CHEMICAL STUDIES OF EFFLUENTS FROM RUBBER INDUSTRY

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BY

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PONNAMMA.M.M.

iii

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The work reported in this thesis is orginal and is carried out entirely by me. It has not been submitted previously for a degree or a diploma of this or any other University. References are given at appropriate places wherever use has been made of work done by others. The results of the enitre work carried out for this thesis have been discussed with Dr. S.S.Dhaktode and jointly interpreted by us.

(Dr.S.S.Dhaktode)
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(Mrs.Ponnamma.M.M)
Candidate

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Treatment of rubber processing effluent has been studied by different methods of treatment such as aerobic/anaerobic, oxidation ditch, filteration, etc.. It has been interpreted differently by different researchers. But an effective method which can remove all the pollutants to a considerable level was not avilable especially in the case of phosphates and nitrogen from latex concentrate effluent. Different flocculating agents at different pH were studied during the experiments for the removal of phosphates. For nitrogen removal, nonionic poly electrolyte, alumina and poly aluminium chloride were used as floccuating agents and effect of granulated activated carbon were studied. Efficency of uv irradiation in reducing pollutants like oxygen demand, micropollutants, etc. and effect of solar radiation on heavy metals with combinations of different oxidants and vessels were also studied.

The important contribusion of this work to the general advancement of knowledge that it has introduced in the country a new method of treatment for the latex concentrating effluent for reducing the phosphates, nitrogen, micropollutants, and heavy metals.

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The sources from which the information derived are investigations, the results of which are reported in the following journls;

1. "Treatment system for Effluent discharged from latex centrifuging factories" by Kumaran M.G, Ponnamma M.M, and Letty A, Proc. of International Natural Rubber Conference, RRII, Bangalore, 1992, pp. 62.

2. Water treatment hand book, vol.1, 5th edition, 1991, Degremant, France.

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4. Removing nitrogen from wastewater by Adams.E.E, Jnl. Envir. Science and Technol. vol. 7, part 8, 1972, pp.696

5.Destruction of Mixtures of pollutants by uv-catalysed oxidation with hydrogen peroxide by Sundstrom D.W. and Weir B.A. Jnl. of ACS Sym. 1990, Ser. 422, pp. 67.

6. Titanium dioxide and Solar purification of Water, by Mathews R.W , Jnl. of Sunworld, 1985, vol.9, pp. 837.

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When a candidate present a joint work, she shall clearly state the portion which is her own contribution as distinguished from the portion contributed by his collaborators"

The sample collection, different treatments and the analysis of the various parameters studied in the experiment except Total organic carbon and heavy metals were done by candiadte.

The presentation of entire results is by the candidate; and the interpretation is done by the candidate with the help and suggestions from the research guide.

(Dr. S.S. Dhaktode)
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Candidate

CONTENTS

CHAPTER - II: EXPERIMENTAL PROCEDURES

CHAPTER - III: RESULTS AND DISCUSSIONS

PART - I: ANALYSIS OF ROUTINE PARAMETERS.

PART II TREATMENT OF EFFLUENT FROM RUBBER INDUSTRIES

PART - III: REMOVAL OF PHOSPHATES

PART - IV: REMOVAL OF NITROGEN

PART - V TREATMENT OF RUBBER PROCESSING WASTEWATERS WITH ULTRAVIOLET RADIATION AND OXIDISING AGENTS

PART - VI EFFECT OF SOLAR RADIATION

SYNOPSIS

CHEMICAL STUDIES OF EFFLUENTS FROM RUBBER INDUSTRY

There are altogether 46 centrifuging and 15 creaming factories producing concentrated latex from natural rubber latex in the country. Several factories of this type will be in operation in the near future, The effluent discharged from each factory vary from 20,000 to 70,000 litres/day. The usual disposal practice is to discharge them into surface waters. This practice may create significant environmental problems such as oxygen depletion of the rivers which will adversely affect aquatic growth as well as survival of marine life and create agricultural problems. Under the water pollution and prevention control act, each factory is legally bound to set up facilities to treat the effluent before discharge into water course or on land for irrigation.

Field latex normally contains about 30 percent of dry rubber and significant amounts of non latex including proteins, sugurs, lipids, carotenoids, inorganic and organic salts. During processing most of the non - rubber constituents will go into the effluent and the wastewater discharged from the latex concentrating factories gets highly polluted(1).

Several researchers had studied the efficiency of different methods of treatment for rubber effluents. Ponniah et al. (2) studied the oxidation ditch system, Moles Worth (3) studied the efficiency of Trickling filteration, Ibrahim et al. (4) reported the anaerobic / facultative ponding system and Kumaran et al.(5) described the flocculation followed by oxidation. The efficiency of ferric chloride in reducing phosphate from the sewage effluents was discussed by Thomas et al. (6). Sunstrom et al. (7 , 8) reported the destruction of pollutants by UV light catalysed oxidation with hydrogen peroxide and this was confirmed by Schonherr et al. (9) in his recent work on wet oxidation - catalysis by UV irradiation. Matthews (10) dicussed the effect of photocatalytic oxidation with titanium dioxide on treating water and Acher et al.(11) conducted pilot plant studies on photochemical disinfection of effluents.

