate by Nitrobacter

In order for effective nitrification to occur the sludge retention period or sludge age must be greater than the growth rate of the nitrifying organisms

Shorter sludge ages will result in a washout of these organisms

$$NH_3 \xrightarrow[\text{Oxidation}]{\text{Nitrosamines}} NO_2 \xrightarrow[\text{Oxidation}]{\text{Nitrobacter}} NO_3 \text{ (aerobic condition)}$$

c. De-nitrification

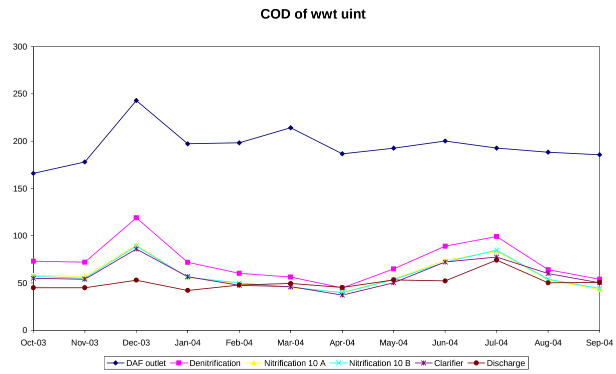
Carbonaceous BOD removal and nitrification is that of nitrogen removal to meet effluent standards it is desirable to remove the nitrate from a secondary effluent after nitrification has occurred if this process occurs under anaerobic conditions with the addition of a carbon source and in the presence of bacteria it is termed de-nitrification, Organic matter is always required for de- nitrification which may be obtained from the cell itself or out side the cell

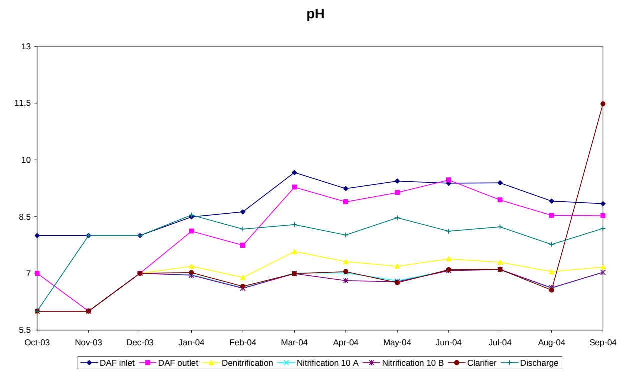
Methanol is the most carbon source because methanol not contain nitrogen and is non- toxic at low concentration but the addition of methanol must be in balance with oxygen demand because the increasing of methanol will increase BOD in the effluent, One study demonstrated that a C: N ratio must be at least 3:1 was necessary after nitrification to promote de- nitrification, if this ratio decreased the rate of de-nitrification decreased, To avoid this problem by putting the de-nitrification basin before nitrification basin (in which carbonaceous removal and nitrification are taking place) and recycle a high volume of the flow from the nitrification basin back to the de-nitrification basin by this way one study show that 70—90% de-nitrification can be obtained without impairing effluent carbonaceous removal or nitrification efficiency or requiring auxiliary carbon source

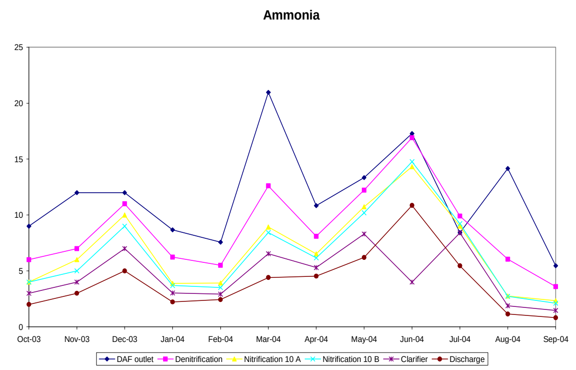
Dissolved oxygen at the discharge from nitrification must be as low to minimize the organic carbon and to maximize the rate of the reaction and also the permissible pH is 5.8-9.2 but the optimum is 7-8.2

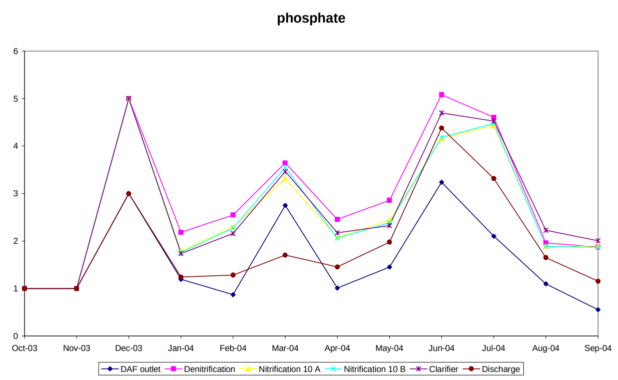
During the process of de-nitrification hydrogen ions are extracted from the wastewater therefore about 3.6 mg alkalinity as $CaCO_3$ are produced per mg nitrate nitrogen de-nitrified

