TREATMENT OF EFFLUENTS
FROM TEXTILE
INDUSTRIES

(A CASE STUDY OF AFPRINT EFFLUENT)

A RESEARCH PROJECT

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TO THE DEPARTMENT

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BY

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SESSION.

MARCH 2000.

CERTIFICATION

This is to certify that I have supervised, read and approved this research work which I found adequate both in scope and quality for the partial fulfilment of the requirement for the award of Bachelor Degree of Engineering (B.ENG.) in Chemical Engineering.

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DECLARATION

I hereby declare that this project work is my original hand work and has not being found written or done elsewhere.

OLANITORI T. O.

DATE.

DEDICATION

I dedicate this project work to the Almighty God, for his goodness. So also I dedicate this to my brother MR. OLANITORI OLU JULIUS and the United Nations International Children Emergency Fund (UNICEF) for their care about the world child.

ACKNOWLEDGEMENT

I thank the Almighty God for keeping me up to this day, for his kindness and provision.

I appreciate my parents Mr. and Chief Mrs. Olanitori for their care as well as the entire Olanitori family. A lot of kudos goes most especially to Mr. Olanitori Olusegun Julius for his moral and financial support throughout the duration of the programme.

Need mention also is the family of Mr and Mrs. Segun Adams who has by no little effort both morally and financial contributed to my success completion of this degree programme.

Of great appreciation are my lecturers in the school. They have being able to made me today, great thanks goes to the able Head of Department who is my project supervisor in person of Dr. J.O. Odigure, he has contributed immensely towards my academic making as an Engineer both in class and the supervisor of this project research work, his advice and criticism has made this work a success. My big thanks also goes to the entire member and staff of the Department of Chemical Engineering, they show a lot of care about their students well being and success, I appreciate you all.

My vote to thanks can never be complete without the mention of some good friends who has being able to stand in times of needs, I appreciate most especially my late good friend in person of Mr. Agbaminoja Ade, his memory lives in me forever, as continue in prayer for the repose of his soul, I give great thanks to the living as well as love Mr. Akeem Adeyemo and family, Mr. B.O. Akala and family, my friend and Engineer Olushola Joseph and family, Engr. A.A. Ayuba, Mr. S.O. Alao, Engr. O. Alao and host of others too numerous to be counted here.

I say may the Lord be with you all.

ABSTRACT

The physio chemical treatment of textile if being considered here to evolve an innovation for the treatment of textile effluent. With the utilization of the Best Available Technology towards achieving the Best Practical Technology _(BPT), a process route and technology is being arrived at with a flow process of effluent moving from plant into an underground reservoir through a holding tank into their reactor clarifier, adsorption column and into the sewer. The parameters measured like filterable solids, hardness, colour, free chlorine, chloride and floating matters with a total mass of 6,781.926g/m^3 of solid + 250g/m^3 of coagulant (Alum) reduced to 980.9g/m^3 which compares favourably with the 1297.01g/m^3 of the maximum allowed limit.

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CHAPTER ONE

INTRODUCTION

1.1 GENERAL

Engineers designing wastewater treatment plants are faced with a large choice of individual treatment options (or unit processes). If these are selected wisely and appropriately, then they are capable of producing an effluent which meets any given discharges standard. It is quite feasible to design a treatment plant, which discharges an effluent having no ecological impact on a receiving watercourse. However, in any Country there are many competing demands for development funds and waster water treatment projects do not always have the necessary priority. Thus designers are frequently called upon to meet rigid environmental constraints while restricted by financial limitations. It is important therefore between prevailing environmental conditions (such as climate, land availability and ready availability of chemicals) and the ability of a particular unit process to perform to its design specification. This is of particular relevance in developing countries where it is important to ensure that money is spent to produce the greatest cost benefit.

Developing Countries pose additional problems in that many facilities which are taken for granted in the developed countries are simply not available includes such things as the lack of availability of skilled personnel, a guaranteed a dependable source and maintenance.

All wastewater treatment plants are required to reduce the level of s solids and organic materials in the in following sewage in addition, ho plants are also expected to remove nutrients and demonstrate efficiency for pathogenic micro-organisms. No single unit process is currently available which can successfully and efficiently achieve all of these requirements.

And consequently some combination is required. All these above is as a result of man insatiable search for industrialization, which lead him to the exploration of the bowel of the earth for minerals without adequate care for the protection of his environment. In the process and by his activities causes great deal deforestation, pollution of his environment and erosion among other environmental problems. The depletion of the ozone layer and the hazard posed by disposal of certain toxic waste on the environment have suddenly re-awakened man's interest in the protection of his environment ecosystem for one thing, we now know that we have no other plant to live then in this global village called earth. It is therefore heart warning to note that environmental protection and conservation have increasingly become subjects of global concern.

Worth nothing in this write up is the fact that the issues of this pollutant effluents and its allies from the various manufacturing industries. With textile ranging among the very first six groups that generate most of the dangerous effluents.With a textile mill in Lagos as a case study, This is a case that calls for urgent attention, care should be taken to check the pollution, which brings about a concept for the design of a set of apparatus to check this menace.

1.2 AIMS AND OBJECTIVES

The aim of this project is to reduce the effluent level to an acceptable value, using the best practical technology (BPT) which will be evolve in this project. Develop to come out with low cost machinery that can easily be adopted in the individual textile industries to check harmful chemical effluents.

1.3 ECONOMY

This equipment is a compact equipment that with eliminate the problem associated with space requirement in effluent and water elated treatment project, and streamline the long process o treatment that do consumes time and energy.

This will encourages individual establishment in owing their private treatment plants as in addition to the above, the rigour associated with training of the working staffs in carrying out the routing job on the very long process of treatment is also reduced.

Saved as well is the foreign exchange that could have being expended in procuring this machinery or the likes from over-sea , the time and foreign expertise to do the installation of the machinery.

The compact nature of the machinery do also save the company at cost of installatio also worth mentioning is the readily availability of raw materials and parts needed locall without thinking of the rigour involved in procurement from the oversea countries.

Expatriate service at the mounting is available locally both for serving and maintenance and also is with little or no environmental degradation.

1.4 LIMITATIONS

The whole laboratory process most especially involving sedimentation can not be done on the laboratory bench but will rather involves some pilot plant studies, so a mathematical equation cannot be easily evolve for the operations in the reactor clarifier.

The bulk of the operations involve lot of financial backing, so literature values are mostly in use.

CHAPTER TWO

LITERATURE REVIEW

2.O. GENERAL

2.1 Industrialisation And It's Effect On The Environment

The water environment, usually the first to be seriously affected by pollution has received a lot of attention because water is a vital resource, satisfying various categories of uses such as the public water supply, fresh water fishes, marine water supply etc. (Kakanfo 1992).

The pollution of water affects the availability of water for most hence, the concern for water pollution control.

Production of waste is an integral part of industrial activity. Natures of industrial wastes vary from one industry to another, and the type of waste on industrial bases produce may also be influenced by the type of technology employed. The organic waste from source industries are mostly chemical and can either be natural or synthetic which can be more toxic and hazardous than the others (FEPA 1991).

The improper disposal of industrial waste into environment gives rise to air, water and land pollution. The importance of air, water and land to man and other living things can not has a lot of adverse effects on the environment and the living things in that environment. (FEPA 1991).

Pollution can be defined as any change in a natural environment, that is contamination of air (gas), water (liquid) and solid (FEPA 1991).

Pollutant may also be simply defined as an unwanted or obnoxious substance that is released to the environment, which has an adverse effect on the environment (FEPA 1992).

The health effects of major pollutants take the form of aggravation of respiratory diseases such as asthma and chronic bronchitis. Particulate matter in the respirable size range (μm) are particularly potent irritant, and toxic or carcinogenic (for example heavy metals like lead) (FEPA 1992).

The indiscriminate discharge of wastewater containing dangerous pollutants into water body has reportedly cause disasters. An example is the "Red Herrings" disaster that occurred in placenta Bay. New found land in 1968 -69

2. Several "Herrings" killed as a result of discharge of waste water containing red phosphorus from a new phosphorus factory in Berry (FEPA 1995).

3. The discharge of methyl mercury a catalyst caused minimata incident in Japan. (Minimata, meaning an unfortunate cause of mercury poisoning) which occurred in minimata region of Japan was first notice in 1953. The Wetis who were inhabitants of the bay fishing community in minimata bay were cripple, deformed and in a number of cases killed. Not less than 900 victims were recorded at the end of 1972. The case of the disease was traced to the consumption of fish contaminated by high levels of methyl mercury (up to 20ppm) by the victims.

4. The Itai -Itai is another Japanese name for a very painful fatal disease resulting from chronic cadmium poisoning. The people affected had been living on rice grown on soil which had been irrigated by water from river Jintsu which had been polluted with waste containing cadmium, lead and zinc from a zinc mine. High level of industrial pollutants such as heavy metals, cyanide, fluoride, nitrate etc. Produce definite health hazards (Kakanfo 1992).

DIAG 1

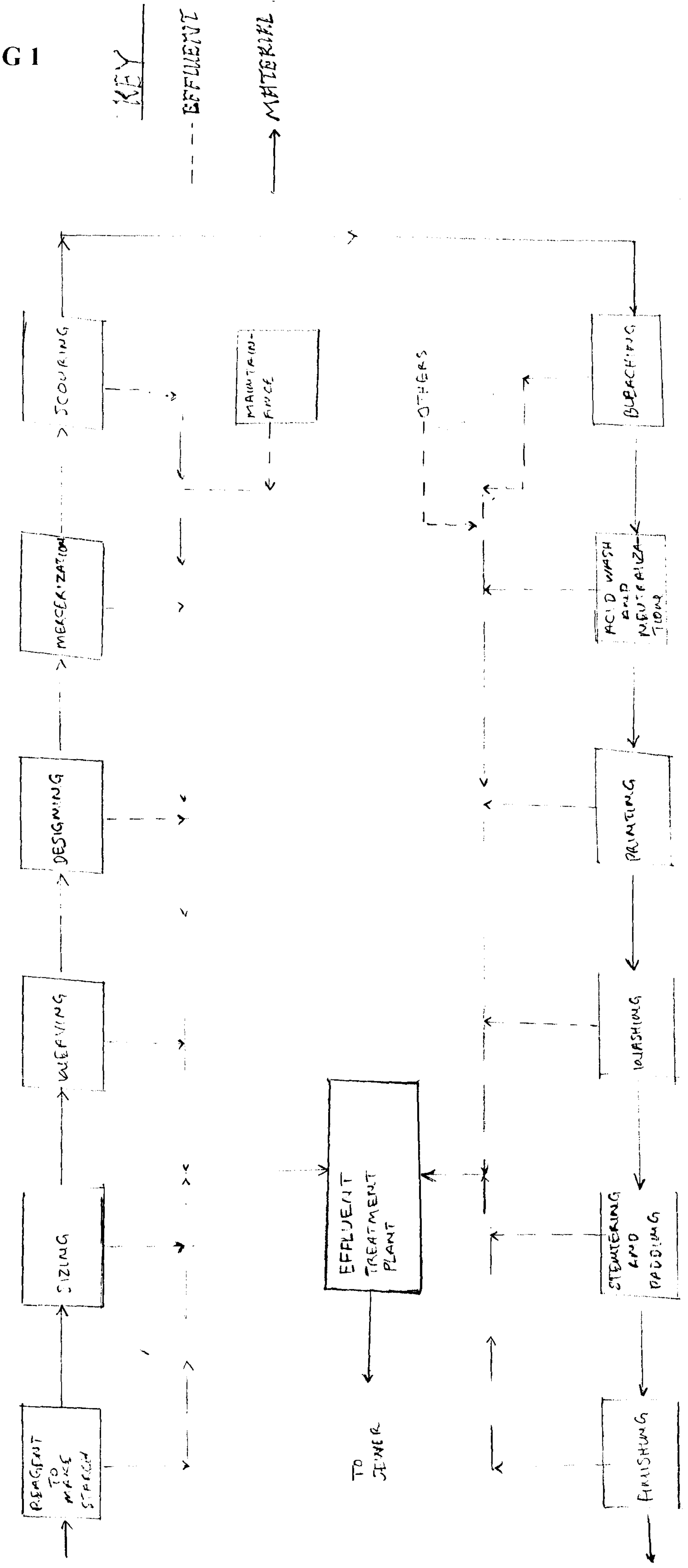


FIG 2.1 GRAPHICAL DIAGRAM OF THE JOURNEY OF EFFLUENT INTO TREATMENT PLANT

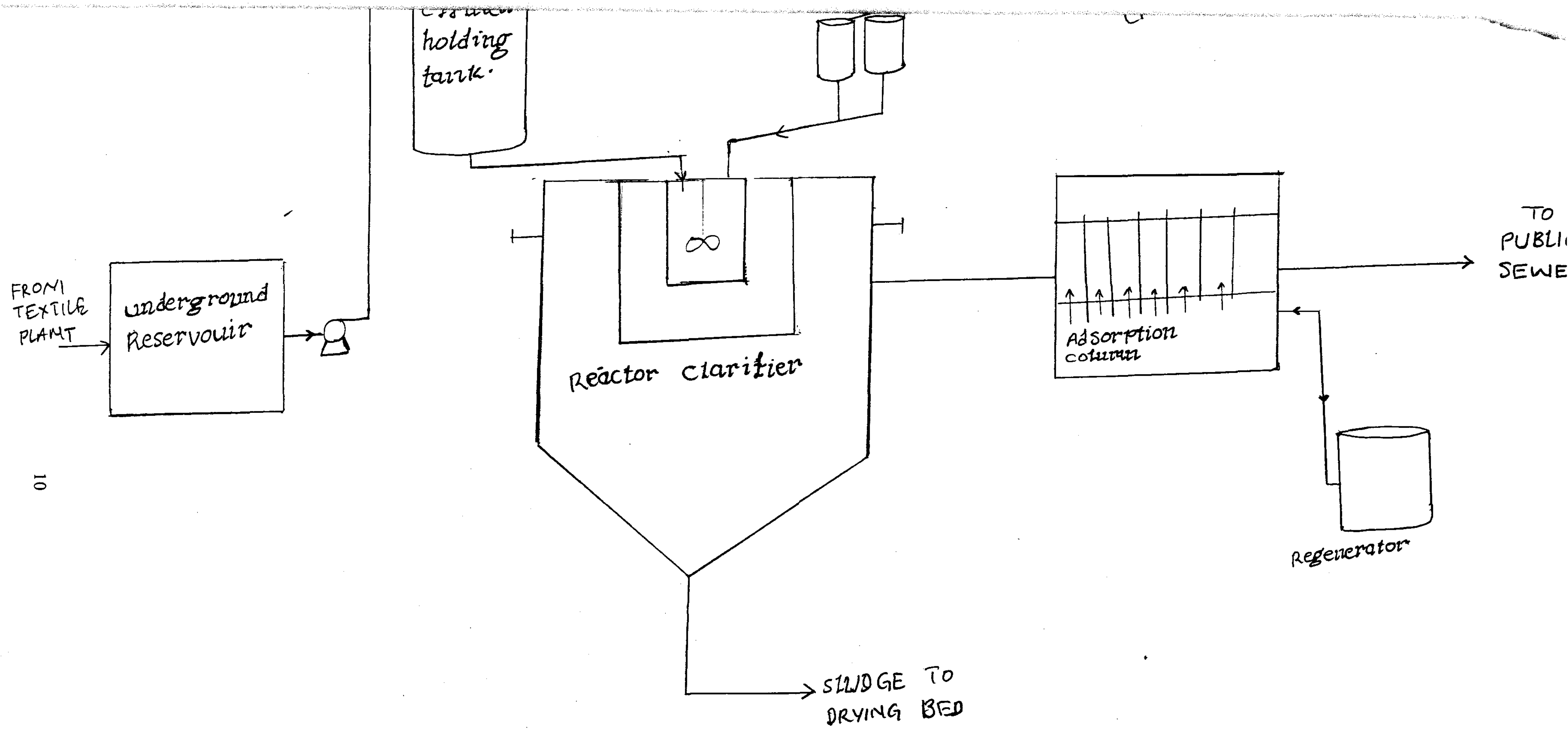


Fig. 2.5· Flow Process of effluent treatment

2.2.0 FLOW PROCESS

The selection of a waster water treatment process or a combination of processes depends upon:

1. The characteristics of the waste water. This should consider the form of the pollutant, i.e. suspended, colloidal, or dissolved the biodegradability, and the toxicity of the organic and inorganic components.

2. The required effluent quality. Consideration should also be given to possible future restrictions such as an effluent bioassay aquatic toxicity limitation.

3. The costs and availability of land for any given waste water treatment problem. One or more treatment combinations can produce the desired effluent treatment level only one of these alternatives, however, is the most cost effective. A detailed cost analysis should therefore be made prior to final process design selection (America Association 1990). For this work the most important parameter which should address and as such has great impact on the equipment process design selection is that of the complete removal of suspended and colloidal matter, others include the removal colour and heavy metal among the less important ones.

So these will determines the process route as we have

Raw wastewater→Reservoir or spill pond with sand trap filter→Chemicals coagulant and flocculent in mixer→Sedimentation in reactor clarifier →Adsorption→ To sewer→

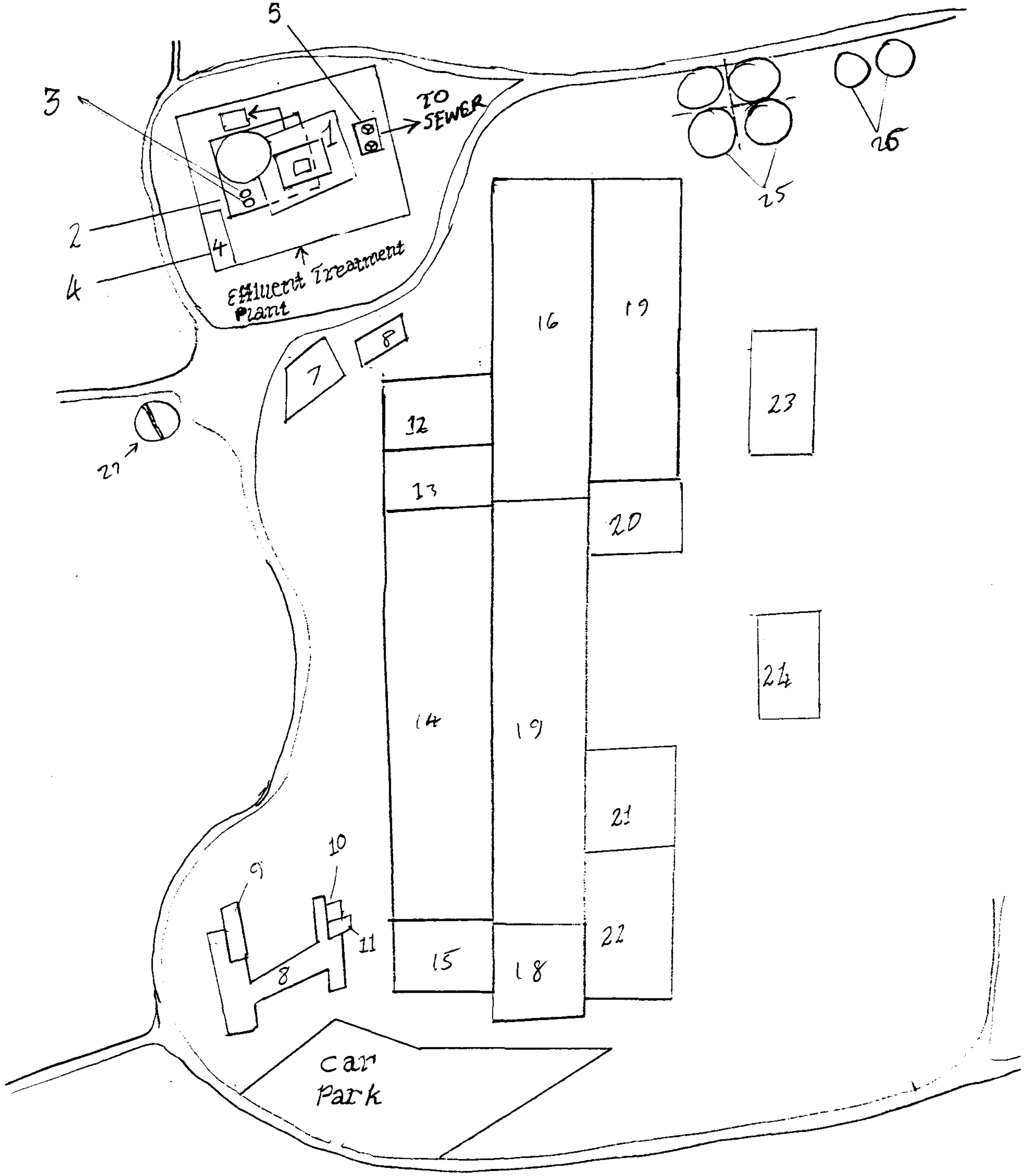
↓

Sludge discharge

↓

Drying bed.

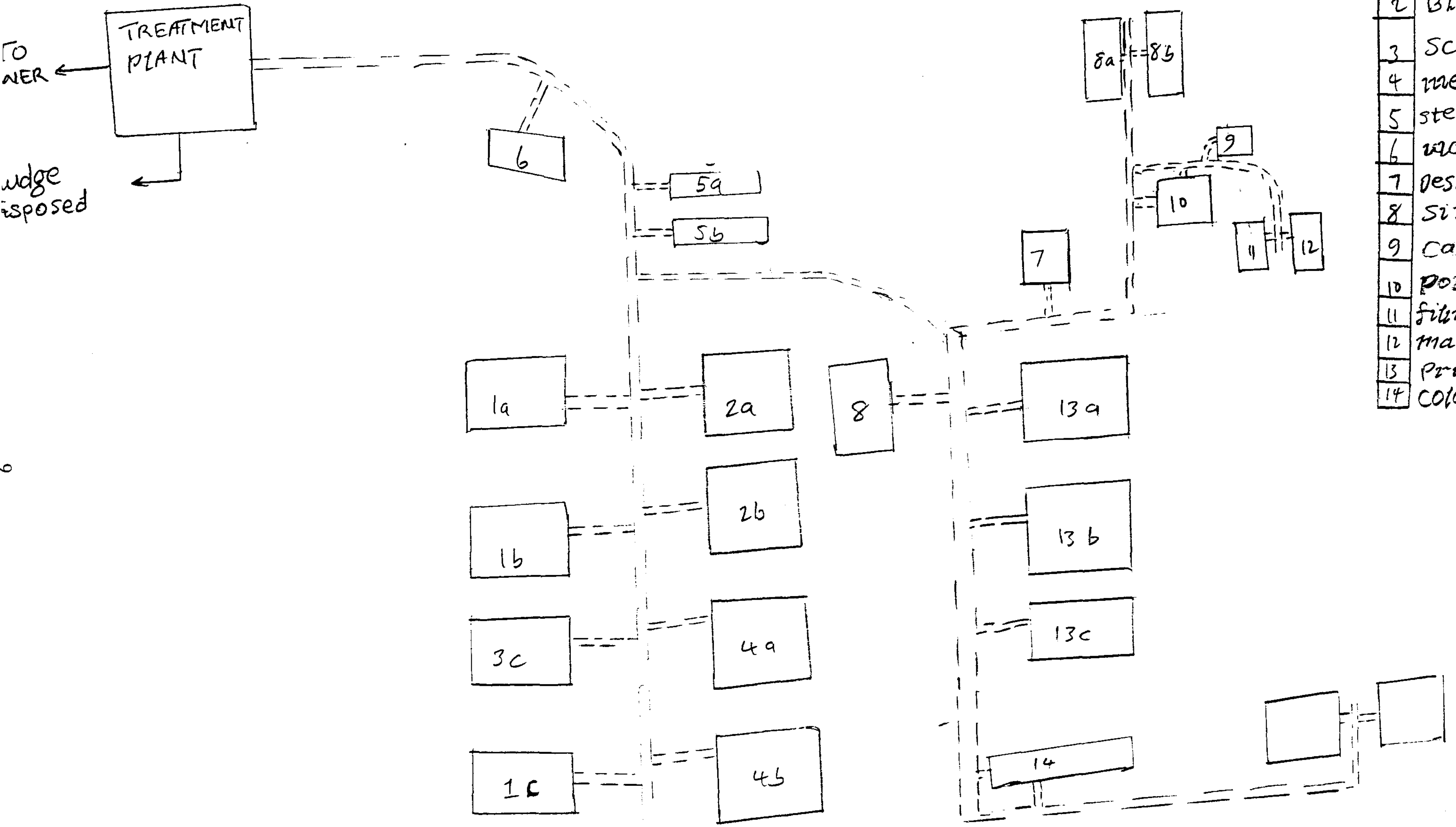
Figs 2.2 FLOW-CHART.



LEGEND

	EFFLUENT TREATMENT PLANT.
1	contact clarifier and Sedimentation
2	underground water
3	chemical vessel
4	control panel
5	Adsorption column
6	Sand drying bed for Sludge
7	Fire point station
8	chemical depot.
9	union office.
10	clinic
11	co-operative Store.
	FACTORY PLOTS
12	yarn store
13	laboratory
14	Processing department
15	caustic recouvery plant
16	weaving preparatory section.
17	Printing section
18	Film development section.
19	weaving department.
20	Canteen.
21	chemical store
22	Maintainace department
23	Generator plant
24	Sales department
25	Water holding tank

DIG 2.3.



LEGEND

1	rung of dying machines
2	Bleaching machines
3	Scourin machines
4	mercerizing machines
5	stentering machines
6	washing machines
7	Desizing machines
8	Sizing machines
9	Canteen
10	power generating plant
11	film development section
12	maintainance
13	Printing machines
14	Colour kitchen.

2.3.0 **Analysis of treatment process**

2.3.1. **Thin layer balancing sand trap**

This is first stage of the sewage treatment. The waste water from the processing ranges of the various machinery's in the plant drain onto an underground reservoir which hold back the water, and equally helps with the retention time involve to reduce the water temperature to a workable level.

The water passes through the sand trap, which removes floatable particles, as well as reduces some suspended matters from the effluent. This does also goes a long way in reducing the oily matter as well as large particles that could have hinder further processing. Like rags, fibres, cotton fluffs, etc that is contained in the water.

The best method of handling this is getting the bulk in a movable compartment such that this could be removed and cleaned up intermittently whenever the services ability of the screen might have started reducing.

The mechanism of this process is that water with impurities is passed through a filtering material, which is permeable to the liquid and impermeable for solid particles.

When water passes through a layer of granular material, three kinds of filtration are possible, depending on the charge and the ratio between the size of water impurities and that of granulated particles of the filter filling.

I Retention of impurities on the surface of filtering bed.

(Film filtration) which is described by Hausen's formula

$$\delta = 0.01 \, (d_{ef} V)^{0.5}$$

Where δ is the diameter of the smallest particles which are retained, mm; d_{ef} is the effective diameter of grams of the filling, mm; and V is the rate of filtration, m/h;

2. Retention of impurity particles in pores of the filtering bed (volume filtration); and

3. Simultaneous formation of a film of impurities and deposition of impurities in pores of the filling. In most types of modern filter, no film is formed on the surface of the filling, but impurity particles penetrate together with water into the bulk of the filtering bed, the depth of penetration being greater with higher rate of filtration, layer grams of filtering bed, and smaller size at suspended particles being extracted from water. (Besselieve and Schwanrtz 1976).

In washing this, back washing present a very good and efficient method.

2.3.2 **Coagulation**

Coagulation is employed for the removal of waste materials in suspended or colloidal form. Colloids are presented by particles over a given range of 1 nm (10^{-2}cm) to 0.1 nm

(10^{-8}cm). These particles do not settle out on standing and cannot be removed by conventional Physical treatment process.