The aim of the present investigation is to study the effect of various type of flocculating agents under different conditions and reduction of pollutants by UV and Solar catalytic treatments. The wastewater collected from Latex Centrifuging Factories were treated with various flocculants and their effect on various parameters was studied. Particular attention was given to the reduction of Phosphate and Nitrogen from effluents. Effect of UV radiation and Solar radiation with different oxidants was also studied for the reduction of micro pollutants and heavy metals respectively.

First chapter incorporates a general introduction to water pollution, Rubber and its processing and the impact of associated pollutants on environment.

Second chapter includes the general discussion and experimental proceedures followed for sample collection and determination of various parameters such as pH, Chemical oxygen demand(COD), Biochemical oxygen demand(BOD), Total dissolved solids (TDS), Suspended solids (SS), Phosphates, Nitrogens, Heavy metals, Total organic carbon(TOC), Cationic surfactant etc..

Third chapter incorporates the results obtained and discussion of the results. This chapter is divided into six parts. The results pertaining to the parameters like pH, Chemical Oxygen Demand (COD), Biochemical Oxygen Demand (BOD), Total Solids (TS), Total Dissolved Solids (TDS), Suspended Solids (SS), Sulphides, Phosphates, Total Kjeldahl Nitrogen (TKN), Ammoniacal Nitrogen (AN), Free Ammonia (FA), Nitrate Nitrogen (NN), Total Organic Carbon (TOC) , Methylene Blue Active Substances (MBAS), Heavy Metals etc. of the raw effluent are discussed in the FIRST part. Flocculation treatment with different flocculating agents is discussed in SECOND part. The different flocculating agents used in the study are Lime, Ferric Alum, Aluminium Alum, Pickle liquor etc. The treatments with ferric alum and pickle liquor are found to be effective in reducing the pH, Chemical oxygen demand (COD), Total dissolved solids (TDS), and Sulphides to the tolerance limit specified by Bureau of Indian Standards (BIS). THIRD part consists of various methods of treatment employed for the reduction of phosphate. Excellant reduction in the phosphate content was observed with all the flocculants used. Quantity of lime corresponding to pH between 9 to 12 practically removes complete phosphates. Nitrogen removal efficiency of Granulated Activated Carbon (GAC) and Poly electrolytes are studied and is included in part FOUR. The optimum concentration of Poly Aluminium Chloride (PAC) for the reduction of nitrogen was found to be 5 ppm. It was observed that for a fix amount of PAC nitrogen removal increases with increasing pH. The optimum nitrogen removal was observed with 0.500 gm/l of alumina at pH 10. With Non Ionic Poly Electrolyte (NIPE) the optimum removal of nitrogen was observed with 100 mg/l of NIPE at pH 10. Effect of UV irradiation with oxidants on the removal of pollutants are described in part FIVE. The treatment with Potassium permanganate (PPM) is effective in removing Chemical oxygen demand (COD) and raising pH to a considerable level than others. In the case of Total organic carbon (TOC), Methylene blue active substances (MBAS) and nitrates, the treatment with Titanium dioxide (TDO) is more effective than other treatments. The effect of Solar radiation in conjunction with different oxidants and vessels, is discussed in part SIX. On solar radiation with different oxidants, it was observed that the aluminium vessel with Titanium dioxide was giving the optimum reduction for Chromium and Copper, whereas the optimum reduction for Iron was found with copper and brass vessels in the presence of Titanium dioxide (TDO) and potassium dichromate (PDC).

The last chapter deals with the summary of results, discussions and conclusions drawn.

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CHAPTER - I

GENERAL INTRODUCTION

1.1 INTRODUCTION: GENERAL

Environmental awareness became pronounced in 1970 (1) leading to debates, discussions, National and International conferences, symposia, intiating rigorous research in diversified scientific disciplines, such as water and air pollution, water and wastewater treatment. The major blame for environmental degradation was ascribed to technological evolution which lead to industrial development.

1.2 INTRODUCTION: ENVIRONMENTAL

Rapid growth in industrialization all over the world also results in the environmental pollution threatening the quality of life . In view of this situation the industrial waste management, including waste treatment technology, assumed significance in controlling the quality of environment.

Environmental pollution can be broadly classified into various groups viz. air pollution, water pollution, pollution due to industrial effluents, pollution due to solid and liquid waste, soil pollution, noise pollution, pollution due to disposal of radioactive waste etc.

1.2.1 WATER POLLUTION

The water pollution is caused by the indiscriminate disposal of water after industrial consumption or domestic use. The tragedy at Minnamata in Japan, which triggered most environmental research was due to the careless disposal of mercury. Many industries discharge wastewater without treatment into the streams which in turn causes serious water pollution and health hazards.

Heavy metals like Mercury, Arsenic, Cadmium, Lead, Chromium, Nickel, Zinc etc. create serious problems in various parts of the world (2). Minnamata tragedy focussed attention to such dangers in advanced countries and the holocast at Bhopal (India) occured in 1984 highlighted such problems in developing nations.

The water pollution is harmful (3) for many reasons including:

1. The contamination of water sources resulting in potential disease hazards and increased demand on water treatment.
2. Adverse effects of water pollution on fish and other aquatic life.
3. Health hazards due to irrigation with polluted water.
4. Restriction on amenity and recreational uses.
5. Creation of odour nuisences
6. Hindrance for navigation by sludge deposits.
7. The presence of nitrate in drinking water has been associated with methemoglobinemia in infants (4).

1.3 SOME EFFLUENT PARAMTERS

The quality and composition of the effluent is highly inconsistant.It will vary from industry to industry , within the industrial limits and hour to hour in a single industrial unit itself. The following are the some of the critical parameters of the wastewater causing severe environmental problems.