Curves of waste water plant









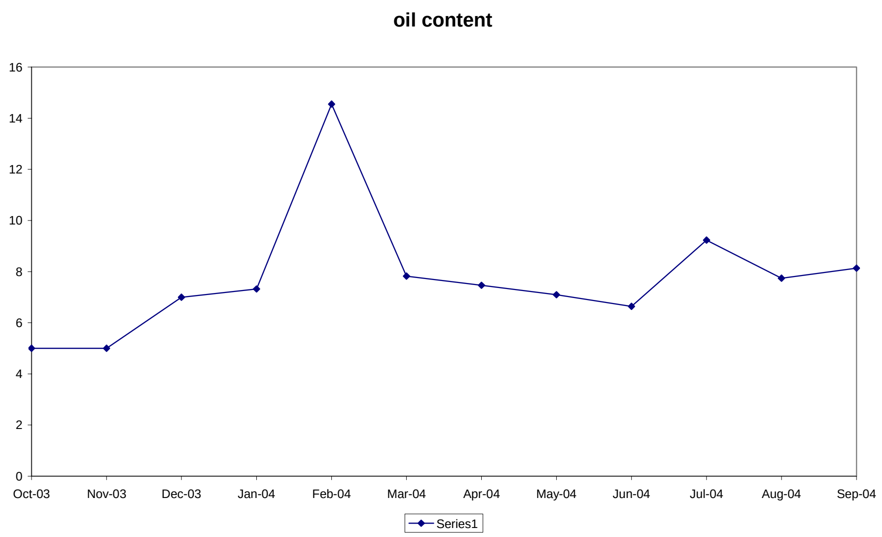
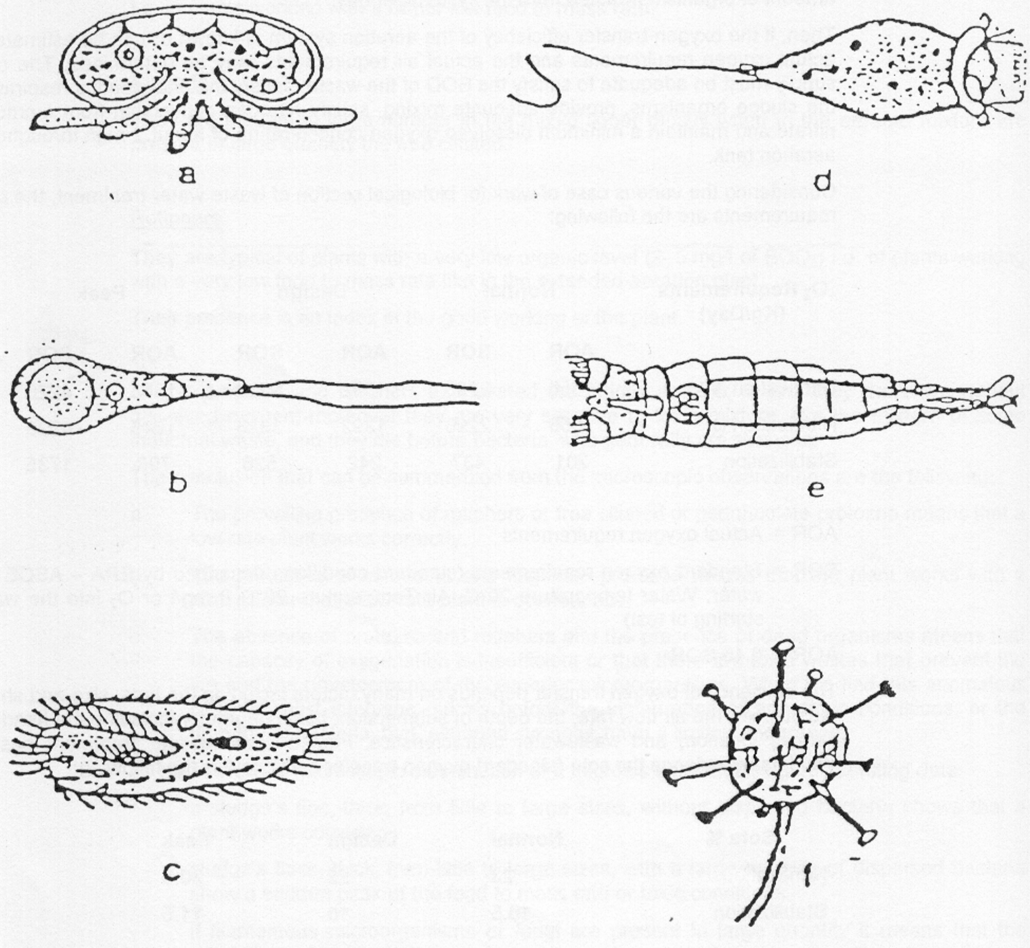


Fig 1 **Various types of micro-organism living in the biological plant**



a) SARCODINA
b) FLAGELLATE PROTOZOA
c) FREECILIATED PROTOZOA
d) PEDUNCULATE PROTOZOA
e) ROTIPHERS
f) SUCTORIA

d. Effect of temperature

Variation in temperature effect all the biological process the rate of the biological reaction will increase with temperature to an optimum value approximately 30ċ for the most aerobic waste system

An increase in reaction temperature increases the biological – oxidation reaction rate constant and has also the following effects

a) Less excess sludge is produced
b) Oxygen consumption is increased
c) Oxygen transfer efficiency is reduced
d) Diffusion of O2 organic matter within the water is increased

e. Effect of pH

The pH of the aeration basin has two effects

i) It determines which microorganisms predominate in the system
ii) It affects the rate of reaction