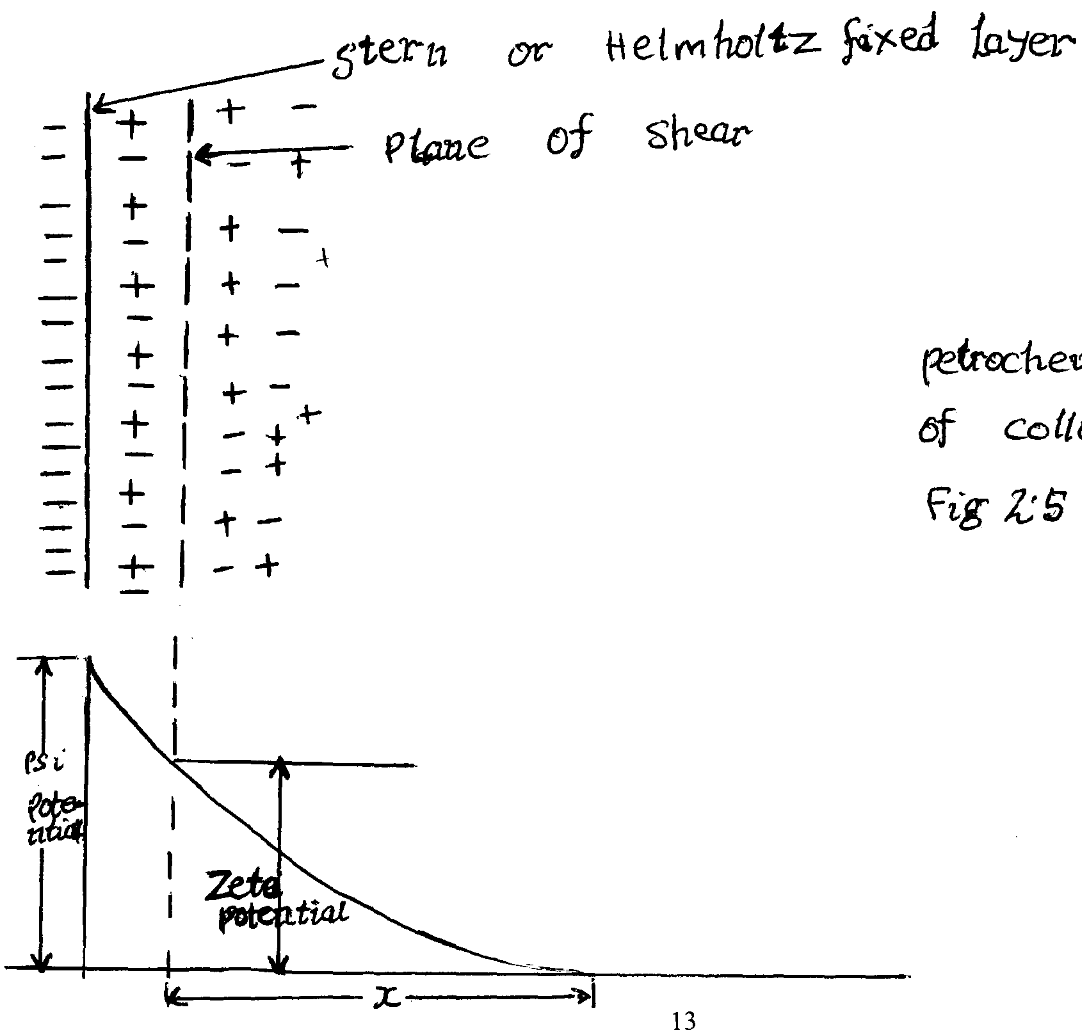
Colloids present in wastewater can be either hydrophobic or hydrophilic. The hydrophobic colloids (clays, etc) posses no affinity for the liquid medium and lack stability in the presence of electrolytes. They are ready susceptible to coagulation. Hydrophilic colloids, such as proteins, exhibit a marked affinity for water. The absorbed water retards flocculation and frequently requires special treatment to achieve coagulation.

Colloid posses electrical properties, which create a repelling, force and prevent agglomeration and settling. Stability ions are strongly absorbed to an inner fixed layer, which provides a particles charge that varies with the valence and number of absorbed ions. Some of an opposite change from a diffuse outer layer, which is held near the surface by electrostatic forces.

The psi (ψ) potential is defined as the potential drop between the interface of the colloid and the body of solution. The Zeta potential (ζ) is the potential drop between the slipping plane and the body of solution and is related to the particle change and the thickness of the double layer. The thickness of the table layer (x) is inversely proportional to the concentration and valence of non-specific electrolytes, as shown below:

A van der walls attractive force is effective in close proximity to the colloidal particle.

The stability of a colloid is due to the repulsive electrostatic forces and in the case of hydrophilic colloids to solvation in which an envelope of water retards coagulation (Ekenfelder 1989)



petrochemical properties of colloidal particle
Fig 2.5

2.3.3 **Zeta Potential.**

Since the stability of a colloid is primarily due to electrostatic forces, neutralization of this charge is necessary to induce flocculation and precipitation. Although it is not possible to measure the psi potential, the Zeta potential can be determined, and hence the magnitude of the charge and resulting degree of stability can be determined as well. The Zeta potential is defined as

$$\xi = 4\pi v/\Sigma X = 4\pi n.EM/\Sigma \quad \text{...........} \quad \text{eqn } 2.1$$

Where:

V = particle velocity.

Σ = Dielectric content of the medium.

n = viscosity of the medium

X = applied potential per unit length of cell

EM= electrophoretic mobility.

For practical usage in the determination of the Zeta potential, eqn: (2.1) can be re-expressed.

$$\xi(MV) == 113{,}000/\Sigma\ n\ (\text{poise})\ EM\ \frac{(\mu m/s)}{v/cm} \text{...........}\ 2.2$$

Where EM = electrophoretic mobility (μm/s) /(v/cm) at 25^0c (2.2.)

reduce to: $\zeta = 12.8EM$. (Ekenfelder 1989).

The Zeta potential is determined by measurement of the mobility of colloidal particles across a cell, as viewed through a microscope. Several types of apparatus are commercially available for this purpose. Recently a lazer zee meter has been developed which does not track individual particles. But rather adjust the image to produce a stationary cloud of particles using a rotating prison technique.

Since there will usually be a statistical variation in the mobility of individual particles, around 20 to 30 values should be averaged for any one determination. The magnitude of the Zeta potential for water and waste colloidal has been found to average from -16 to -22mV with a range of -12 to -40 mV[3].

The Zeta potential is unaffected by pH over a range of pH 5.5

The Zeta potential is lowered by

1. Change in the concentration of the potential determining ions
2. Addition of ions of opposite charge.
3. Contraction of the diffuse part of the double layer by increase in the ion concentration in solution.

Since the vast majority of colloids in industrial waste posses a negative charge, the Zeta is lowered and coagulation is induced by the addition of high valence cations. The precipitating power of effectiveness of cation valence in the precipitation of arsenious oxide is

$Na^{+}: mg^{2+}: Al^{3+} = 1: 63:570$.

Optimum coagulation will occur when the Zeta potential is zero, this is defined as the isoelectric point. Effective coagulation will usually occur over a Zeta range of ±0.5mV.

(Ekenfelder 1989).

2.3.4 Mechanism of Coagulation

Coagulation results from two basic mechanism: perikinetic or electrokinetic coagulation, in which the Zeta potential in reduced by ions or colloids of opposite charge to a level below the van der walls attractive forces, and orthokinetic coagulation, in which the micelles aggregate and form lumps which agglomerate the colloidal particles.

The addition of high valence cations degrees the particle charge and the coagulant dissolves, the cations serve to charge neutralize the negative charge on the colloids. This occurs before visible floc formation, the rapid mixing which "Coats" the retain a positive charge in the acid range because of the adsorption of H^+. These microflocs also serves to neutralize and coat the colloidal particle. Flocculation agglomerates the colloids with a hydrous oxide floc. In this phase, surface adsorption is also active. Colloid met initially adsorbed are removed by enmeshment on the floc.

(ii) Riddick has outlined a desired sequence of operation for effective coagulation. If necessary, alkalinity should first be added. (Bicarbonate has the advantage of providing alkalinity without raising the pH). Alum or ferric salts are added next, they coat the colloid with Al^{3+} or fe^{2+} and positively charge microflocs. Coagulant aid, such as activated silica and/or polyelectrolyte for the build up and Zeta potential control, are added last, addition of alkali and coagulant, a rapid mixing of 1 to mix is recommended, followed by flocculation, with addition of coagulant aid, for 20 to 30mm. Destabilization can also be accomplished by the addition of cationic polymers, which can bring the system to the isoelectric point without a change in pH. Although polymers are 10 to 15 times as effective as alum as a coagulant they are considerably more expensive. The mechanism of the coagulation process is shown below:

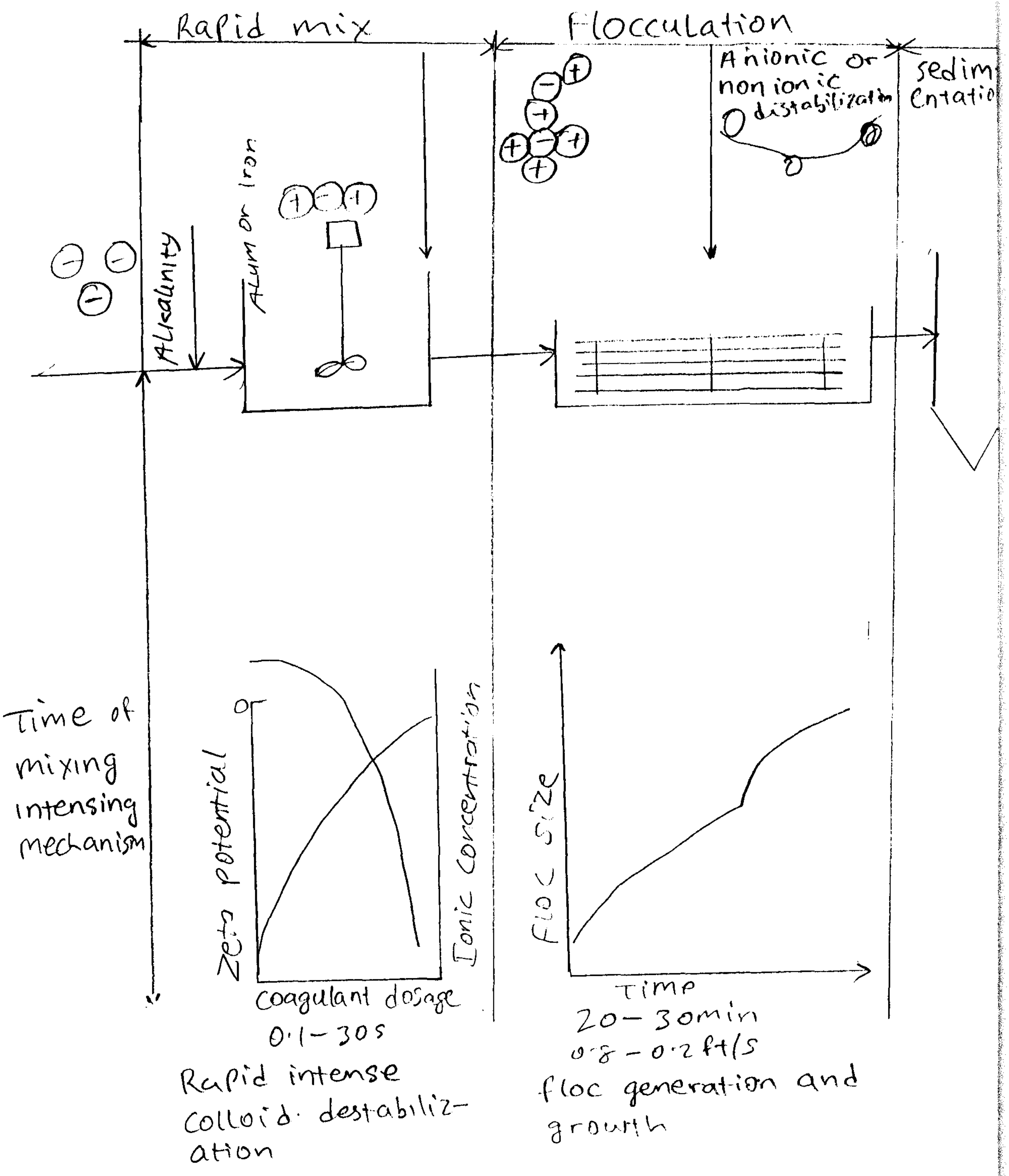


Fig 2·6 mechanism of Coagulation

2.3.5 Properties of coagulants

The most popular coagulant in waste-treatment application is aluminum sulphate or alum ($Al_2(SO_4)_3\ 18H_2O$), which can be obtained in either solid or liquid form. When alum is added to water in the presence of alkalinity, the reaction is

$Al_2(S0_4)_3.18H_20+3Ca(OH)_2 \rightarrow 3CaS0_4 + 2AI(OH)_3 + 18H_2O$.

The aluminum hydroxide is actually of the chemical form $Al_2O_3.xH_2O$ and is amphoteric in that it can act as either acid or a base. Under acidic condition

$(AI)_3+(OH-)_3 = 1.5 \times 10^{-33}$

At pH 4.0.51.3 mg/l of Al_3+ is in solution. Unlike alkaline conditions, the hydrous aluminum oxides dissociates:

$Al_2O_3 + 20H- ---- 2AlO^{-2} + H_2O$.