1.3.1 pH

An acid or alkaline effluent needs to be neutralised before discharge to authoritative biological treatment or to the fresh water or, for the matter prior to any biological treatment. On the other hand neutralisation should not be necessary for a well dispersed sea discharge (5-6).

A small change in pH corresponds to a large change in hydrogen ion activity and it is perhaps surprising that the tolerance often shown by living system in aquatic environments to change in pH is between 6.5 and 8.5. Nevertheless it is generally true that it is the pH rather than titrable acidity or alkalinity, that is important in aquatic systems and consequently the process of pH adjustmeht constitutes one of the key operations in pollution control(7).

Highly acidic waters may induce adverse effects on plant growth and may also affect corrosion of river structures. High basicity also affects the aquatic life.

1.3.2 OXYGEN DEMAND

This is a key parameter for the effect of an effluent on the receiving water and it is most usually and effectively dealt with by some of biological treatment. The high Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) indicate that the total solids in the effluents are mainly of organic origin with high oxygen requirement for their oxidation. The wastewater having high biological oxygen demand when discharged into inland waters, use up the dissolved oxygen readily and induce a series of chain reactions involving both biotic and abiotic components of the community. As the organic matter decomposes, ammonia and phosphates are released and ammonia is finally oxidised into nitrate. Concurrently, the macro and micro-organisms exhibit substitution of one by a succession of others. Thus a simple discharge causes a complex chain reaction in the ecosystem resulting in anaccelerated rate of eutrophication of the receiving waters.

Eutrophication is a slow and natural process of enrichment of poor improductive oligotrophic waters and by itself is beneficial to biotic community. But the discharge of large quantity of organic wastes to an aquatic system, results in the sudden and complete deoxygenation causing mass mortality of fish and fauna(8).

1.3.3 TOTAL SOLIDS CONTENTS

The effluent samples contain a huge quantity of solid contents in the dissolved, suspended and settelable forms. Solids in the dissolved form increase oxygen demand. While discharging the wastewater having high total solid contents, it may affect the depth of the stream and results unncecessary floods, and soil errosion.

Wastewater having suspended particles or solids may consist of inorganic or organic particles of immiscible liquids. Inorganic solids contain clay, silt and other soil constituents. Organic materials may be plant fibers and biological solids Alagal cells, bacteria etc are also common constituents (9). The solids contain heavy metals also.

1.3.4. NUTRIENTS

Nutrients such as nitrogen and phosphate present a special problem. These nutrients help the growth of flora and fauna in the receiving water but this can include excessive algal growth. The decaying algae then provide oxygen demand load for the water and deplete its oxygen level.

1.3.5. AMMONIA

Ammonia causes a special problem. Free ammonia is toxic to fish at levels below 0.5 mg/l. Because the molecular ammonia (NH3), the form responsible for toxic effects, predominates high pH. Ammonia toxicity is most severe where conditions, such as discharge of alkaline wastewaters on rapid photosynthesis leading to depletion of biocarbonates results in pH elevation.

Nitrification, the oxidation of ammonia to nitrate, in the receiving water can excert a significant oxygen demand.

Ammonia in water used for water supply increases the chlorine dosage required to achieve a free chlorine residual in disinfection.

It reacts with chlorine to form a series of chloramines. To achieve chlorination beyound break point requires about 7-10 mg/l of chlorine for each mg/l of Nitrogen present (10).

1.3.6. TRACE ELEMENTS

Several trace elements are found in polluted water. These are classified as noncritical and toxic, most of which are insoluble in water. The noncritical group contains elements which include alkali and alkaline earths while the toxic group includes seventeen elements. Of these most critical ones are Berylium, Thalium, Osmium, Platinum, Selenium, Tellurium, Cobalt, Nickel, Manganese, Cadmium, Mercury and metaloids such as Arsenic, Selenium, Antimony, Copper, lead, Chromium, Zinc etc. Various authors (11-27) explained in excellent monographs about the environmental chemistry of these trace metals.

The heavy metals have a great affinity for sulphur and attack sulphur bonds in enzymes immobilizing the latter. Other vulnerable sites are protein carboxylic acid (- COOH) and amino (- NH_2) groups. Heavy metals bind to cell membrane, affect the transport process through the cell wall.

They also tend to precipitate phosphates from biocompounds or catalyse their decomposition. Many of the these trace metals are carcinogenic. Cadmium provides biochemicial replacement of zinc causing high blood pressure, kidney damage, distruction of testicular tissues and red blood cells. Toxicity of lead may cause diseases like anameia, kidney and nervous disorders.

Many metals are toxic to aquatic flora and fauna in relatively low concentrations. They can also accumulate through the food chain to affect man who eats fish or shell fish. The effect of some heavy metals on fresh water fish and prawns were studied (28,29). The effect of Mercury on fish and crab was recorded by Mahajan (30). Toxic effects of zinc and mercury on chronomial larvae and spirutina plantensis from tropical waters were reported (31,32). The effects of mercury pollution on fresh water murrel channa punetatus (33) prawn (34), nussel lamellidens margenalis (35) were studied. Toxicity of copper, zinc and iron to fish plankton and worm (36) and the adverse effects of zinc exposure to ovarion developments of freshwater crab were discovered (37). The phenomenon of accumulation of zinc in the grills of fish (38) and growth and reproduction was hampered by the high concentration of zinc (39) brought attention to the effect of zinc on fresh water fish. Toxicity of cadmium and lead to fish and snail (40), Mercury poisoning on aquatic and human life (41) and the effect of selenium on soil, plants and animals (42) were reviewed.