The optimum pH of about 7.0

f. Toxicity

Toxic materials in the wastewater has bad affect in the performance of an activate sludge unit and reduce this efficiency

The effects depended on the

a) Concentration of the toxic materials
b) Contact time
c) Environment

g. Heavy metals

Inhibit the activate sludge

h. Organic compounds

Inhibit microorganismsʾs utilization of other Materials

i. The time required

For microorganisms to acclimated to an organic compound varies with the compound it take from several days to several months

j. Under these conditions oxygen availability and not food supply

Controls the activity of the microorganisms causing further deterioration of effluent quality.

k. Rapid changes in salt concentration

can revitalize the microorganisms and any concentrations of dissolved salts reduce the solubility of oxygen in water and increase the rate of through of oxygen to water Influent is diluted by the aeration tanks contact can be eliminate the toxic effect, however is very important to consider an equalization before the biological treatment

3- Tertiary treatment

a) Sedimentation

Settling units are used to accomplish a certain amount of thickening of the settled solids, The major aim of settling process to obtain maximum removal of settling sludge is best achieved when the settled sludge is rapidly removed from the tank on the basis of the concentration and the tendency of particles to interact four settling can occur

- Discrete particle
- Flocculants
- Hindered also called zone type
- Compression

Discrete particle

Particles settle as individual and there is no significant interaction with neighboring particles, it҆s function to remove grit and sand particles from wastewater.

Flocculants

By coalescing the particles increase in mass and settle at a faster rate.

It's function to removes a portion of the suspended solid in untreated Wastewater in primary settling facilities and in upper portion of secondary settling facilities also remove chemical floc. in settling tanks**.**

Hinder also called zone type

Refer to suspensions of intermediate concentration in which inter-particle forces are sufficient to hider the settling of neighboring particles it's function to use in conjunction with biological treatment facilities**.**

Compression

Settling can occur only by compressing of the structure, compressing takes place from the weight of the particles which are constantly being added to the structure by sedimentation from the supernatant liquid usually occurs in the lower layers of a deep sludge mass such as in the bottom of deep secondary settling facilities and in sludge thickening facilities.

b. Chlorination

Wastewater disaffection is employed in an attempt to destroy the pathogenic agents in a water stream; disaffection effectiveness generally has been measured by the concentration of the chloroform bacteria indicator group that remains after disinfection has taken place.

The possible application for wastewater disinfection are liquid – gas chlorine, hypo chlorites, chlorine dioxide, ozone, bromine , iodine, silver, ultra-violet radiation gamma radiation liquid-gas chlorine (liquid-gas chlorine and hypo chlorites) have the most usage.

4- Treatment of sludge

Oily sludge treatment and disposal

Oily sludge from API is sent to the sludge pit and pumped to DAF sludge sump

Sludge and scum from DAF unit is sent to the DAF sludge sump, the mixed oily sludge is pumped to the Coker unit if Coker unit out of work the oily sludge is sent to the flocculation pit or directly to dewatering unit

a) Digestion

The excess sludge and scum from clarifier is sent to the aerobic digestion.

Digestion process reduces the quality of sludge and improves dewatering and handling properties In industrial plants The aerobic process has many advantages than anaerobic digestion as described below

a) Volatile solids reduction is approximately equal to the obtained anaerobic
b) Lower BOD_5 concentration.
c) The production of an odorless.
d) Production of sludge with excellent dewatering characteristics.

Following the digestion process the biological sludge is pumped to the flocculation pit and the thickness The end products of anaerobic digestion are

Carbon dioxide, Methane and Water as shown in the next equation:

$$\text{Sludge (H.C)} \xrightarrow{\text{Anaerobic digestion}} CO_2 + CH_4 + H_2O$$

b) Thickening

Thickening is a procedure used to increase the solids content by removing a portion of the liquid fraction, This section is to thicken by gravity the digested biological sludge for better thickening of flocculation is provided in the sludge flocculation pit equipped with a mixer where polyelectrolyte solution is dosed the thickened sludge is sent by pump to the Coker unit the excess of water overflows into recycle pit and then is recycled to biological section, In case the Coker unit is not working the thickened sludge can be sent to sludge dewatering section for final disposal to landfill.

c) Dewatering

Dewatering is a physical unit operation used to reduce the moisture content of sludge for one or more of the following reasons:

a) The coast of the trucking sludge to the ultimate disposal site
b) Dewatering is easier to handle than thickened or liquid sludge
c) Dewatering water produce more energy content when incinerated
d) According to removal of moisture content the sludge will be odorless

There are three applications for dewatering sludge Gravity drainage it is allowed to thicken, a majority of the free water is removed from the sludge by gravity mechanically applied pressure following gravity drainage, and pressure is applied in a low pressure where the sludge is squeezed opposing porous cloth belts

Chemical conditioning, the liquid sludge is mixed with polyelectrolyte.