$(AlO^{2-})\ (H^+) = 4x10^{-3}$

At pH 9.0, 10.8mg/l of aluminum is in solution

The alum floc is least soluble at a pH 7.6 and negative above pH 8.2. Between these limit the floc charge is mixed. These relationships with respect to the Zeta potential are shown in Fig2.7 below:

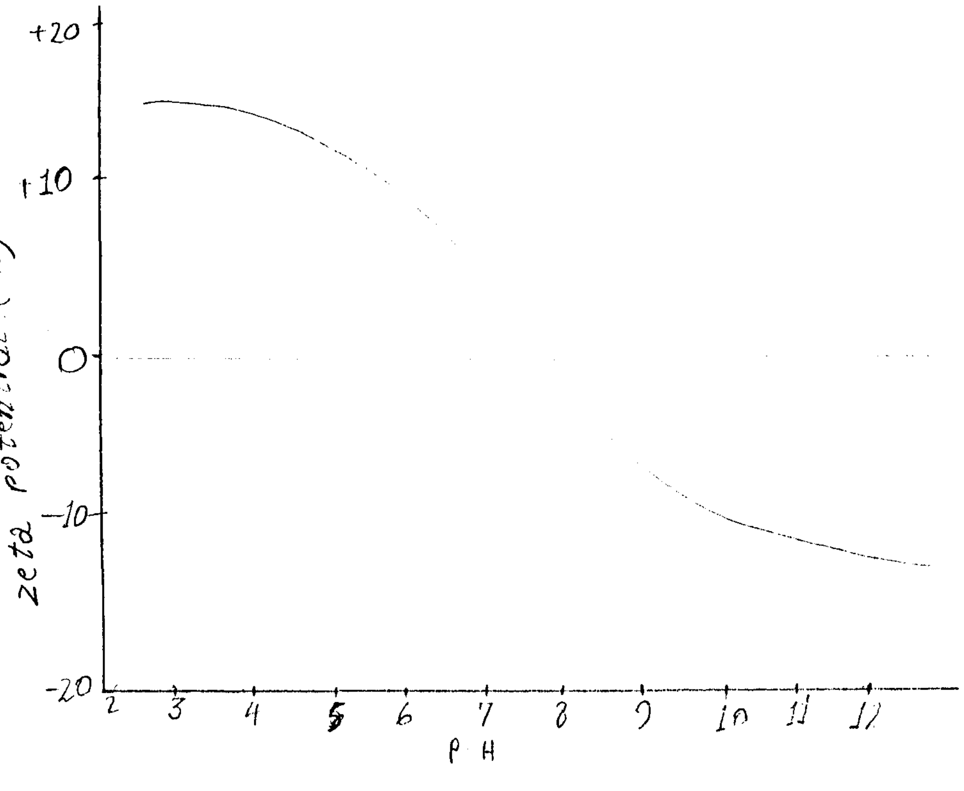


Fig. 2.7. Zeta Potential-P.H Plot for electrolytic aluminum hydroxide

High aluminum dosages used in the treatment of some industrial waste may bring about post precipitation of alum floc depending on the pH of flocculation. Ferric salts are also commonly used as coagulants but have the disadvantage at being more difficult to handle. An insoluble hydrous ferric oxide is produced over a pH range of 3.0 to 13 (Ekenfclder 1989)

Fe_3^{++} 30H- ------ $Fe(OH)_3$

$(Fe^{3+}) - (oH-)_3 = 10^{-36}$

The floc charge is position in the acid range and negative in the alkaline range, with mixed charges over the pH range 6.5-8.0.

The presence of anions will alter the range of effective flocculation. Sulphate ions will increase the acid range but decrease the alkaline range. Chloride ion increases the range slightly on both sides.

Lime is not a true coagulant but reacts with bicarbonate alkalinity to precipitate calcium carbonate and with ortho-phosphate to precipitate calcium hydrophosphate. Magnesium hydroxide precipitates at high pH levels. Good clarification usually requires the presence of some gelatinous $mg(OH)_2$ but this does make the sludge more difficult to dewater. Lime sludge can frequently be thickened, dewatered, and calcined to convert calcium bicarbonate to lime for reuse. (Ekenfelder 1989).

2.3.6. Coagulant aids

The addition of some chemicals will enhance coagulation by promoting the growth at large, rapid-settling flocs. Activated silica is a short chain polymer that serves to bind together particles of microfine aluminium hydrate. At high dosages, silica will inhibit floc formation because of its electronegative properties. The usual dosage is 5 to 10mg/l. (Ekenfelder 1989).

The polyelectrolyte is substantially unaffected by pH and can serve as a coagulant itself by reducing the effective charge on a colloid. There are three types of polyelectrolytes in a cationic which adsorbs on a negative colloidal particle; anionic, which replaces the cationic groups on a colloid particle and permits hydrogen bonding between the colloid and the polymer; and a nonionic which adsorbs and flocculated by hydrogen bonding between the solid surfaces and the polar groups in the polymer.

Chemical Process	Dosage	pH range mg/l	Comment
Lime	150-500	9-0-11.0	For colloid coagulation and P removal. Wastewater with low alkalinity, and high and variable P Basic reaction $Ca(OH_2)+ Ca(HOO_3)_2 \rightarrow 2CaCO_3+2H_20$ $MgCO_3+Ca(OH)_2 \rightarrow Mg(OH)_2+CaCO_3$.
Alum	75-250	4.5-7.0	For colloid coagulation and P removal. Wastewater With high alkalinity and low and stable to Basic Reaction. $Al_2(S0_4) + 6H_20 \rightarrow \mathbf{2Al(OH)_3+3H_2S0_4}$.
$Fecl_3$,$Fecl_2$	35-150	4.0-7.0	For colloid coagulation and P removal.
FeSo4.7H2)	70-200	4.0-7.0	Wastewater with high alkalinity and low

stable P.

Where leaching of iron in the effluent

is allowable or can be controlled.

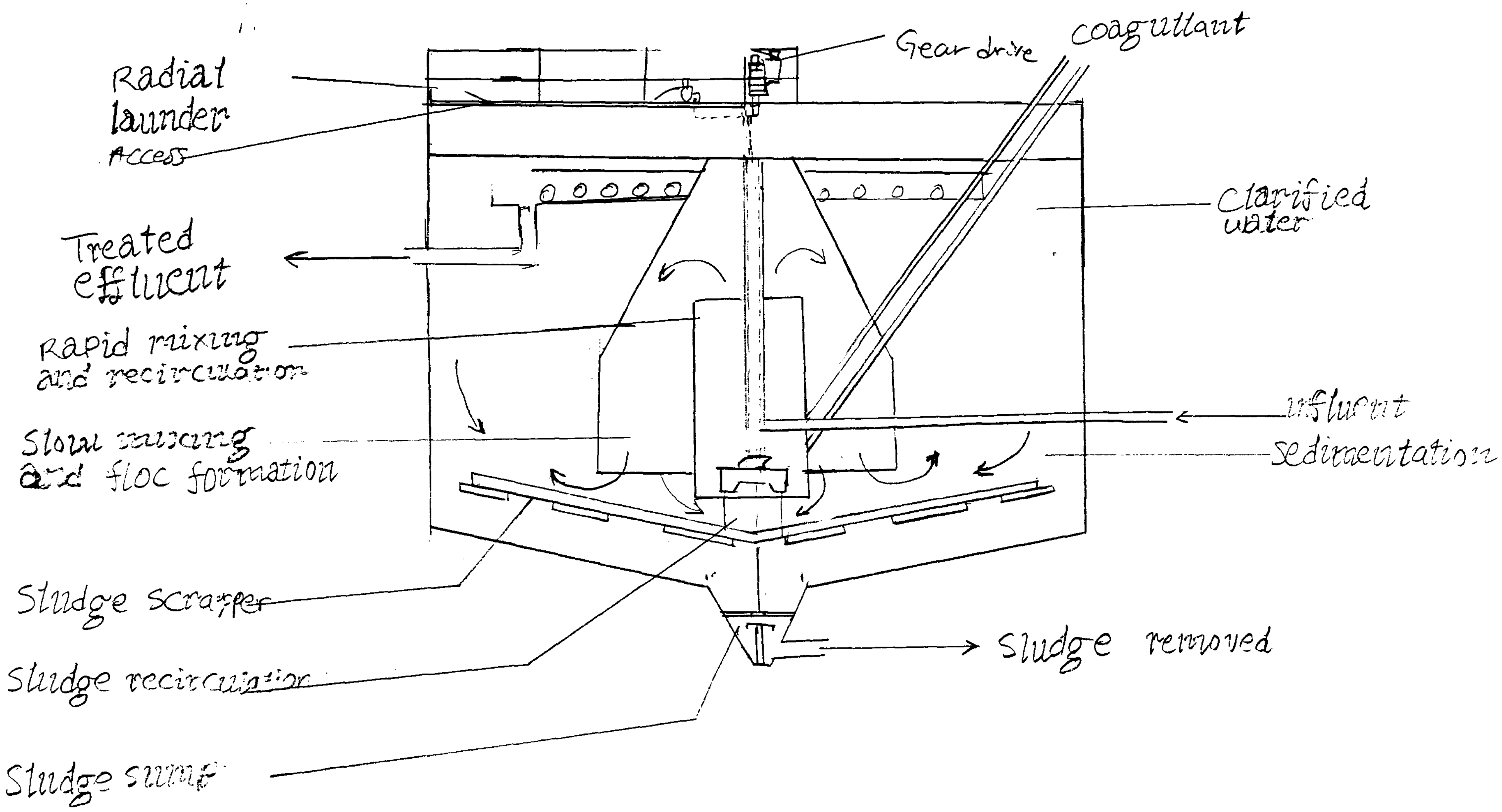
Table 2.1 Chemical coagulant application (Ekenfelder 1989)

2.3.7 Coagulant Equipment

There are two basic types of equipment adaptable to the flocculation and coagulation of industrial textile waste. The one adopted here is a conventional types which uses a rapid-mix tank, followed by a flocculation tank containing longitudinal paddles which provide slow mixing. the flocculated mixture is then settled in a conventional setting tanks.

A sludge blanket unit continues mixing, flocculation and setting in a single unit; although colloidal destabilization might be less effective than in the conventional system, there are distinct advantages in recycling preformed floc. With lime and a few other coagulation the time required to form a settle able floc is a function of the time necessary from calcium carbonate on other calcium precipitates to form a nuclei on which other calcium materials can deposit and grow large enough to settle. It is possible to reduce both coagulant dosage and the time of floc formation by seeding the influent wastewater with previously formed nuclei or by recycling a portion of the precipitated sludge. Recycling preformed floc can frequently reduce chemical dosages, the blanket serves as a filter for improved effluent clarity, and denser sludge are frequently attainable. (Ekenfelder 1989).

A sludge – blanket is shown below:



29. A Reactor Clarifier designed for mixing, coagulation and Sedimentation

2.3.8 Coagulation Of Industrial Textile Waste

Coagulation may be used for the clarification of industrial waste containing colloidal and suspended solids. Textile waste can be effectively coagulated with low dosage of alum. Silica or polyelectrolyte will aid in the formation of a rapid-setting floc. E.g. BOD removal of 75 to 80% have been obtained on wool- scanning wastes with 1 to 3 Ib $CaCl_2$/lb BOD (1to 3 kg/kg). Carbonation was used for pH control effect at coagulation at textile effluent is indicated in the table below. For various experimental days of operation (Ekenfelder 1989).

Day	Coagulant	Dosage mg/l	pH	Influent mg/l	Removal %	Influent mg/l	Removal %
1	Fe(So4)3	250	7.5-11.0	0.25	90	584	33
	Alum	300	5-9		86		35
	Lime	1200	-		68		30
2	Fe2(S04)3	500	3-4,9-11	0.74	89	840	49
	Alum	500	8.5-10		89		40
	Lime	2000	-		65		40
3	Fe2(S04)3	250	5-11	4.60	89	1570	31
	Alum	250	5-6		89		44
	Lime	600			87		44

Colour sum of adsorbances at wavelength of 480,550 and 650mm.

Table 2.2 **Coagulation of Textile Wastewater**

2.3.9Element of Design of sedimentation bed.

2.3.9.1 Zones of sedimentation basin: Sedimentation basins have traditionally been divided into four zones. Each with a specific function. These four zones and their individual function are:-

(1) The inlet zone provides a smooth transition from the influent flow to the uniform steady flow desired in the sedimentation zone.

(2) The sedimentation zone provides volume and surface area for sedimentation to take place.

(3) The sludge zone receives the settled floc particles.

(4) The outlet zone provides a smooth transition from the sedimentation zone to the effluent flour (Ekenfelder 1989)

2.3.9.2 General Considerations

The density and volume of both flocculating particles and precipitating particles change as they become attached to one another through flocculation and chemical precipitation. The setting velocities of the particles change with time and depth as the particles agglomerate and form larger floc; this, sedimentation is influenced by flocculation within the sedimentation basin, and as a result, both depth and detention time, along with surface area and overflow rate, become considerations in the design of setting basis.

In addition to depth and detention time, flocculation is dependent on the number of particle contacts per unit time, the size, density and fragility of the floc, particles surface charge; and pH and other factory. There is no commonly acceptable formulation relating the variables influencing the setting of flocculent particles. The number of particles contact per unit of time depends on the concentration of material in the water, the relative sizes and velocities of the particles, and the velocity gradients that increase the probability at contact setting rates for a flocculent suspension can be determined from batch setting data developed in the laboratory.

The time concentration curve is determined by injecting a tracer (a dye or electrolyte) in the outlet of a sedimentation basin and repeatedly measuring its concentration at the outlet. The concentration at the outlet will use to a peak, then decrease more slowly than it rose until all of the tracer has passed through the basin (max). The less the difference between pH and the theoretical time, the nearer to the ideal is the basin.

The time-concentration curve is, therefore, a useful device for studying the time-concentration curves. For a particular basin is pour, then the basin is said to be hydraulically unstable. This hydraulic instability is a result of short-circuiting and jet streaming. (Eddy 1980).