1.4 NECESSITY OF TREATMENT

The treatment of liquid industrial wastes is a well established practice in developed countries. In India also similar methods are being applied increasingly as the rules and regulations regarding pollution abatement are being enforced. More emphasis is laid on highly polluting industries like tanneries, paper mills, slaughter houses, dairy industries, textiles, petro chemicals, rubber industries and chemical industries.

For the treatment of effluents from industries processing naturally occuring materials, biochemical oxidation seems to be the effective remedy (43-45). But the effluents from chemical industries contain bioresistant organic materials, heavy metals and other inorganics which are not amenable easily to the treatment methodology of primary treatment followed by secondary oxidation. Specific physico-chemical methods like adsorption, absorption, ion-exchange, solvent extraction, chemical precipitation (46,47) are needed to tackle them.

1.5 RUBBER: GENERAL INTRODUCTION

Natural rubber is a Cis- poly isoprene.

The most important commercial source of Natural rubber is Hevea brasiliensis.

Rubber cultivation in India at present is mainly conifned to a narrow belt extending from Kanyakumari district, the South west region of Tamilnadu in the South, to the Coorg district of the Karnataka State in the north lying in general west of the western ghats and parallel to them for approximately 400 km. The soil of this rubber tract are highly weathered and consists mostly of laterile and laterristic type. Red and alluvial soils are also seen in some areas.

The laterite and lateritic soils are generally found to be very porous, well drained moderately to highly acidic, deficient in available phosphrous and variable with regard to avaialble pottassium and Magnesium . The red soils found in some areas are characterised by this reddish to brown colour and finely loamy texture, are also generally acidic and highly deficient in available phosphrous.

1.5.1 TOPOGRAPHIC AND CLIMATIC CONDITIONS FOR RUBBER

The climatic conditions prevailing in the rubber tract vary from region to region and from year to year particularly in the case of annual rainfall. In fact, the avrage annual rainfall in the tract varies from about 2000 to 4500 mm and the distribution of the rainfall is more uneven. However variation in temperature and humidity in the rubber tract is not so marked as in case of rainfall. The temperature remains to be very warm, and the atmospheric humidity quite high throughout the year in all the regions in the rubber tract. The land in the rubber tract consists mostly of hills and slopes. The desireable conditions for natural rubber cultivation are:-

1. Evenly distributed rain fall of 200mm per annum.
2. Warm humid equable climate of temprature between 21 deg.C and 35 deg. C.
3. Continuous sunshine for 200 hours per annum.
4. Altitude of 200 to 250 meters.
5. Soils provided are deep and well drained.

Thus the climatic conditions and topographic features of the rubber growing belt are conducive for the rapid degradation of the soils through erosion, leaking and progressive depletion of humus due to high microbiological activity.

1.5.2. PROCESSING OF THE CROP

The main crop from the rubber tree is the latex, which is a milky white dispersion of rubber in water, and harvested by the process of tapping. The latex flowing out from the trees on tapping is channeled into a container attached to them. In Indian estates coconut shells and polythene cups are popularly used as container. Latex collected in the cups is transferred to clean buckets, two to three hours after tapping. Around eighty percent of the crop from plantaions is in the form of latex.

The latex which gets dried upon the tapping panel and the collection caps, called tree lace and shell scrap respectively, also form a part of the crop. The latex split and or overflow on the ground, the earth scrap when gets dried up, is also collected as scrap. Normally 15 to 25 percent of the total crop constitute tree lace, shell scrap and earth scrap which together are called field coagulum.

The different kinds of crop harvested from rubber plantations are highly susceptible to bacterial action due to contamination on keeping. Therefore it is essential to process them into forms that will allow to safe storage and marketing.

1.5.3 MARKETABLE FORMS OF NATURAL RUBBER

The important forms of Natural rubber are:-

1. Preserved latex and latex concentrate
2. Ribbed sheet rubber
3. Crepe rubber
4. Technically specified block rubber

The crop collected in the form of latex can be processed into any of the above forms. But the crop collected as field coagulum can be processed only into crepe or block rubber.

1.5.4 PROCESSING INTO PRESERVED LATEX AND LATEX CONCENTRATE

1.5.4.1. LATEX

It is a white or slightly yellowish opaque liquid with a specific gravity between 0.974 and 0.986. It is a weak lyophillic colloidal system of spherical or pear-shaped rubber globules suspended in an aqueous serum. The rubber globule is surrounded by a protective layer of proteins and phospholipids, which impart the hyrophyllic colloidal nature to latex and the stability of latex is due to the negative charge present on the protective layer.

1.5.4.2. RUBBER MOLECULE.

A typical composition for the rubber phase of Hevea latex (48) is :

Rubber Hydrocarbon - 86 %
Water (dispersed in the rubber hydrocarbon - 10 %
Proteinous substances - 1 %
Lipid substances - 3%

The diagrammatic representation of probable structure of natural rubber latex particle is depicted in Fig 1.1.