Other treatment technologies

Other options for water treatment and disposal include

- Composting
- Pyrolsis
- Gasification
- Anaerobic digestion

1. Composting

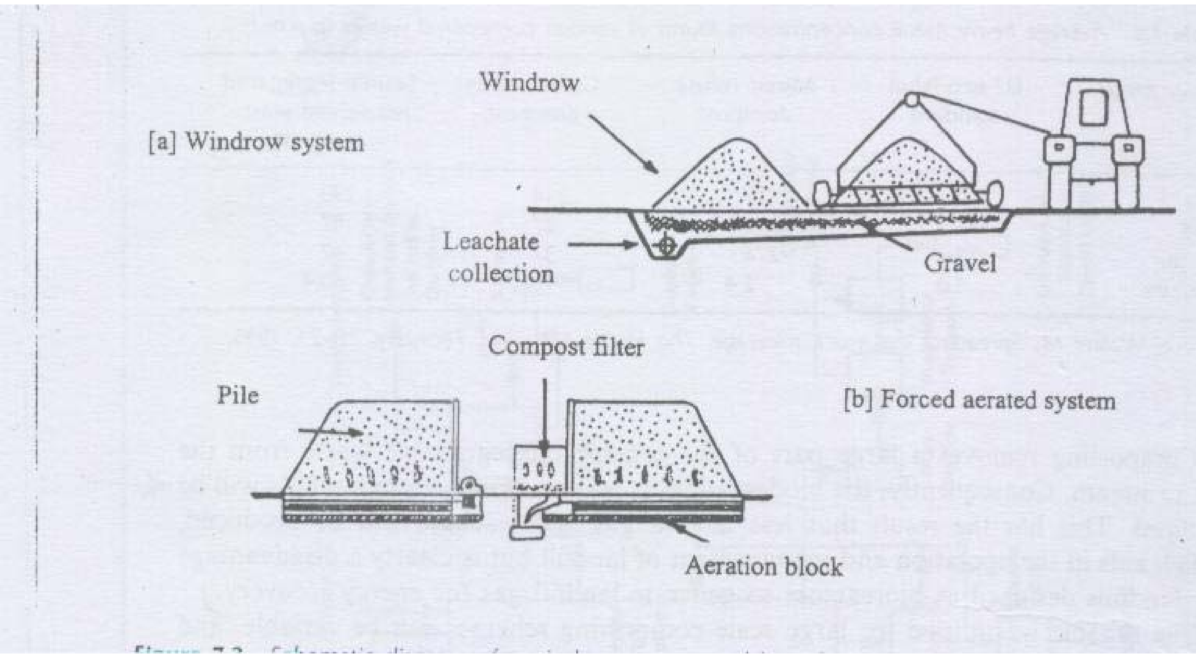


Fig 2 **Composting process:**

Composting is the aerobic rather than anaerobic biological degradation of biodegradable organic waste. Composting is a relatively fast biodegradation process taking about 4—6 weeks to reach a stabilized product. Small –size composting has been practiced for many years at the individual household level, The degraded product is a stabilized product is a stabilized product which is added to soil to improve its structure especially for clay soils acts as a fertilizer to improve the nutrient content acts as mulch and it is used to retain moisture in the soil, Composting removes a large part of the organic biodegradable waste from the waste stream Consequently the biodegradation process operating in landfills will be reduce this has the result that less landfill gas leach ate will be produced which aids in the operation and management of landfill but is clearly a disadvantage for landfill designed as bioreactors to generate landfill gas for energy recovery, Regular aeration is required to maintain aerobic conditions and this is achieved by regularly turning the composting waste or by air injection biodegradation of the waste by micro-organism is an exothermic process and temperature in the composite pile can reach up to 70 C°.

The six main factors influencing composting:

1. Suitable oxygen content to maintain aerobic conditions, minimum oxygen content in the composting of 18% is recommended
2. Temperature maximum micro-organism activity observed in the temperature range 30--35 C°.
3. Moisture content below a minimum 40% moisture content biodegradation is significantly reduced high moisture contents are also to be avoided since the moisture occupies intra-partial spaces and therapy produces anaerobic conditions.
4. pH range of the waste material optimal composting is achieved in the pH range 5.5—8 bacteria prefer a near neutral pH whereas fungi develop better in slightly acidic environment.
5. C: N ratio of the waste material optimal C: N ratio in the starting waste material is about 25 higher value resulting in a slow rate of decomposition and lower ratio resulting in nitrogen loss.
6. Size range of waste material shredding of the starting waste material increase the surface area and results in enhanced rates of composting.