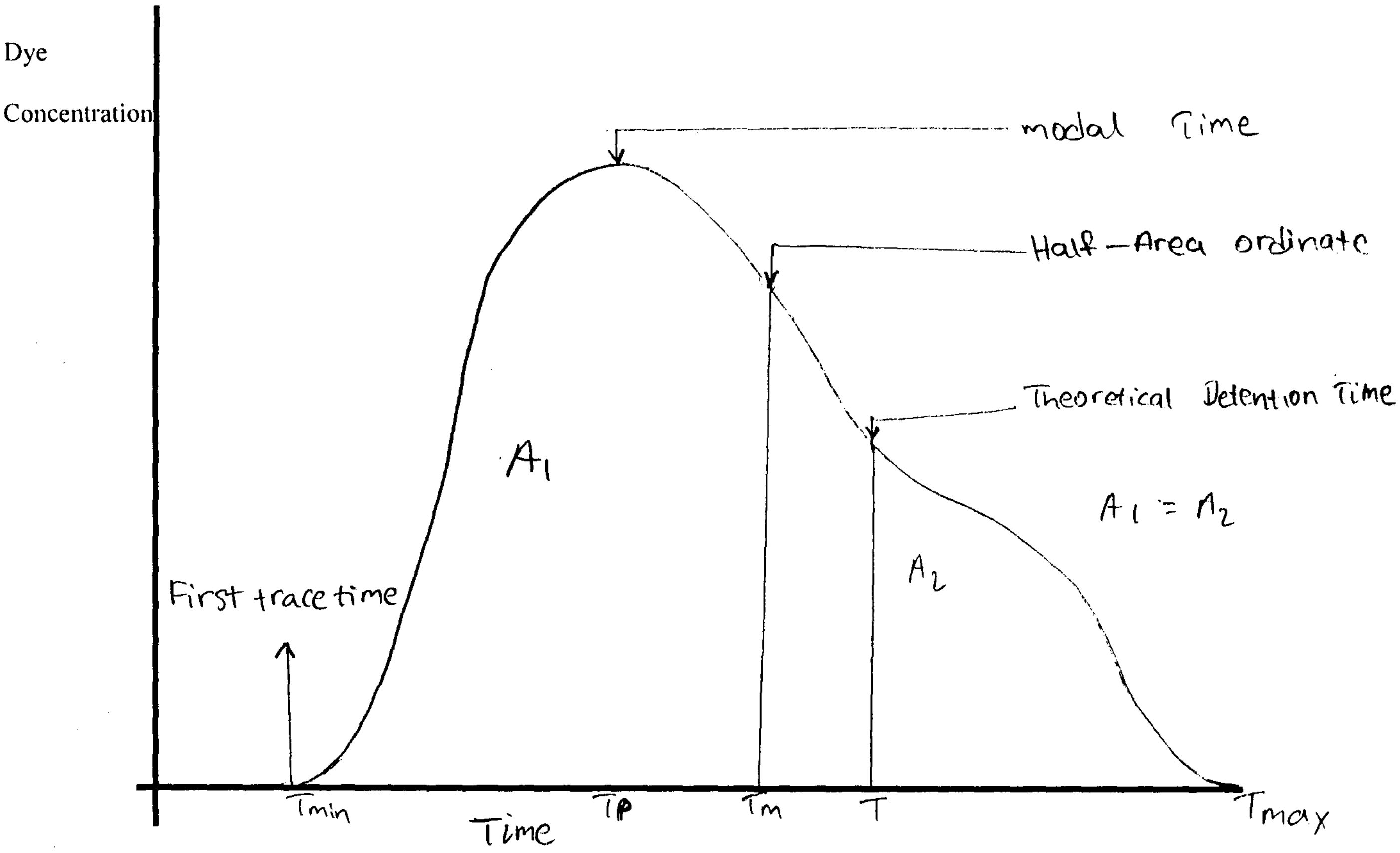


Fig 2.10. Time Concencentration curve and its Characteristics

2.3.9.3 The Effect Of Water Properties On Sedimentation

Several properties of the water and its suspended solids influence sedimentation, including the temperature of the water, the specific growing of the materials in suspension and particles. Water temperature has been found to be very important design criterion; in fact, it may be even more important than the specific gravity of the particles. The setting velocity, which is related to water temperature. With cold waters, basin overflow rates should be lower than with warmer waters. The engineer is thus required to design for the lowest water temperature of the supply source, unless demand is lower in cold weather.

The setting velocity of a particles varies directly with its specific gravity. Thus, the higher the specific gravity of the gravity of the particle, the higher will be its setting velocity and higher the corresponding overflow rate that a turbid surface water may contain suspended matter whose specific gravity range from 2.65, such as for sand, to about 1-30 for flocculated particles of organic matter and mud containing 95% water. Floc particles resulting from coagulation with alum

2.4.0 Adsorption For Treatment Of Coloured And Colourless Organics In Effluents Using Fixed Bed System

Adsorption operation is based on the ability of certain solids to concentrate specific substances from solution into the surfaces.

The treatment of waste waters by adsorption techniques is receiving growing attention since the standards for the quality of a waste effluent are usually becoming more rigid. This work is in accordance with a report by

Hassler (1) and Davies et al on treatment of textile effluent by adsorption methods (Kriton 1980).

2.41. Equipment

A flow diagram of the apparatus is shown in fig 2.6 and consists of vertical fixed bed columns. The vessel is used in the storage of the assumed effluent from the clarifier zone, for the experimentation stage a 60dm^3 of dye is use (phenol). The dye solution is fed, using up-flow condition, to the column from a constant temperature, constant headstand C and the flow rate to the column controlled. Perspex column c having I.D 5 x 10^{-2}m and length 40 x 10^{-2}m. Pressure tapping and sample points were available distributor at the base of each column and also place at the top of the column to prevent carry-over.

For the experimental sake the dyestuffs used include Telon Blue (Acid blue 25), Astrazone Blue (Basic Blue 69) and Deorlone Yellow (Basic Yellow) and Phenol (Kriton, 1980).

2.42 fixed bed adsorption model (Bed Depth Service Time Model (BDST)

The major problem in designing adsorption column is to predict how much effluent the bed will treat, or low long the bed with bed adsorbers in available to correlate the service time, θ, with the operation variable. The BDT model proposed by Hutchins for the adsorption of phenol or carbon is based on work originality undertake by Bohart and Adams. The theory states that the service time, θ_b, of or iron oxides may have a specific gravity as low as 1.02 to 1.10. This value may be increased by the presence of organic matter or entrained or absorbed water. The specific gravity of particles of calcium carbonate formed during the softening process may be as high as 1.2 (Kfiton 1980)

bed is: $\theta_b = N_0/c_0 \{z - u/KN_0 \text{ in } (C_0/c - 1\}$ .... (I)

equation (I) may be represented by equation (ii) which is the equation of a straight line and consequently a plot of service time against bed depth can be used to test the model.

$\theta_b = az + b$............II

A. Effect of Dye flowrate.

The influence of dye velocity for the adsorption of Telon blue dye into carbon has studied using a modified form of equation (I) &(ii)

$\theta_b = u_2/u_1\ a * z - b$ .... (iii).

Where: U_2 = test data velocity and u_1 = new velocity.

Four dye flow-rates were studied, namely 0.73×10^{-3}, 1.25×10^{-3} , 2.21 x 10-3 and 3.33×10^{-3} $dm^3\ 5^{-1}$ and all other system variables were maintained constant. The BDST results are shown solidus line in fig 2 and the equation of A are experiment data. The results are for 40% dye removal and all constants were obtained for the 'test' run at $2.21 \times 10^{-3} dm^3 2\ 5^{-1}$. The intercept on the abscissa is the critical bed depth and this decreases with increasing dye velocity. This depth is the minimum depth for obtaining satisfactory effluent at time zero under the test operating condition (Kriton 1980).

B. Optimization of fixed Adsorbers.

Similar fixed studies were undertaken with phenol solution to assess the effect of flow-rate. It is possible to optimize such date for coloured and colourless organics using the following technique.

I the carbon exhausion rate: This variable is usually expressed as pounds of carbon reactivated per volume of liquid treated.

Ii Empty bed contact time (EBCT): This variable is the time that the liquid would take to fill the volume of carbon bed and is a direct function of liquid flow-rate and carbon volume.

The total capital cost is primarily dependent on the volume of the carbon beds, and to a lesser extent, on the size of the reactivation furnance. The operating costs are determined by the carbon exhaustion rate since the largest variable is usually the cost of make up carbon.

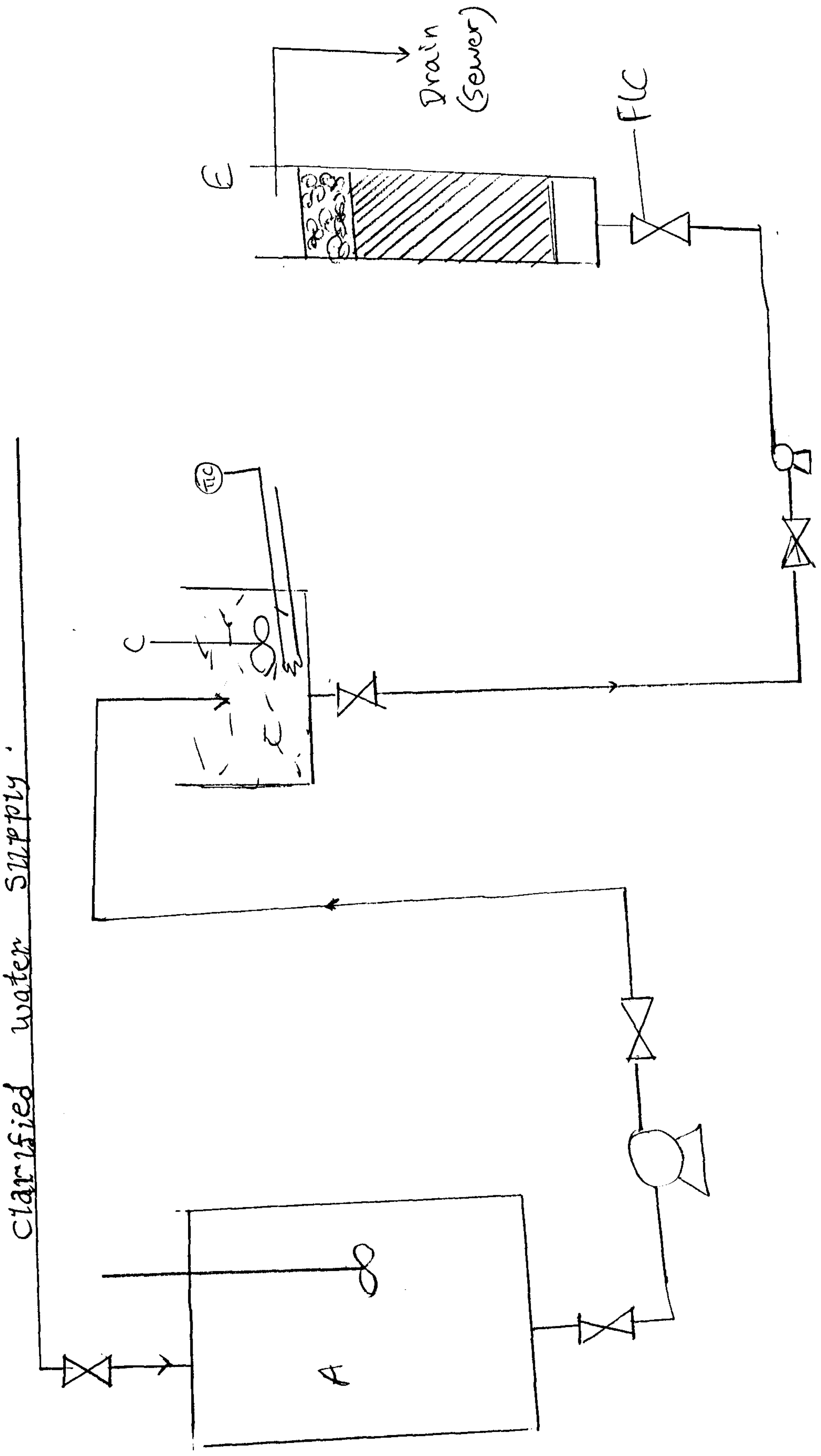
The relation between these two variables can be established by tests and plotted as shown in fig 2.9. For a given system to achieve a given performance, there is a single line relating these two variables which can be called the 'operating line.

The operating line information can be used to optimize the basic design to achieve the lowest cost or other objectives.

The points on the operating line for the desired maximum effluent concentration are obtained from column data. Once the operating line is established, it is possible to select the combination of carbon exhaustion rate and liquid retention time which gives the optimum or lowest cost design.

Fig. 213 shows a series of break through curves for the adsorption of phenol on carbon (R 400) at various bed heights. The data are plotted in fig14 which enables the optimum conditions to be predicted as shown , for the minimum exhaustion rate and minimum empty bed residence time for the system.

DIG. 2.11



2.11 Apparatus for column Adsorption studies

2.4.3 FORMULATION OF ADSORPTION

The degree to which adsorption will occur and the resulting equillibrium relationships have been correlated according to the empirical relationship of freundllich and the theoretically derived langmur relationship. For practical application, the freudlich isotherm usually provides a satisfactory correlation. The freundlich isotherm is expressed as

$$x/m = KC^{1/2} \quad \ldots\ldots\ldots\ldots\ldots\ldots \text{(iv)}$$

Where x = weight of substance absorbed

m = weight of adsorbent

C = concentration remaining in solution.

K and m are constants depending on temperature, the adsorbent, and the substance to be adsorbed.

The langmur equation is based on an equilibrium between condensation and evaporation of adsorbed molecules, considering a monomolecular adsorption layer.

$$X/m = abc/1{+}ac \quad \ldots\ldots\ldots\ldots\ldots\ldots \text{(v)}$$

This can be re-expressed in linear form as

$$1/\,x/m \quad = 1/\,b + \;1/\,ab\,.c \ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(Vi)}$$

Where b = amount adsorbed to form a complete mono-layer on the surface

a = constant which increase with increasing molecular size.

Since most wastewater contain more than one substance which will be adsorbed, direct application of the langmur equation is not possible. Morris and Weber have developed relationship from the langmur equation for competitive adsorption of two substances:

$$YA/M = a_A\, b_A\, C_A/\ 1 + a_A C_A + a_B\, C_B \ \ldots\ldots\ldots\ldots \text{(vii)}$$

$$xB/m = a_B b_B C_B / 1 + a_A C_A + C_B C_B \text{ .... (viib)}$$

More complex relationship, could similarly be developed for multi-component mixtures. It should be noted that although the equilibrium capacity for each individual substance adsorbed in a mixture is less than that of the substance alone, the combined adsorption is greater than that of the individual alone. In industrial application, contact times of less than 1h is usually used (Kriton 1980).