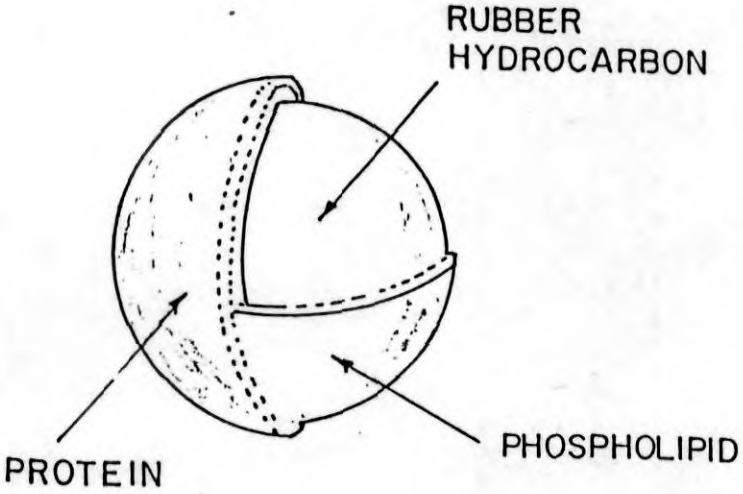


FIG. 1.1 : DIAGRAMMATIC REPRESENTATION OF PROBABLE STRUCTURE OF NATURAL RUBBER LATEX PARTICLE.

1.5.5 COMPOSITION OF LATEX

Latex contains a variety of non rubber constituents, both organc and inorganic, in addition to rubber. The porportion of these constituents may vary, with clones, nutrition, climate etc. But in general, the latex has the following constitutents.

Constituent	Concentration range(% by wt)
1. Rubber	30 - 40
2. Protein	2.0 - 2.5
3. Ash	0.7 - 0.9
4. Resin	1.0 - 2.0
5. Sugar	1.0 - 1.5
6. Water	55 - 60

Fresh latex as it comes out of the tree is slightly alkaline or neutral. It becomes acidic rapidly due to bacterial action. The formation of organic acids neutralises the negative charge on rubber particles and the latex gradually gets coagulated on keeping. Therefore, fresh latex cannot be kept for long time without precoagulation.

1.5.6 ANTICOAGULANTS

An anticoagulant is a chemical added to latex before it is processed, inorder to prevent precoagulation. Generally fllowing anticoagulants are used:

1. Ammonia
2. Sodium sulphite and
3. Formalin

Of these, ammonia is widely used when the latex is to be processed as preserved latex or latex concentrates. For sheet rubber processing, anticoagulants are used only if essential and sodium sulphite is prefered in this case.

1.5.7. PRESERVATIVE.

A preservative is a chemical or mixture of chemicals which, when added to latex, can prevent bacterial action in it and at the same time stabilises it. Ammonia is the most popular latex preservative.But a variety of other substances also could be used with advantage along with low level of ammonia for effective preservation. For manufacture of certain latex products, low ammonia lalices are prefered. The various preservatives used are:-

1. Ammonia
2. Sodium pentachlorophenate and ammonia
3. Zinc diethyl dithio carbamate and ammonia
4. Sodium pentachlorophenate, ethylene diammine tetra acetic acid and ammonia
5. Boric acid, lauric acid and ammonia
6. Tetramethyl thiuram disulphide (TMTD) Zinc oxide, Lauric acid and ammonia

Field latex preserved with suitable preservative is known as preserved field latex.

1.5.8 LATEX CONCENTRATE

Generally there are two forms of preserved latex concentrates:-

1. Latex having dry rubber content of 36-50%
2. Latex having dry rubber content of 51-60%

The preserved latex concentrate is an important raw material having wide uses. The major methods of processing latex into preserved latex concentrates are commercially in practice and following are the common methods.

1.5.9 LATEX CONCENTRATION BY CREAMING:-

Flow chart (F.C) - No. 1.1 shows the processing of creaming, mixing the properly preserved latex with creaming agents such as ammonium alginate or tamrind seed powder and allowing the latex to seperate into two layers, and an upper layer of concentrated latex and a lower layer of serum containing very little rubber.