2. Pyrolsis

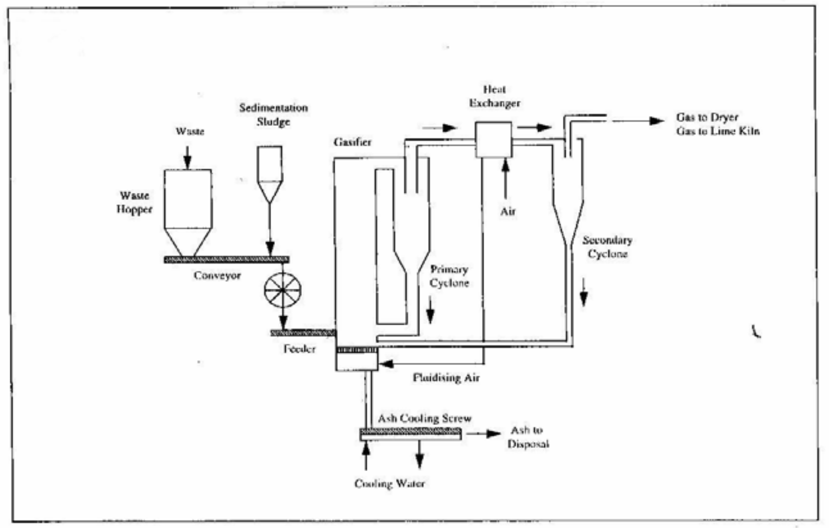
Pyrolsis is the thermal degradation of organic waste in the absence of oxygen to produce a carbonaceous char, oil and combustible gases Relatively low temperature are used in the range 400—800 C°. The application of pyrolsis to waste materials is a relatively recent development In particular, the production of oils from pyrolsis of waste has been investigated with the aim of using the oils directly in fuel application or with upgrading to produce refined fuels, The oil has a higher energy density that is a higher energy content per unit weight than the raw waste the solid char can be used as a solid fuel or as a char – oil (char- water slurry for fuel) alternatively the char can be used as carbon black or upgraded to activated carbon the gases generated have medium to high calorific values and may contain sufficient energy to supply the energy requirements of a pyrolsis plant. The process condition are altered to produce the desired char, gas or oil end-product with pyrolsis temperature and heating rate having the most influence on the product distribution. The heat is supplied by indirect heating such as the combustion of the gases or oil, or directly by hot gas transfer The product oil from pyrolsis has the advantage that it can be used in conventional electricity generation systems such as diesel engines and gas turbines However the properties of the pyrolsis oil fuel may not match the specifications of a petroleum-derived fuel and may require modifications to the power plant or upgrading of the fuel Pyrolsis produces char, gas and oil the relative proportion of which are dictated by the pyrolsis technology used and the process parameters of which temperature and heating rate have the most influence as shown in the table-1.

Table 1: **The process parameters of pyrolysis:**

Pyrolsis	**Residence time**	**Heating rate**	**Reaction environment**	**Pressure (bar)**	**Temperature (C˚)**	**Major products**
Carbonization	Hours or days	Very low	Combustion products	1	400	Charcoal
Conventional	10s—10 min	Low-moderate	Primary/ secondary products	1	<600	Gas, char, liquid
Flash-liquid	<1s	High	Primary products	1	<600	Liquid
Flash-gas	<1s	High	Primary products	1	>700	Gas
Ultra	<0.5s	Very high	Primary products	1	1000	Gas, chemicals
Vacuum	2—30s	Medium	Vacuum	1	400	Liquid
Hydropyrolsis	<10s	high	Primary products+ H_2	≈20<0.1	<500	Liquid
Methanloysis	0.5—1.5s	high	Primary products+ CH_4	≈3	1050	Chemicals benzene toluene xylene + alkenes

3. Gasification

Fig 3 **Gasification process**



Gasification differs from pyrolsis in that oxygen in the form of air steam or pure oxygen is reacted at high temperature with the available carbon in the waste to produce a gas product ash and tar product partial combustion occurs to produce heat and the reaction proceeds exothermically to produce a low to medium calorific value fuel gas

The principal reactions occurring during gasification of waste in air are

$C + O_2 \rightarrow CO_2$ Oxidation -- exothermic

$C + CO_2 \rightarrow 2CO$ Boudouard reaction – endothermic

$2C + O_2 \rightarrow 2CO_2$ Exothermic

In steam gasification the reactions are

$C + H_2O \rightarrow CO + H_2$ Carbon steam reaction exothermic

$C + 2H_2O \rightarrow CO_2 + 2H_2$ Carbon steam reaction exothermic

$CO + H_2O \rightarrow CO_2 + H_2$ water gas shift reaction exothermic

$C + 2H_2 \rightarrow CH_4$ Hydrogenation- exothermic

In high pressure steam gasification addition reactions include:

$$CO + 3H_2 \rightarrow CH_4 + H_2O \text{ Hydrogenation- exothermic}$$

$$CO_2 + 4H_2 \rightarrow CH_4 + 2H_2O \text{ Hydrogenation- exothermic}$$

The main types of waste gasification reactor systems:

1. Updraft gasification

   Air flows up from the base of the reactor with the waste flowing down counter- current to the air flow gasification occur in a slowly moving fixed bed

2. Downdraft gasification

   Air and waste flow co-currently down the reactor gasification occur in a slowly moving fixed bed

3. Fluidized bed gasification

   Waste is fed into the fluidized bed at high temperature

4. Anaerobic digestion

The anaerobic degradation process found in landfills which lead to the formation of methane and carbon dioxide from organic waste are utilized in anaerobic digestion but in an enclosed and controlled reactor. The main aim of the process is to produce a product gas rich in methane which can be used to provide a fuel or act as a chemical feedstock

<u>The main types of anaerobic digestion</u>.

1. Dry continuous digestion

   The waste is fed continuously to a digestion reactor with dry matter content of 20—40% both completely mixed and plug- flow system are available with plug- flow systems relying on external recycling of a proportion of the outgoing digested waste to be mixed with the incoming waste feedstock to initiate digestion.