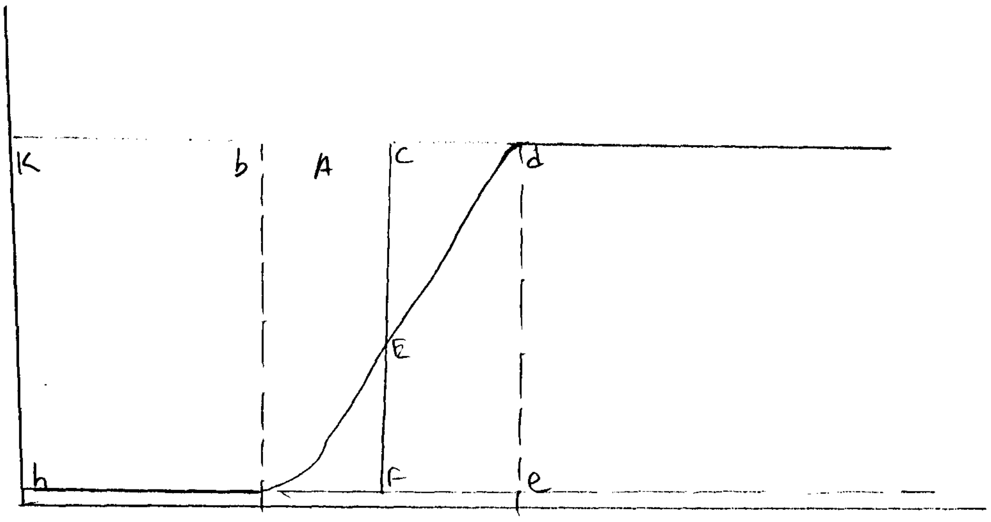
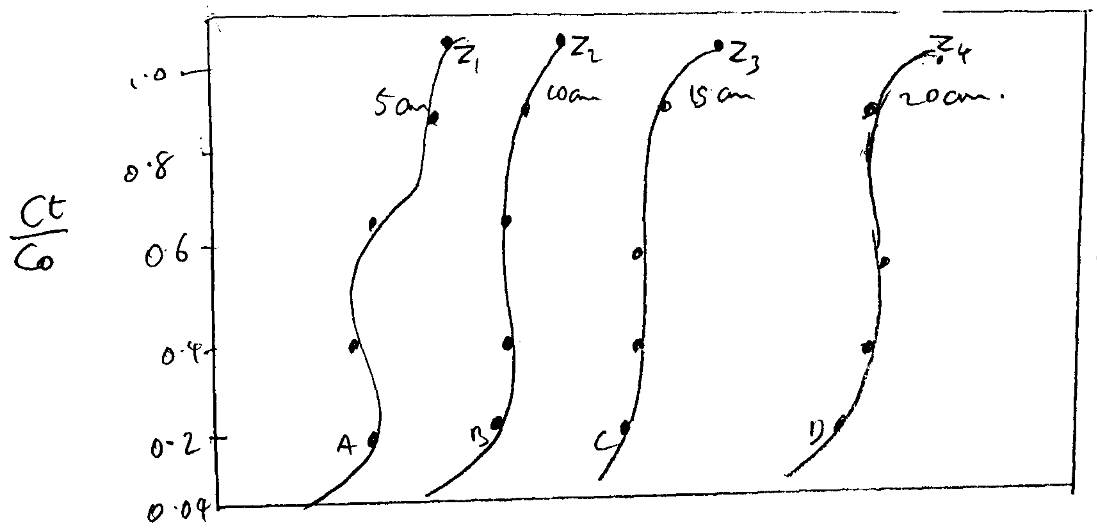
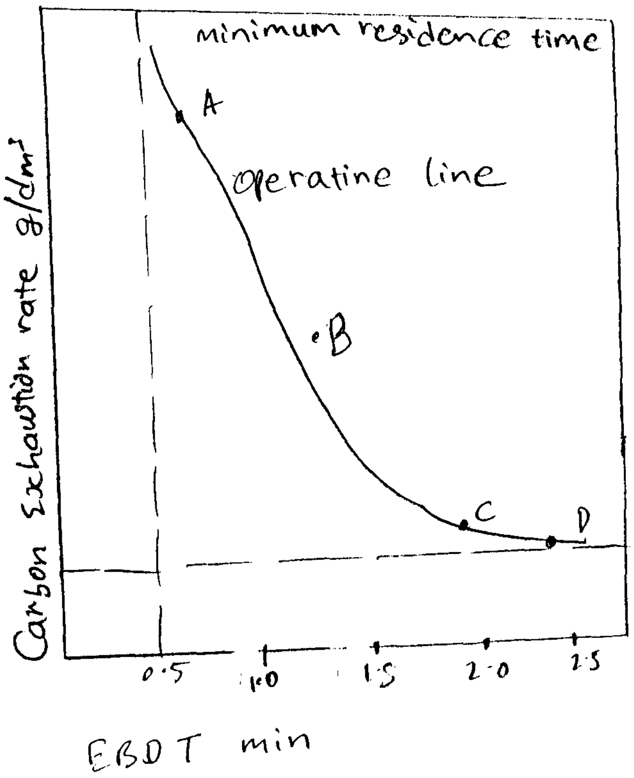


Fig 2·12· Mass trasfer zone·



Co =400 mg/dm³
particle range=
355-550µm
flow rate =
150ml/min.

Fig 2·13 Phenol Breakthrough curves·



minimum carbon exhaustion rate at 16ppm ϕOH breakthrough.

Fig 2.14 Optimisation Plot for data in 2.13.

A.	BDST constant in equation (ii)
a*	Modified BDST in equation (iii)
b	BDST constant in equation (ii)
c	Solute concentration in liquid at time t mgdm^{-3}
ce	Equilibrium solute concentration in liquid, mgdm^{-3}
Ch	Capacity factor.
D	Mean particle diameter, μm, m.
U	Solute velocity, m5^{-1}
v	Volume solution, dm^{3}
y	Solute concentration on solid at time t, mg g^{-1}
z	Adsorbent bed length, m.

2.5 Sand Bed Drying

The industrial waste plant here is of relatively small capacity and as such, the sludge can be dewatered on open or covered sand beds, drying of the sludge occur by percolation and evaporation. The proportion of the water removed by percolation may vary from 20 to 55 percent, depending on the initial solid content at the sludge and on the characteristics of the solids. The design and use of drying beds are affected by climatic conditions (rainfall and evaporation). Sludge drying beds usually consist of 4 to 9in (10 to 23cm) of sand over 8 to 18cm in (20 to 46cm) of graded gravel or stone. The sand has an effective size of 0.3 t0 1.2mm and a uniformity coefficient less than 5.0. Gravel is graded from 1/8to 1cm (0.32 to 22.54cm). The beds are provided with underdrains placed from 9 to 20ft apart (2.7 to 6.1m).

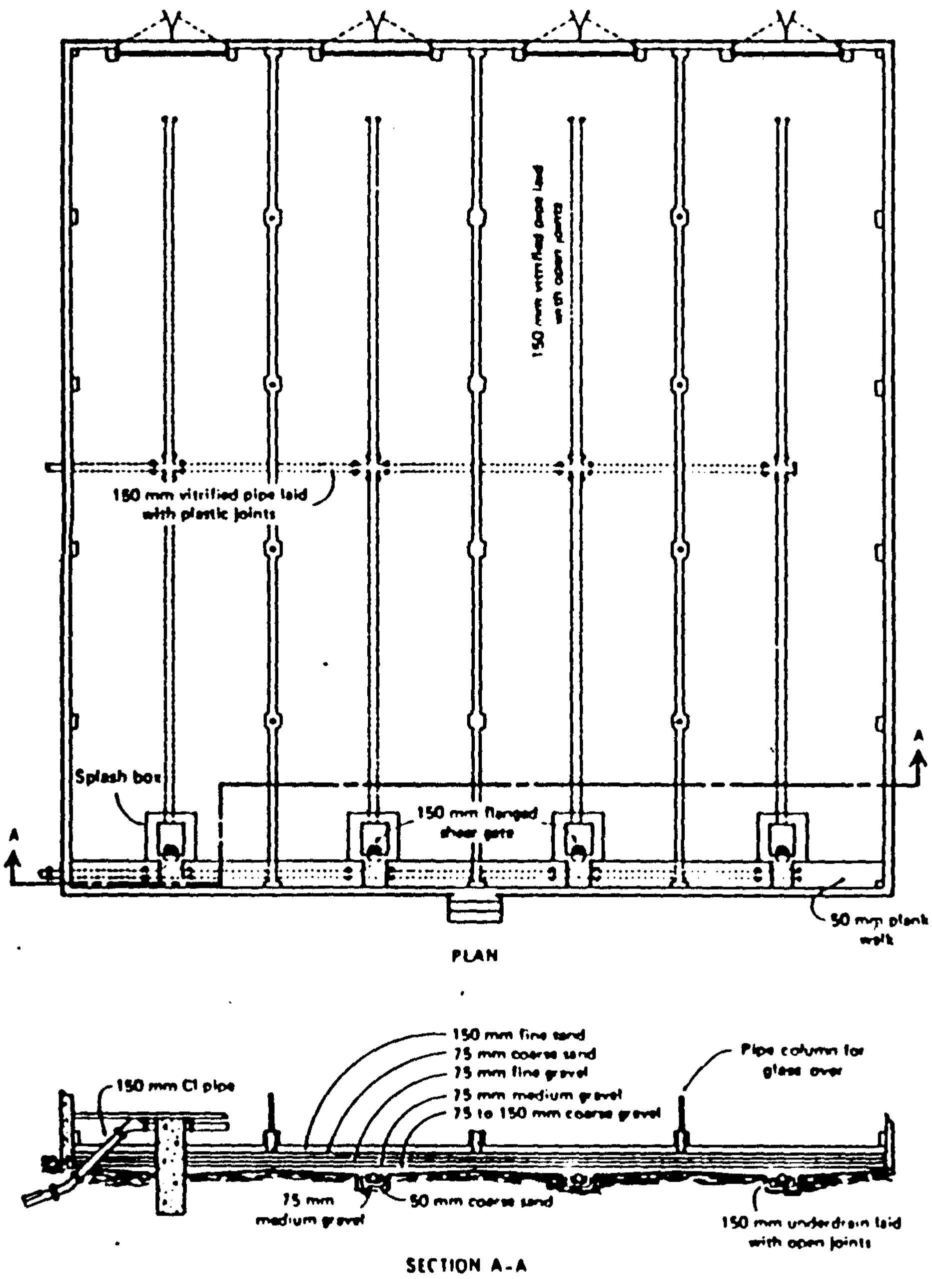


fig 2-12 plan and section of a typical sludge drying bed.

The underdrain piping may be vitrified day laid with open joints having a minimum diameter of 10cm and minimum slope of about 1%. The filtrate is returned to the treatment plant (metcalf 19880) wet sludge is usually applied to the drying beds at depth of 8 to 12in (20 - 30cm). Removal of the dried sludge in a "liftable state" varies with both individual judgement and final disposal means, but usually involves sludge of 30 to 50 percent solid (metcalf, 1980).

The Alum use here was found to have reduce the sludge drying time by 50%.

Piping to the sludge beds should drawn to the beds and should be designed for velocity of at least 0.75m/s. Cast-iron pipe is frequently used. Distribution boxes should be made to flush the lines if necessary to divert the sludge flow into the bed selected. Splash plates are placed in front of the sludge outlets to spread the sludge over the bed and to prevent erosion of the sand.

Sludge is removed from drying bed after it has drained and dried sufficiently to be spadable (metcalf 1980).

CHAPTER THREE

3.0 EXPERIMENT

3.1 Methodology

The method involves that of collecting the textile effluent at its points of discharge into the public sewer system. The parameters looked into includes: the total dissolved solid, the total suspended solid, the total hardness, oil and grease content, conductivity, total alkalinity, pH. Ca^{2+} , chlorine and the colour observed visually.

In the course of carrying out the analysis, quantitative and titrimetric methods were mostly used. This is informed by lack of sophisticated analytical equipment and cost of employing such analytical services.

3.2.0 The Effluent Analysis

3.2.1 Total Dissolved Solids.

APPARATUS: Watchman Gf/c grade or glass fibre grade filter discs; filter holder, suction flask (500ml), evaporating dishes (50 - 250ml), porcelain dish, stream bath, drying oven 105± 1^0C, dessicator, sensitive balance, furnance.

Procedure:

- Heat the clean dish 200 - 250^0C for one hour in a furnance.
- Cool in a dessicator and store until needed weight immediately before use.
- Assemble filtering apparatus with watchman glass-fibre filter (c) grade and the filter holder
- Shake sample vigouriously and rapidly transfer into 300ml graduated cylinder.

- Filter sample through the glass fibre filter and continue to apply suction for about 3 minutes after filteration is complete to remove as much water as possible.
- Transfer and continue to apply suction for about 3 minutes after filteration is complete to remove as much water as possible.
- Transfer 100ml of filterate to a weight evaporating dish.
- Evaporate to dryness on steam bath, wipe the outside of dish to remove condensed steam.
- Dry the evaporated sample for 1 hour at 105 ± 1^0C cool in a dessicator and weight. Repeat the drying cycle until a constant weight is got ± 0.5mg. (Kakanfo 1992)

To calculate this value sees the appendix

Indentification of gases

3.2.2 Total Suspended Solids (TSS)

Suspended solids are these solids that are retained by a standard filter (and dried to constant weight).

Apparatus:

- Glass fibre - filter discs, watchman Gf/C, grade 70mm, filter holder, suction flask 500ml, drying oven 103 - 105^0 C dessicator, analytical balance. (200g capacity).

Procedure:

- Place the disc on the filter holder.
- Apply suction and wash the disc with 3 succedive 20ml volume of distilled water.

- Remove all traces of water by continuos suction, after water has passed through.
- Dry filter in an oven at 103 - 105^{0}C for 1 hour.
- Store in a dessicator until needed.
- Weigh immediately before use.
- Assemble filtering apparatus and began suction, shake sample vigorously and rapidly transfer 300ml to the funnel by means of a 100ml volumetric cylinder.
- Remove filter from holder carefully
- Dry for 1 hour at 103^{0}C - 105^{0}C .
- Cool in a dessicator and weigh.
- Repeat until constant weight is obtained in the range of ± 0.5mg (Kakanfo 1992).

For calculation see appendix.

3.2.3 **Chloride**

Chloride is determined in a neutral or slightly alkaline solution by titration with standard silver nitrate ($AgNO_3$), using potassium dichromate as indicator, silver chloride (AgCl) is quantitatively precipitated before red silver chromate is formed.

Reagent Shaping:

- Standard AgNO, solution: dissolve 4.79g of $AgNO_3$ in distilled water and dilute to 1 litre. Store in brown bottle.

  1.0ml - 1.0mgcl$^-$.
- Standard NaCl solution.

- Potassium chromate indicator: Dissolve 5g of potassium chromate K_2cr0_4, in 100ml of water. Add $AgNO_3$ drop-wise to produce a slight red precipitate of silver chromate and filter.

Procedure

- Measure 50ml of sample (filtrate) into a 250ml conical flask.
- Add 1ml of potassium chromate solution.
- Titrate with $AgNO_3$ solution, with constant stirring until only the slightest perceptible reddish colouration persists.
- Carry out a blank determination to allow for the presence of chloride in and of the reagent and for solubility of the silver chromate.

N.B.: If more than 25ml of titre value is required, it is recommended to take a smaller quantity and diluent it to 100ml before titration (Kakanfo 1992).

For calculation see appendix).