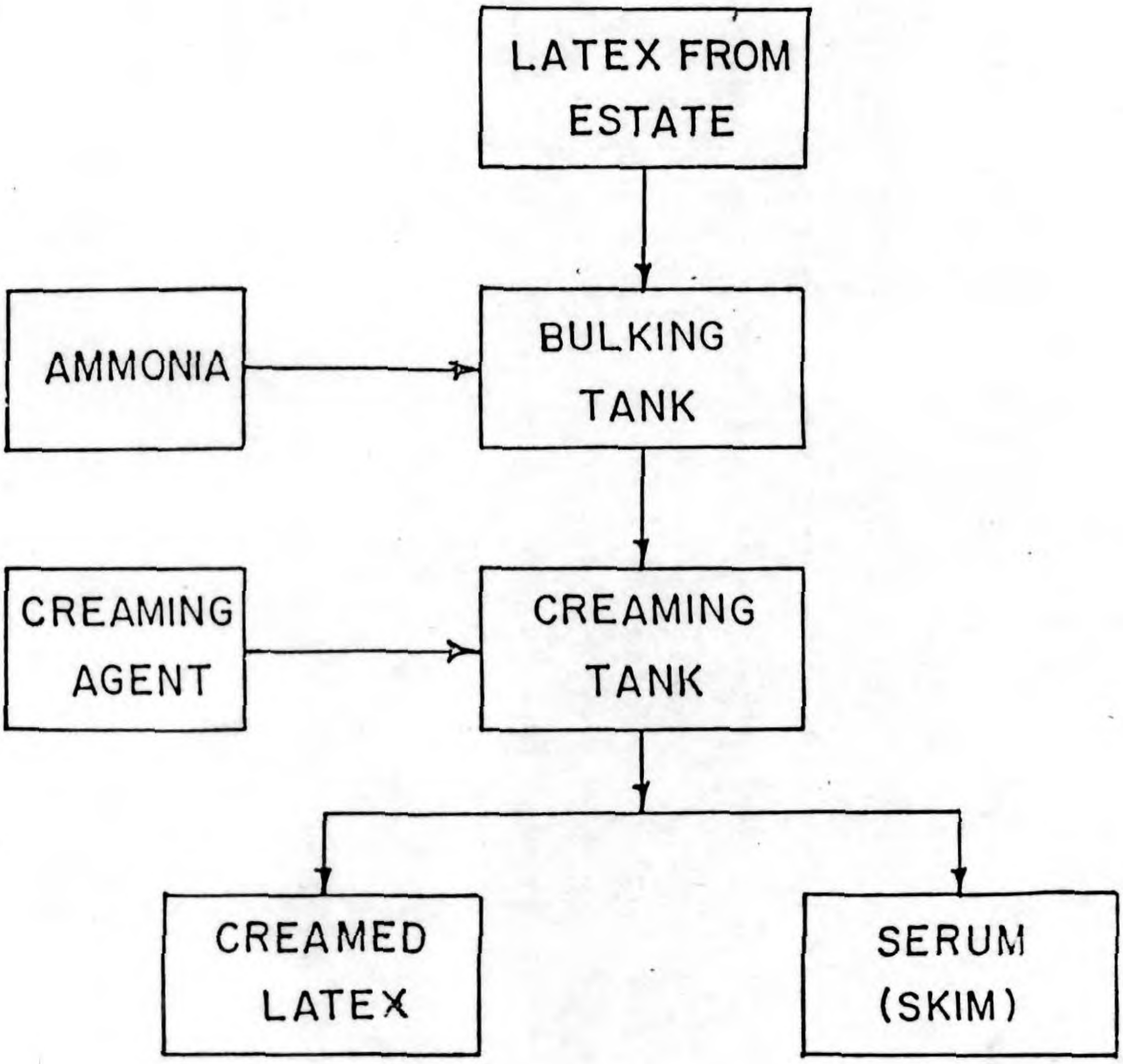
The lower layer of serum, generally known as skim, is removed leaving the latex concentrate which is used for manufacturing various products.

1.5.10 LATEX CONCENTRATION BY CENTRIFUGING

The processing of latex into latex concentrates by centrifugation involves the seperation of preserved field latex into two fractions as in the FC - 1.2, the one containing concentrated latex of 50 to 60 percent dry rubber and the other containing 5 to 10 percent dry rubber by a suitable centrifuge machine.

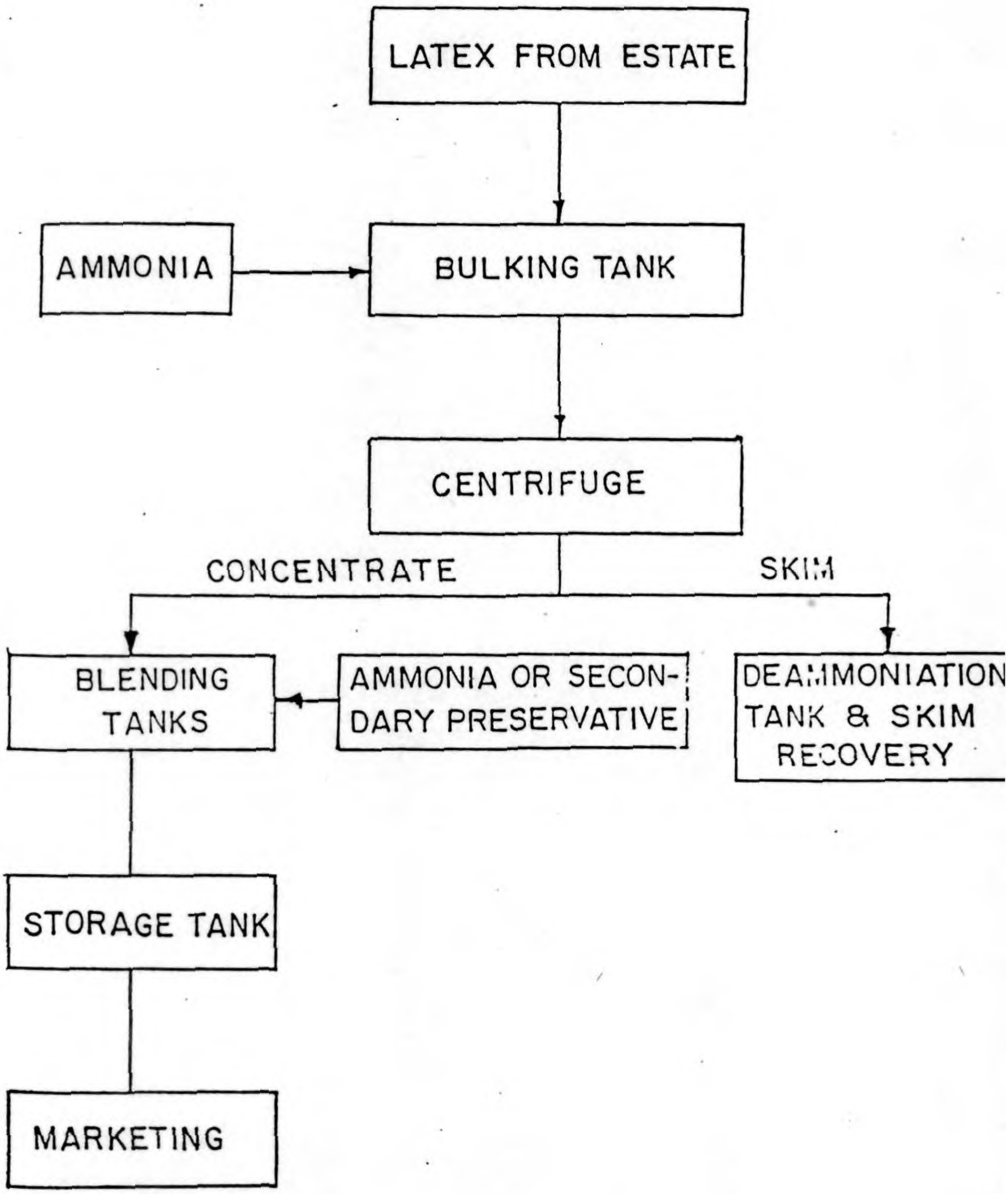
In practice , the rotating bowl of the centrifuging machine is fed continuously with latex which leads to the continous collection of latex, that can be drawn out through an outlet at the centre and serum fraction, (known as skim latex) near the circumference through another outlet. The centrifuging factory consumes a huge quantity of water for processing and cleaning of the vesseles. The water after such use is discharged as effluent. Thus waste water treatment plant is essential for centrifuging factories.