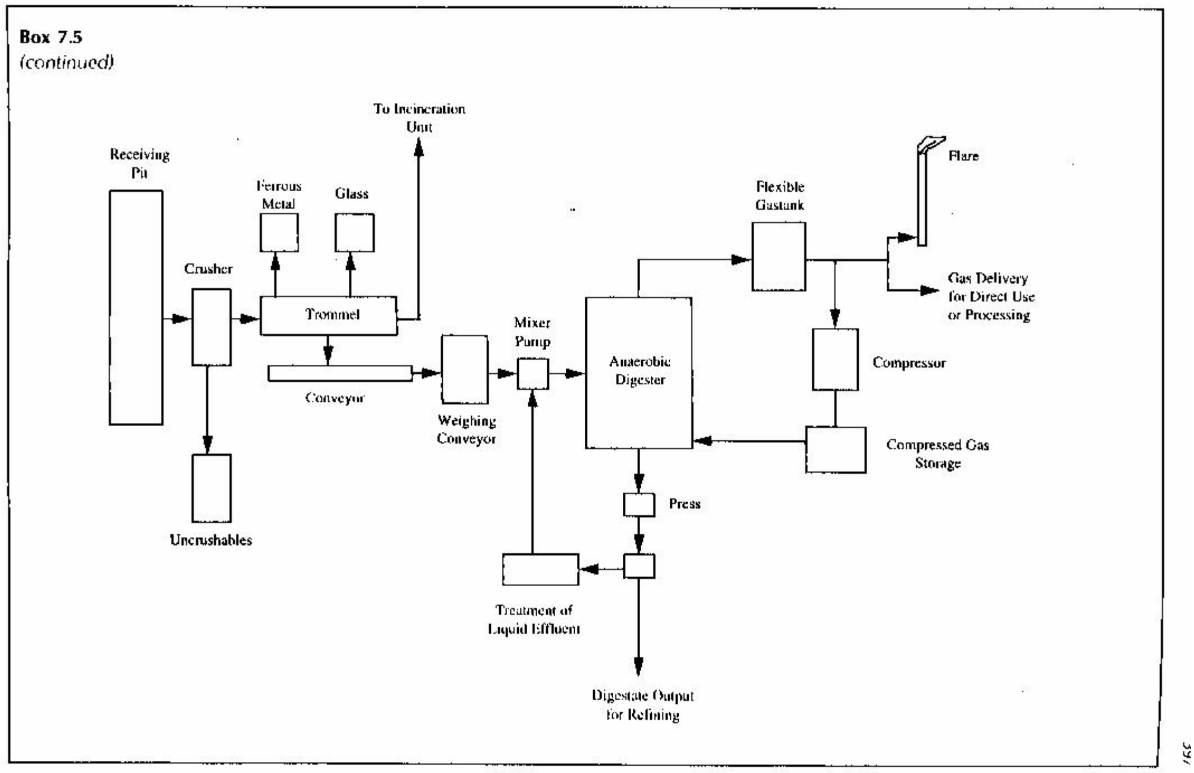


Fig 4 Anaerobic digestion process:

2. Dry batch digestion

   The waste is fed to the reactor with digestion material reactor. The reactor is then sealed and left to digest naturally leachate derived from the biodegradation process is collected from the bottom of the reactor and re-circulated to maintain a uniform moisture content and redistribute nutrients and micro-organism when digestion is complete the reactor is opened unloaded and refilled to start the batch process again.

3. Leach-bed process

   The process is similar to the dry batch process but the Leach ate derived from the biodegradation of the waste is exchanged between established and new batch of waste to facilitate start-up of the biodegradation process after Methanogenesis has become established in the waste the reactor is Uncoupled and reconnected to fresh solid waste in a second reactor.

4. Wet continuous digestion

   The waste is slurred with a large proportion of water to provide a dilute (10%dry solids) waste feedstock that can be fed to a convention completely mixed digester.

5. Multi-stage wet digestion

   There are also a range of multi- stage wet digestion process where solid waste is slurred with water or recycled liquor and fermented by hydrolytic and fermentative micro-organisms to release volatile fatty acids which are then converted to gas in a specialist high –rate industrial anaerobic digester.

5- Deviation from normal operation and trouble-shooting measures

a) Equalization

The principal troubles is high-high level in Equalization basin we can intervene by closing the gats at inline of the API separators

b) DAF

In case of high TOC , Ammonia , Sulphide contents in the de-oiled water, We can intervene by closing the gats at outlet of the DAF, the de-oil water flows by gravity in off spec basin if the flotation does not work properly (for ex. absence of polyelectrolyte) the suspended solid increase in the recycle and tends to clog the valve reducing the recycle rate the valve is to be opened for some seconds to clean itself and then closed and regulated till the pressure/flow rate reaches the required valves

c) Biological treatment

In steady condition we must control the suspended solids concentration, to avoid forming of foams

Bulking phenomena in the presence of filamentous organisms

It indicated by poor settling of the sludge

The causes of this phenomenon can be:

- a) Absence of food in the liquor
- b) Absence of microelements
- c) Presence of toxic substances
- d) A sharp change of pH or temperature
- e) Insufficient aeration

We can intervene by:

- a) Doing a controlled dosage of chlorine in the sludge recycle
- b) Adding some digested sludge after having strongly aerated them
- c) Injecting an inorganic or organic coagulant dosage
- d) reduce the food to mass ratio
- e) Increase the sludge's age
- f) Correcting pH and dissolved oxygen value
- g) Correct BOD_5 nutrients (BOD_5 : N:P) ratio in the influent liquor
- h) Adding microelements to the influent liquor

Forming of foams in the aeration basin

Caused by high concentration of surface-actives in the influent liquor
This case usually in start up phase

We can intervene by:

a) Doing a controlled dosage of antifoam during the aeration process.
b) In creasing the concentration of the suspended solid during the aeration by decreasing the sludge withdrawal.
c) Decreasing the aeration provided that the dissolved oxygen dose not goes under 1.5-2 mg/l.