3.2.4 Calcium

When EDTA is added to water containing calcium ca2+ and magnesium mg2+, soluble EDTA chelates are formed.

The stability constant for the calcium chelate is larger than for the magnesium chelates/.

In a titration, calcium can be determined in mg2+ presence by EDTA titration. when an indicator is used that reacts with calcium only. Murexide is used as indicator.

Reagents

- 1 mol/1, NaOH
- Murexcide indicator.

- Standard EDTA, titrant 1 mol/1
- Standard calcium solution. Weigh 1.0g at $CaCO_3$ that has been previously dried at 105^{0}C and placed in 500ml Erlenmeyer flask. Place a funnel in the neck of the flask and add small volume of 1+1 HcL until all the $CaCO_3$, has dissolved. Add 200ml of distilled water and boil for a few minutes to expel CO_2. Cool, add a few drops of methyl red indicator, and adjust the intermediate orange colour by adding 3 mol/1, NH_4OH as required. Transfer to 1 litre volumetric flask and make up to mark.

  1.0ml = 0.04008mgCa^{2+}

Procedure

- Use 50ml of sample or a smaller quantity diluted to 50ml.
- Analyse hard water with alkalinity higher than 300mg $CaCO_3$/litre, by taking smaller portion and diluting to 50ml by neutralizing the alkalinity with acid boiling for 1minute and cooling before titration.
- Add 2.0ml of NaOH solution, or a volume sufficient to result in a pH 12 - 13.
- Stir and add 0.1 - 0.2g of mucexide indicator.
- Titrate with 0.001mol -C^{-1} EDTA until a purple red end point is reached

  For calculation Appendix) (Kakanfo, 1992).

3.2.5 Magnesium (mg^{2+})

Reagents

- Ammonium solution 5%.

- Buffer solution (add 55 ml of Hcl to 400ml distilled water slowing with stirring add 310ml of 2 - amino-ethanol (ethanolamine). A 5g magnesium disodium tetracetate and make up to 1 litre mark with distilled water.
- Indicator EBT.
- EDTA titrant, 0.01/mol/l and weight 3.723g of disodium ethylenediamine tetracetate dihydrate in distilled water and make up to 1 litre mark.
- Standard Calcium solution.

Procedure

- 25ml of treated sample is dissolve to 50ml with distilled water in a conical flask.
- Add 25ml of buffer solution.
- Add 5 drops of EBT indicator
- Titrate with EDTA until end point is reached, bright blue colouration. (Kakanfo 1992)

See Appendix for calculation).

3.2.6 **P.H**

Two methods are use: these are (I) the use of a universal indicator in the form of a litmus paper, here the litmus paper is imply dipped into the waste water collected and the colour change compare to a standard scale to determine the pH level.

The second method, which though is not occasionally use, is that of use of sophisticated probe with a transmitter/recorder and controller units. One simple type of unit is a hand held battery operated pH tester, which gives direct readings from pH 1 to 13 worth a 0.1 pH accuracy. It is easy to operate.

Switch it on, immerse the sensing element in the solution to be tested and read the pH value directly from the scale. It has the advantage of spot measurement and saves time of taking samples to the laboratory for analysis. (Metcalf 1980).

DIG.

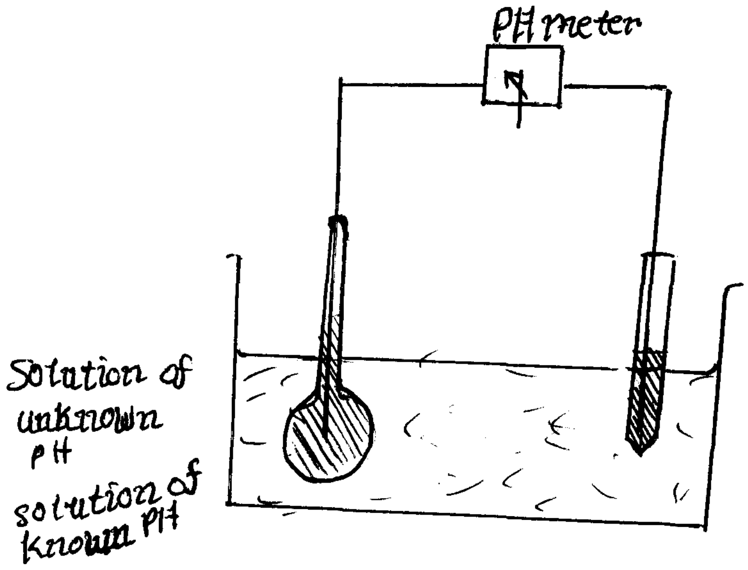


Fig 3·1 Diagram of a pH meter

3.3.1 Water Quality Standard

The World Health Organisation (WHO) standard is the standard being adopted by many Countries including Nigeria for their effluent control. The maximum permissible level for drinking water intake is being adopted for the sewerage level.

Parameters	Health Desirable Level	Max permissible Level
Odour	Unobjectionable	unobjectionable
Suspended matter	5 FTU	25 FTU
Total Solids	500mg/dm^3	1500mg/dm^3
pH range	7.0 - 8.5	6.5 - 9.2
Phenolic Compounds	0.001mg/dm3	0.002mg/dm3
Total Hardness	100mg/dm^3 $CaCO_3$	500mg/dm^3 $CaCO_3$
Chloride	200mg/dm^3	600mg/dm^3
Calcium	75mg/dm^3	200mg/dm^3
Iron	0.1mg/dm^3	1.0mg/dm^3
Magnesium	Not more than 30mg/dm^3	150mg/dm^3

Table 3.2 World Health Organisation International Standard For Drinking Water (Nikoladze 1989).

3.4 **Interim Effluent Limitation guides in Nigeria for textile industries.**

The major problem in textile discharge are the high pH, the processes carried on in this type of industry. Others include sludge and textile waste.

The table below shows the permissible level of discharge of textile protection agency.

Parameters	Unit In Milligram Per Little(mg/l) Unless Otherwise Stated.	
	Units for discharge into surface water	Limit for land application
Temperature	Less than 40^{0}C within 15meters of outfall.	Less than 40^{0}C
Colour (Lovibond Unit)	7	-
pH	6 –9	6 -9
Total Suspended solids	30	-
BOD_5 at 20^{0}C	50	500
Sulphide (as S^{2-})	0.2	-
cyanide (as CN-)	0.1	-
Chlorine (as Cl-)	600	600
Detergents (linear alkylate Sulphonate as methylene blue active substance).	15	15
Oil and grease	10	30

Phenolic compound (as phenol)	0.2	-
Chromium (trivalent and hexavalent)	less than 1	-
Total Metals	3	-
Suspended fibre	-	-
Odour	-	-
Coliform 400 MpN	100ml	-
Alkalinity ($CaCO_3$)	50	-
Total hardness	500	

Table 3.3 **Guideline for Maximum Concentration Allowed For Discharge into Surface Water. (FEPA 1995).**

3.4

Example of Chemicals	**Process of Application**
Surface active agents	**Detergents, wetting agents, dispersing agents**
Starch and related synthetic polymer	**Sizing, Thickeners.**
Enzymes	**Desizing, deguming**
Dyes and pigments	**Dyeing and printing**
Acid and Bases	**Wide application e.g. Scouring, mercerization etc.**
Oxidizing agents e.g. sodium hypochlorite, sodium chlorite,	**Bleaching and other oxidative** applications.

hydrogen peroxide.	
Heavy metal salts, e.g. chromium, salts, copper salts, zinc salts.	**Metal complex dyes and printing pastes, planting of printing rollers.**
Reducing agents e.g. sodium dithionite(hydrosulphite)	**Dyeing and printing.**
Inorganic salts e.g. NaCl, NaSO4	**Dye aids.**

Table 3.4 Some Chemicals Commonly use in wet processing o textile (Olanitori 1999).

CHAPTER FOUR

4.0 RESULTS

4.1 Grouping of Textile Effluent Composites.

Ideally, each pollution source should be detoxified with the installation of anti-pollution equipment based on Best practical Technology (BPT) and / or Best Available Technology (BAT). In congnisance of the high cost of imported BPT and BAT, and the non-availability of local environmental pollution technology, uniform effluent standards (UES) is normally based on the pollution potential of effluent and /of the effectiveness of current treatment technology. This approach is easy to administer, but it can result in over-protection in some areas and under protection in others. To over come this problem, uniform effluent limitations based on the assimilative capacity of the recovery water have been drawn up for all categories of individuals effluents in Nigeria while additional sectoral effluent limitation have been provided for individual industries here with focus on textile as in table below (FEPA1992)

Group 1	**Group II**
BOD5	Heavy metals
COD	Colour
pH	Oil and grease
Suspended Solids	Total dissolve solids.
Chromiums	Sulphides

Phenolics	Temperature
Sulphides	Toxic materials
Alkalinity	
GROUP 1	**GROUP 2**
Consist of the most significant parameters for which effluent limit will most often be set.	Consist of some additional parameters for which effluent limit can be set on an individual basis.

Table 4.1 Grouping of Effluent Composites (FEPA II, 1995).

4.2 Effluent from Some Textile Industries

The information below presents in detail the extent of pollution from textile facilities. The Ogun River effluent data show that the dyeing process of textile manufacturing discharge high suspended solid, total solids and total nitrogen loads into receiving waters. To survive in the Ogun River, fish must also be tolerant to moderately high pH environments (pH 10).

See table 4.1 Discolouration of Water is also common downstream from many dyeing facilities. In comparison with water quality guidelines for the textile industry and dyeing process in particular, this facility was consistently non-compliant. For instance, suspended solids are not supposed to be greater than 5 milligrams for litre but were measured to be 1,930 milligrams per litre. BOD5 levels were much greater than acceptable level (27 times). COD result were also grossly above compliance level (63 times) with a total nitrogen value at 3,300 milligrams per litre, the nitrate standard of 20 milligrams per liter, it measured, would probably be substantially excess. Effluent characteristics of five Nigerians textile mills were reported by FEPA guidelines and standards monograph were equally unacceptable (FEPA 1991), see table 4.2 below. The pH unit of 9 was exceeded by three of the five factories of the two factories sampled for BOD5, both were over twice the standard of 20 miligrams per litre. All five facilities have elevated COD levels. Only one factory had measurements less than twice the national limit. Chromium discharge was measured at only one plant, which was discharging at two and half times the limit. Although guidelines specify that effluents must be colourless, it was variously describe as yellow, green, or deep purple depending on the factory. Other water quality limits consistently exceeded were manganese, turbidity and alkalinity.

Industry	Location	Major Waste Type	Quantity of Waste Water	Total Waste	Water Consumed
Specomill Textiles	Ikeja	Bleach Dye Print	2,500m^3/d		
Nigeria Textiles	Ikeja	-Ditto-	3,000m^3/d		
West Africa Thread Company	Apapa	-Ditto-	300m^3/d	45.5m^3/d	95.5m^3/d
Nigeria Tejin Textiles	Ikeja	-Ditto-	1000m^3/d	3,200m^3/d	3,360m^3/d
Atlantic	Ilupeju	-Ditto-	1,500m^3/d	900m^3/d	1,200m^3/d

Textile					
Assan Industries	Ilupeju	Bleach, dye, print	300m^3/d		
Fablom	Ilupeju	-Ditto-	300m^3/d		
Enpee Industries	Ilupeju	Bleach, dye	1,500m^3/d		
Swarntex	Ilupeju	-Ditto-	100m^3/d		
Bhojson Industries	Ilupeju	Bleach, Dye, Print.	1,000m3/d		
Nigeria Synthetic	Ilupeju	Bleach, Dye	50m^3/d		
Afprint	Iganmu	Bleach, Dye, print	2000m^3/d	2,409.1m^3/d	2,500m^3/d
Sunflag Knitting	Iganmu	Bleach, Dye	500m^3/d		
Five Star Industries	Oshodi	Bleach, Dye, Print	1000m^3/d	40m3/d	710m^3/d
Arcee Textile	Oshodi	Bleach, Dye	300m^3/d	109.1m^3/d	180.8m^3/d
Dalamal Textile	Oshodi	Bleach, Dye, Print	600m^3/d		

Table 4.1 Effluent data from some selected textile industries in Lagos (FEPA1991).

Parameter	Units	A1	B1	A2	B2	C
PH		8.5	9.2	9.3	6.3	11.7
Conductivity	Mmho/cm	1,750	2100	325	190	5.800
Alkanity	mgCaCO3/ l	-	-	167	56	846
Total solids	mg/l	1,815	2050	430	360	3,510
Turbidity	NTU	-	-	32	22	30
COD	mg02/l	725	150	660	227	583
Colour	-	Yellow	Yellow	Green	Yellow	Deep Purple
Chloride	mg/l	-	-	285	312	222
BOD	mg02/l	41	47	-	-	-
Nitrite	mgN/l	158	-	-	-	-
Ammonia	mgN/l	48	-	-	-	-
Sodium	mg/l	245	-	100	33	1,000
Manganese	mg/l	0.23	-	-	-	0.2
Calcium	mg/l	69	-	4	41	12
Chromium	mg/l	0.225	-	-	-	-
Magnesium	mg/l	8.0	-	1.3	1.7	0.3

Table 4.2 Effluent Quality of Some textile mills in Nigeria (Single Grab Samples at 3 sites) (FEPA 1991).

M^3/d = cubic meter per day.

Waste Description	Waste Quantities Generated	
	Medium – Large Industries	Small-Scale Industry.
Fuzz	0.55 - 7.77	10
Bleaching Effluent	20,200	460
Dyeing Effluent	5,165	440

Table 4.3 Comparison of Waste Generated in Medium and Large Verses small-scale Textile. Kg/month/employee (FEPA 1991).

4.3 Efficacy result of Afprint effluent discharge.

Parameter	Inference
Appearance	Not clear
Colour	Cream
pH Value	5.90
Temperature(OC)	32.0
Total Dissolved solid mg/dm^3	2,500
Suspended solid mg/dm^3	100
Total hardness (mg/dm^3)	50
Oil and grease (mg/dm^3)	500
Conductivity (micro Ohms)	230
Total alkalinity as $CaCO^3$ (mg/dm^3)	530
Iron (mg/dm^3)	0.02
Calcium as $CaCO^3$ (mg/dm^3)	18

Magnesium Hardness as $mgCO^3$ (mg/dm^3)	32
Chloride mg/dm^3	256.9
Total chlorine mg/dm^3	0.006.