PROCESSING OF LATEX CONCENTRATE BY CREAMING



FLOW CHART No. 1.1

PROCESSING OF LATEX CONCENTRATE BY CENTRIFUGING.



FLOW CHART No. 1.2

1.5.11 RIBBED SHEET RUBBERS

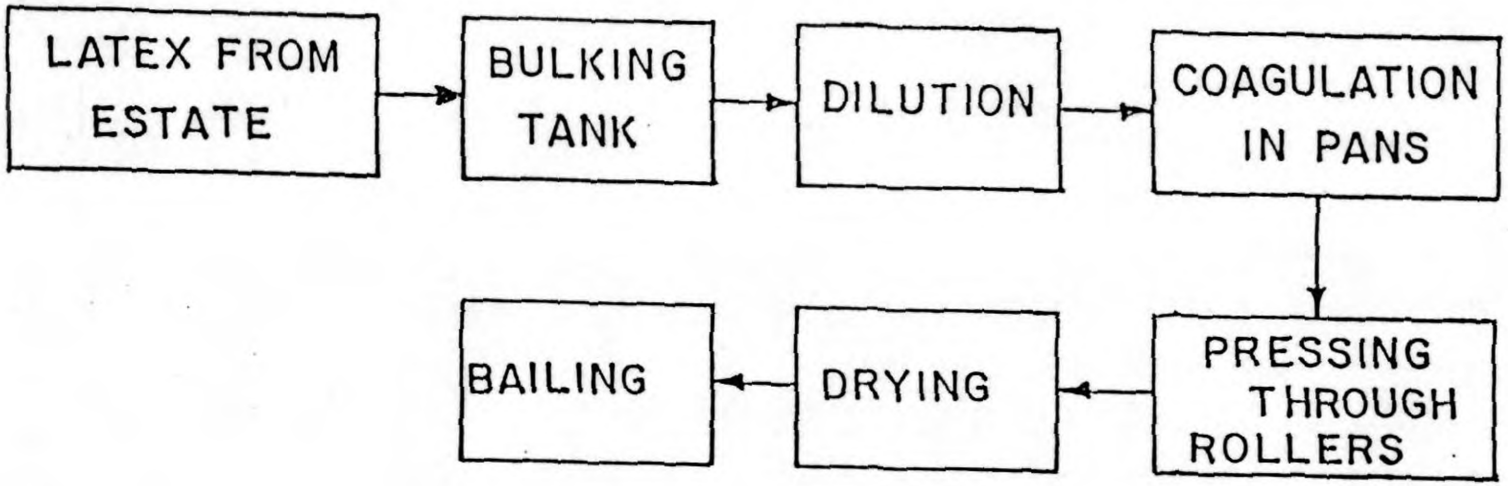
Latex is used for the preperation of ribbed sheet rubber. As shown in the FC - 1.3. The latex collected from the plantations is brought to the factory stained through 40 and 60 mesh seives, and diluted with water. The diluted latex is poured into coagulation pans and required quantity of acid is added for coagulation. After mixing it thoroughly, the whole contents are kept aside without disturbance. After few hours the coagulum is removed from the pans and thoroughly washed with running water. They are sheeted either in a sheeting battery or smooth rollers to a thickness of 3mm and finally passed through the graved rollers. It is then washed again in running water and dried in smoke houses or air.

At present about 70% of natural rubber produced in India, is in the form of sheet rubber. It is the oldest and simplest method of processing latex into a marketable form.