Difficulty to maintain adequate values of oxygen during the aeration process

Indicate by decrease of depurative efficiency or dark color of the aeration mixture.

We can intervene by:

a) Increasing if possible the volume of basin.
b) Skimming over with by pass a part of the liquor if there is overloading.
c) Increase the aeration.
d) Enslaving the equipments that provide air to a dissolved oxygen indicators.

Table 1

Basin of waste water treatment unit

Basin	***Name***
1	Oily water (diverter)
2 A/B	API
3 A/B	Equalization
4	Neutralization
5 A/B	Coagulation
6 A/B	Flocculation
7 A/B	Dissolved Air Flotation
8	DAF effluent Champers
9 A/B	De-nitrification
10 A/B	Nitrification
11	Bio-recycle
12 A/B	Clarifier
13	Observation
14	Final retention
15 A/B	Sludge pit
16	Oil pit
17	DAF sludge sump
18	Off-spec.
19	Bio sludge sump
20	Scum sump
21	Aerobic digestion (stabilization)
22	Flocculation pit
23	Thickness
24	Recycle pit
25	Oily water
26	Storm water
27	Lifting sump
28	Biological inlet diversion pit
29	Storm water lifting sump

Table 2

Specification of unit (waste water treatment)

	Analysis	Test	Typical value	Main Equipment
API inlet	pH	ASTM D 1293	6.5---8.5	pH meter
	COD	HACH	369 ppm	Spectrophotometer
	BOD_5	HACH	290 ppm	Spectrophotometer
	TSS	APHA2540D	132 wt%	Spectrophotometer
	Free Oil	ASTM D3921	2100 wt%	Infra red
	H_2S		7 ppm	Glass wear
	NH_3	UOP 740	41 ppm	Kjhldal
API outlet	pH	ASTM D 1293	6.5---8.5	pH meter
	COD	HACH	332 ppm	Spectrophotometer
	BOD_5	HACH	261 ppm	Spectrophotometer
	TSS	APHA2540D	26 wt%	Spectrophotometer
	Free Oil	ASTM D3921	100 wt%	Infra red
	H_2S		7 ppm	Glass wear
	NH_3	UOP 740	41 ppm	Kjhldal
Equalization	pH	ASTM D 1293	4.5---9.5	pH meter
	COD	HACH	379 ppm	Spectrophotometer
	BOD_5	HACH	282 ppm	Spectrophotometer
	TSS	APHA2540D	116 ppmDe	Spectrophotometer
	Free Oil	ASTM D3921	45 ppm	Infra red
	H_2S		7 ppm	Glass wear
	NH_3	UOP 740	43 ppm	Kjhldal
DAF inlet	pH	ASTM D 1293	6.5---7.5	pH meter
	COD	HACH	379 ppm	Spectrophotometer
	BOD_5	HACH	282 ppm	Spectrophotometer
	TSS	APHA2540D	116 ppm	Spectrophotometer
	Free Oil	ASTM D3921	45 ppm	Infra red
	H_2S		7 ppm	Glass wear
	NH_3	UOP 740	43 ppm	Kjhldal

DAF outlet	pH	ASTM D 1293	6.5---7.5	pH meter
	COD	HACH	341 ppm	Spectrophotometer
	BOD_5	HACH	253 ppm	Spectrophotometer
	TSS	APHA2540D	35 ppm	Spectrophotometer
	Free Oil	ASTM D3921	9 ppm	Infra red
	H_2S		6 ppm	Glass wear
	NH_3	UOP 740	43 ppm	Kjhldal
De-Nitrification	pH	ASTM D 1293	6.5--7.5	pH meter
	COD	HACH	348 ppm	Spectrophotometer
	BOD_5	HACH	254 ppm	Spectrophotometer
	TSS	APHA2540D	40 ppm	Spectrophotometer
	Free Oil	ASTM D3921	11 ppm	Infra red
	H_2S		<6 ppm	Glass wear
	NH_3	UOP 740	43 ppm	Kjhldal
	NO_3	ASTM D	2 ppm	
Nitrification	pH	ASTM D 1293	7--8	pH meter
	COD	HACH	81 ppm	Spectrophotometer
	BOD_5	HACH	53 ppm	Spectrophotometer
	TSS	APHA2540D	4200 ppm	Spectrophotometer
	Free Oil	ASTM D3921		Infra red
	H_2S			Glass wear
	NH_3	UOP 740	10 ppm	Kjhldal
	NO_3	ASTM D	1.8 ppm	Spectrophotometer
Clarifier	pH	ASTM D 1293	7--8	pH meter
	COD	HACH	28 ppm	Spectrophotometer
	BOD_5	HACH	17 ppm	Spectrophotometer
	TSS	APHA2540D	30 ppm	Spectrophotometer
	Free Oil	ASTM D3921		Infra red
	H_2S		<1 ppm	Glass wear
	NH_3	UOP 740	7 ppm	Kjhldal
	NO_3	ASTM D	22 ppm	Spectrophotometer