Table 4.4 **Efficacy Result of Afprint Effluent discharge**

The result above is the outcome of a result carried out on the effluent being discharge at the Afprint processing plant, Iganmu using all the necessary instruments to determine the most significant parameters present in the discharge and the additional parameter on which effluent limits are being set on the discharged effluent.

Having gotten the efficacy result from the test being carried out, the next is the equipment design to check this menace.

4.4 Discussion Of Result

Comparison of Result

Parameter	Unit	Effluent Level	Discharge Level	World Trade Effluent Level (FEPA Standard).
Solid hard matter	g/m^3	2,200	0.000	-
pH Value	-	5.9	5.9	6 - 6
Temperature	0C	42.00	20	40

Total Filtrable Solid	g/m^3	2,500	50	30
Total Suspended solid	g/m^3	100	25	30
Oil and grease	g/m^3	500	40	10
Total hardness	g/m^3	50	40	500
Conductivity	μΩ	230	-	-
Iron	g/m^3	0.02	0.01	0.01
Total Alkalinity as $CaCO^3$	g/m^3	530	220	50
Calcium as $CaCO^3$	g/m^3	18		
Magnesium hardness as $magCO^3$	g/m^3	32	20	37
Chloride	g/m^3	851.9	560.0	600
Total Chlorine	g/m^3	0.006		

Table 4.5 Comparison Effluent Discharge Level, treated composite and world trade discharge level.

With the experimental result it could be affirm that a bulk of the effluent composites which accomplish the discharge has being removed during the course of treatment.

As stated earlier in the literature review concerning the apparatus configuration, the hard solid matters, such as the floating fibres, the rags, and other scavengers in the waste is being removed via thin layer, balance trap, this also removed some element of floating oil and grease in the effluent. Taking a detail analysis of the process about 99.9% of this scavengers is being removed this which could have caused some disturbance and chemical waste in the subsequent stage after this we have the heart of the whole process which is the contact chlarifier with mixing, coagulation and flocculation embedded under a single unit. Here the filterable matters with an approximate diameter range of from 1 milimicron (μΩ) to 1Ω and suspended matters with an approximate diameter of 1Ω - 100Ω and above are being removed.

The total filterable solid includes the dissolved and colloidal matters which are not settleable accept by coagulation. The suspended or non-filterable particles to some extent are settleable.

These particles which are mostly charged are made settleable with the use of alluminium sulphate (hydrate) (Al_3SO_4 x H_2O) and the level reduced from the toxic level of 250g/m^3 for total filtrable solid and 100g/m^3 for suspended solids to 20g/m^3 and 29g/ m^3 respectively. This level which is further reduced to 50g/ m^3 and 25g/ m^3 in the subsequent activate carbon adsorber.

The oil first scheme of removal of the grease and oil started right from the sand trap where some of the oil and grease which are floatable are removed together with the scavengers, then letter with the aid of the alkaline solution present in the effluent accomplished with the agitator which mixes this with the alkaline solution present in the effluent, this are being emulsified and the level cut down from the alarming 500mg/l to 40g/m3. This process can be seen to be very economical as the process almost follows the catalytic process of pollutant conversion and reduction. As part of the effluent is used in taking care of the other.

As a result of the charge removal and emulsification the alkalinity is being brought inside this reactor clarifier from 530 and calcium as CaCO3 of 18 to a cummulative of 220gm/m3. Some mechanism of settling is also responsible for that of the magnesium hardness in form of mgCO3 from 30g/m3 to 20g/m3.

The total toxic chlorine level is reduce from a total of 851.9 and 0.006 for free chlorine to 845.7 and 0.004 respectively in the sedimentation take to a final 560.0 to 0.002 respectively in the carbon adsorber.

It can be infer from the result that this process derive is suitable for use in the close system for the process treatment of the effluent treatment as the result compares favourably with the international standard of discharge set by the WHO which is also being adopted by the Federal Environmental Protection Agency (FEPA) as the effluent discharge limit in Nigeria.

A general material balance taken around the process indicate that a 6,781.926g/m^3 at solid + 250g/m^3 of coagulant (Alum) was fed to the system with 6076.896g/m^3 of solid was being removed. A breakdown which reads:

2,199.99g/m^3 removed through sand trap in reservoir.

3,835.064g/m3 removed through sedimentation in contact reactor clarifier.

309,715g/m3 removed through carbon adsorption column.

Worthy being mention is the fact that the system uses a sludge recalculation system, which enhances its efficiency, and this happens in the contact reactor clarifier which is the heart of the whole system.

Now taking a critical comparative study of this in relation to the world trade effluent discharge, it could be understand that for some of the discharge is not up to the world standard maximum discharge limit and so effort need not be focused on such area as it couldn't posses any deleterious effect e.g. the total hardness, while there are some that demand for serious attention and most of these parameter result, there are those that the degradation will continue along the course of the effluent.

CHAPTER FIVE

5.0 SAFETY, CONSTRAINT AND CONCLUSION

5.1 Safety

5.1.1 This rung of equipment ensures a high safety standard. So also if an environmental impact assessment of the equipment rung is being taken, this by no way produces an environmental hazard, because,

i. There is no spill of any hazardous substance or chemical into the surrounding.

ii High-pressure build up could not be involve in any of the machinery's which could subsequently have led to explosion.

Iii the Rung of machinery's are user friendly and easy to operate.

Iv The is non-open rotationally part that could cause accident.

V Most of the chemicals used are easy to handle and not dangerous.

5.1.2 For efficiency of the system the following should be observed:

i though these rung of machinery is user friendly power, so all rules pertaining to electrical harzardouse and accident must be observe.

ii Negligence should not be brought into play with the mechanical parts despite its user friendliness.

iii An electrode pH control should be mounted in the inlet of the sedimentation tank to control the pH through feed forward control system.

Iv An analyser should be install in the underground reservoir to check any fluctuation in the solid loading and as result effect a feed forward control. Though this could also be mounted at the exit to effect a feed back control. Others include a level indicator at the reserviour tank.

5.2 Economy

- These rung of machinery is so cheap to obtain as the no of machineries involve is very limited.
- It is easy to maintain because of its simple nature.
- It conserves space as few machineries are involve in a compact form.
- Any medium textile company can easily adopt it.
- It serviceability. Component can be made available locally.
- High relieve is never a must in the construction.
- It helps reduces excessive charge from the environmental protection agency.
- It helps remove precise element or compound from an effluent discharge.
- It may be stepped up a little bit when recirculation of used water is required.
- It is simple and as a result gives room for modification.
- Cost of tracing fault using any of the techniques for synthesis of failure logic e.g. the checklist, the hazard and operability study (Hazop), fault tree, event tree, etc is made so easy, and so reduce cost.
- Maintenance turn around is very easy and cheap.

5.3.0 Constraint To Pollution Control In Nigeria

5.3.1 **Institutional: Industrial pollution** central is fragmented among at least two Federal agencies and three Government levels with no clear designation of responsibilities. Co-ordination among the various agencies and levels is weak. Division of Federal and State responsibilities is a source of disagreement, with Nigeria's Federal Environmental protection Agency (FEPA) preferring a more centralised pollution management process and some of the state EPA'S (SEPA'S) emphasising more State control.

5.3.2. **Capacity constraint:**

Financial, personnel, and technical constraint at all Government levels severely limit industrial pollution management capabilities. FEPA is too understaffed to monitor or enforce pollution regulations adequately. Furthermore, the staff is largely untrained in industrial pollution, laboratories, outfitted offices and vehicles. For example, neither the FEPA zonal offices not the Rivers SEPA has a laboratory. As a result, after oil contamination incidents, the authorities need to request that the comprises responsible provides soil and water analyses, leading to a conflict of interest.

Ii State agencies are also understated,pareticularly in comparison to SEPA in other countries. Furthermore, the SEPA's in Nigeria have insufficient monitoring and laboratory equipment. Even basic needs such as office equipment and vehicles are unmet. One of the principal reasons for the poor resources of the SEPA's is their dependence on finding from state budget.

The Lagos SEPA, which is considered the strongest of the state owned EPA's has been able to generate substantial revenue through it's pollution discharge charge. It ha a laboratory funded by its pollution charge system but has yet to equip it.

Lagos State is one of the first States to implement regulations requiring environmental assessment for all new projects.

5.4 **Monitoring and Enforcement:**

With insufficient resources, FEPA and the State Agencies are not able to enforce regulations adequately. WASTEC found that enforcement is generally limited to accidents that cause visible pollution. FEPA has yet to impose any penalties for non-compliance. It is allowing a short-term moratorium for polluters during which it advertises that pollution compliance is mandatory.

Until FEPA ends its moratorium on enforcement, companies have little incentive to improve their pollution records.

5.4.1 **Regulatory Aspects and Economic Incentives**

Nigeria have a sound legislative and regulatory framework for controlling industrial pollution. It enable the Federal and State Governments to establish the necessary environmental Agencies and Industrial discharge standards and also create an appropriate monitoring, enforcement, each legal prosecution process for polluters. The guideline states that each state should adopt FEPA'S standard as their minimum standards. All four of the industrialised states have developed their own standards, which tend to be stricter than FEPA's limits. The regulations are contained in a disparate regulations for health, drainage, and sanitation, which inhibit a co-ordinate approach to industrial pollution abatement. (FEPA 1995).

Ii A major limit to the effectiveness of current regulations to reduce pollution is the absence of economic incentives. Other than the Lagos -Kanopollution charge programme, market incentives or pollution control do not exist.

The lack of incentive is further exaggerated by excessive low energy, water and waste disposal charges. In addition no subsidy programme, such a tax credits, grants, or lines of credit, exist to provide a positive incentive for industry to abate pollution.

5.4.2 **Policy Constraints**

Industrial and economic development polices often have unintended and indirectly detrimental environmental impacts. Industrial policy influences industrial pollution in three days. First, it affects the speed and type of industrial expansion. Second, polices can distort decision making on whether industrial by products are treated as waste or recycle and reused. Third, subsidies of input to the production process cause excessive use of whatever is being subsidies policy failures in these areas are common in Nigeria.

ii Tariffs and other trade barriers, which remain substantial in Nigeria, increase of pollution protectionism reduces competition, allowing firms to be less efficient and less conscious.

iii Water prices, which are also much lower than the cost of purification and wastewater treatment, act as de-facto subsides and lead equally wasteful practice.

iv Both weak enforcement of waste disposal regulations and disposal prices that do not include the social costs of unregulated dumping allow firm to treat waste disposal costs as externalities.

5.4.3. **Financial and Other Constraints Faced by Industries:**

Fiscal polices on credit on credit and exchange rates affect the costs of capital and indirectly the magnitude of industrial pollution. In Nigeria, only is percent of commercial loans mature in ten years or more and 70% have a maturity of six or fewer months.

In addition, although commercial leading rates averaged 32.8% in 1993 through the central Bank of Nigeria keeping the spread at 5% above average funding costs, commercial and merchant Bank branches of this regulation were widespread.

ii Lack of information also plays a critical role in perpetuating uneconomic pollution practices. In the absence of information on pollution prevention or control alternatives, forms are not able to be environmentally responsible for an efficient and cost effective operations.

5.5 Recommendation

To avoid or minimize environmental pollution, textile manufacturing companies must be planned and built with the need to protect the environment enforceable by law that is, before approvals for factory building is given, FEPA should give a no-pollution involved certificate or where there will be pollution, satisfactory effluent management plants are embodied in the approved plan.

Furthermore, these approving Agencies must satisfy themselves that adequate arrangements exists in the plan under consideration for disposal of other industrial wastes.

At Government and industry levels, the following are recommended.

I FEPA should establish guidelines for effluent treatment and disposal of waste as well as responsible or tolerable effluent levels.

2. Government through FEPA should enter into dialogue with industry to determine effluent tolerant levels and possible methods of effluent treatment. The punitive aspects of the decree establishing, FEPA should be de-emphasised.
After this dialogue, existing companies should be given a comfortable time frame within which to comply or face the wrath of the law.

3. FEPA should mount a mass enlightenment campaign to educate the populace on the health hazards inherent in manufacturing. This will go a long way towards creating the awareness necessary to alert those who would suffer from environmental pollution.

4. Textile workers must be compulsorily educated on the dangers and prevention of pollution. The legislation on worker protection at the place of work should be observed and enforced.

5. Indiscriminate dumping of solid industrial and social waste must be checked

5.6 **Conclusion**

The development of an in-house effluent control plant of the type as simple as the one in this work with limited rung but very efficient system with the heart centred on the aspect of sedimentation contact reactor. Clarifier design for both coagulation and settling, the issue of pollution will be reduced and will have a safe sewer resulting from textile effluent pollution. This system has being found to reduce textile effluent to both the FEPA standard as well as the WHO requirement of effluent discharge into the public sewer system. With little addition like an adsorption column the water could be given a higher degree of purity even for recycling. So the aim of a in-house effluent has being achieved, to reduce the amount of solid hazardous waste that could be discharge into the environment.

12. W. Wesley Ekenfelder Jr. Industrial Water Pollution, Control, McGraw -Hill Book Company, Singapore, 1989.

APPENDIX

1. Total suspended solids at 105^0C (TSS)

Formula = mg/l+1 = A -B/C x 106

Where: A =Wt of filter/residue (g)

B= Wt of filter (g)

C = Volume of Sample filter. (Effluent)

2. Total dissolved solids (TDS) mg/l

(A-B)/C x 106

where: A 2= Wt of dried residue/dish (g)

B= Wt of dish (g)

C=Volume of filtrate used.

3. Chloride (C-) mg/l

V1-V2 x 100/Volume of Sample.

Where V1 = Volume of required by sample

V2 = Volume of required by blank.

4. Mg2+ (mg/l)

= (A-B) x C x 2 x3-1/Volume of sample.

Volume of sample used from procedure

A = Volume of EDTA used as titrant

B= ml of EDTA used in titration of blank.

C = ml of standard calcium solution/ml of EDTA titrant.

5. Calcium (Ca2+) mg/l.

= A x B x 400.8/ml of sample

Where A = Volume of EDTA used for Titration.

B = ml of standard calcium solution/ml of EDTA titrant.

6. = A x c x 1000/V

Where: A = Volume of 0.25m EDTA.

V = Volume of sample

C= Concentration of EDTA.