Discharge	pH	ASTM D 1293	6.5--8.5	6--9	pH meter
	COD	HACH	47 ppm	<100 ppm	Spectrophotometer
	BOD_5	HACH	25 ppm	<60 ppm	Spectrophotometer
	TSS	APHA2540D	48 ppm	<60 ppm	Spectrophotometer
	Free Oil	ASTM D3921	1 ppm	10 ppm	Infra red
	H_2S		<1 ppm		Glass wear
	NH_3	UOP 740	1 ppm	3 ppm	Kjhldal
	NO_3	ASTM D	9 ppm	<40 ppm	Spectrophotometer
	PO_4	APHA 4500		<10 ppm	Spectrophotometer
	TDS	APHA 2540-C		<2000ppm	Conduct meter
	Turbidity	ASTM D 1889		<40 NTU	Turbid meter
	$D.O_2$	ASTM D 888		>4 ppm	Probe
	Cyanides	APHA 4500		<0.1 ppm	I.S.E
	Fluorides	APHA 4500		<0.5 ppm	I.S.E
	Phenol	APHA 5530		<0.005 ppm	Spectrophotometer
	T.H. Metal			<1 ppm	ICP
	Color			Colorless	Spectrophotometer

Test methods used to monitoring the waste water treatment

- **pH**

  The pH of water is a critical parameter affecting the solubility of trace minerals and the suitability of the water to sustain living organisms.

- **Total solids**

  Solids refer to matter suspended or dissolved in waste water, solid may affect Water or effluent quality adversely in a number of ways, solids analysis is Important in the control of biological and physical wastewater treatment process

  And for assessing compliance with regulatory agency wastewater effluent limitations.

- **Sludge volume index**

  The (SVI) is the volume in milliliters occupied by 1 gm of a suspension after 30 min settling SVI typically is used to monitor settling characteristic of activated sludge and other biological suspensions.

- **Chemical oxygen demand**

  Chemical oxygen demand (COD) is defined as the amount of a specified oxidant that react with the sample under controlled conditions, COD often is used as a measurement of pollutions in wastewater.

- **Bio-chemical oxygen demand**

  Bio-chemical oxygen demand (BOD) determination is an empirical test in which Standardized laboratory procedure are used to determine the relative oxygen Requirements of waste water effluents and polluted waters. The test has its widest Application in measuring waste loading to treatment plants and in evaluating the BOD removal efficiency of such treatment system.

- **Oil and Grease**

  The presence of oil and grease in industrial waste water is of concern to the Petroleum refinery because save the amount of oil which recycle and reuse and also its impact on aquatic life.

- **Phenol**

  Phenol is defined as hydroxyl derivatives of benzene may occur in petroleum Industry chlorination of such water may produce odorous and objectionable-testing chloro-phenols phenol removed by using activated carbon, chloramines

  Treatment, Ozonation and chlorine dioxide.

- **Turbidity**

  Turbidity in water is caused by the presence of suspended and dissolved particles of gas, liquid or solid of organic or inorganic matter, removal of suspended matter is accomplished by coagulation, settling, and filtration measurement of turbidity provides a rapid means of process control foe when, how and what extent the water must be treated to meet specifications.

- **Ammonia and (nitrite and nitrate)**

  Ammonia is nitrogen compound which consider as a source of neutrinos and also indicate the efficiency of the biological treatment process.

- **Phosphorous**

  Phosphorous consider as a source of neutrinos.

References

1- Terry, LA Water Pollution environs. Law pract. vol. 4, no. 1, pp. 19-29, 1996

2- Poppe, Wayne; Hurst, Renee Water Pollution water qual int, pp. 39-43, 1997

3- Richman, M IND. Water Pollution wastewater, vol. 5, no. 2, pp. 24-29, 1997

4- Tibbetts, J Anon. Water environ. solutions, vol. 9, no. 8, p. 26, 1996

5- US EPA, WASHINGTON, D.C. 20460 (USA), 1996, v.p.

6- Onsdorff, KA Pollution; Water environ. law pract., vol. 4, no. 1, pp. 14-18,

7- Brassard, PG Wetlands and Water Pollution boston coll. environ. AFF. law rev., vol. 23, no. 4, pp. 885-919, 1996

8- Ungate, CD Clean Water Initiative J. environ. plann. manage., vol. 39, no. 1, pp. 113-122, 1996

9- Lindsey, T; Neese, S; Thomas, D Pollutin Prevention water qual. int., pp. 32-36, 1996

10- Gannon, RW; Osmond, DL; Humenik, FJ; Gale, JA; Spooner, J Agricultural Water Quality water resour bull, vol. 32, no. 3, pp. 437-450, 1996

11- U.S. environmental protection agency, washington, dc (USA), 1996, 253 pp

12- MacKenzie, SH The Ecosystem island press, CA (USA), 1996, 240 pp