1.5.12 CREPE RUBBERS

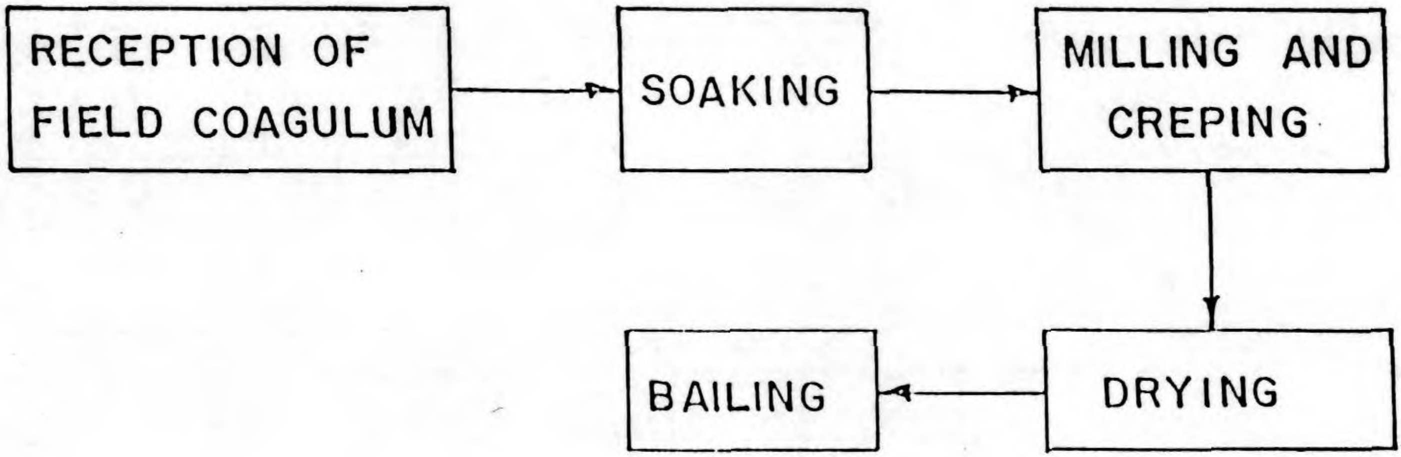
The coagulated latex, or any other form of field coagulation such as tree lace, shell scrap and earth scrap when passed several times through a minimum of 3 mills with heavy rolls crinkly lace-like rubber will be obtained, which when dried is known as the crepe rubber. The processing is explained in the FC - 1.4.

PROCESSING OF RIBBED SHEETS



FLOW CHART No.1.3

PROCESSING OF CREPE RUBBER



FLOW CHART No.1.4

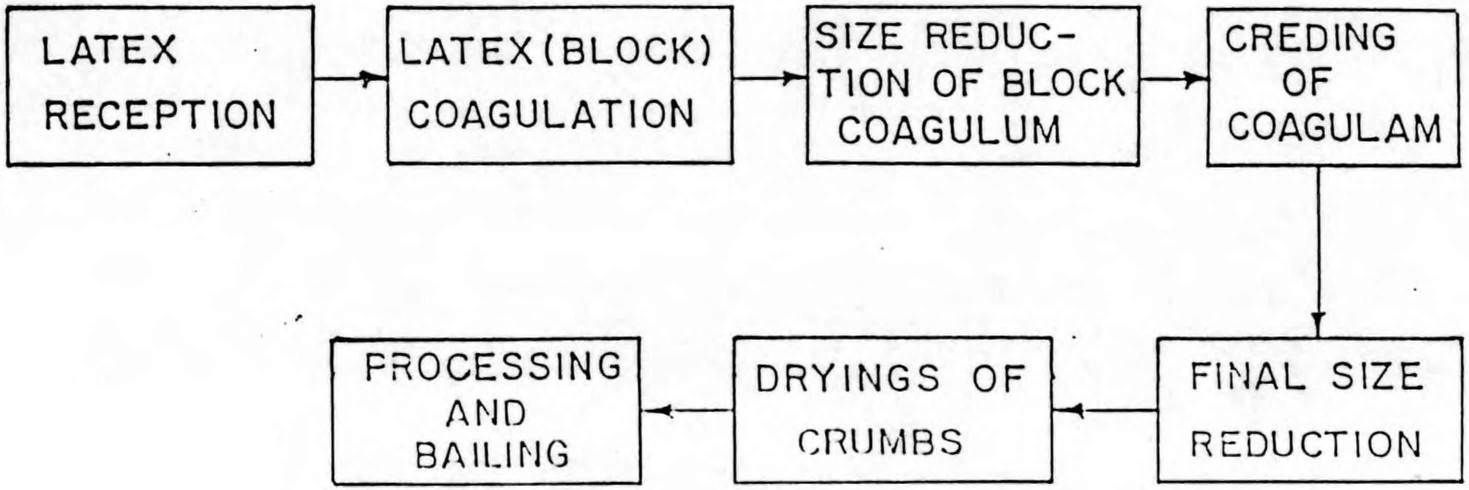
There are different types of crepe rubber depending upon the type of the starting materials from which they are manufactured.

Type of crepe	Starting material
1. Pre-coagulated crepe	Fresh field latex
2. Sole crepe	Pre-coagulated thin crepe
3. Pale latex crepe	Fresh coagulum produced from natural rubber latex
4. Estate brown crepe	Cup lumps and other higher grades of field coagulum
5. Remitted crepe	Wet slab coagulum,unsmoked sheets and cup lumps
6. Smoked blanket crepe	Ribbed smoked sheets and its cuttings
7. Flat bark crepe	All type of low grade scrap including earth scrap.

1.5.13 TECHNICALLY SPECIFIED RUBBER (TSR)

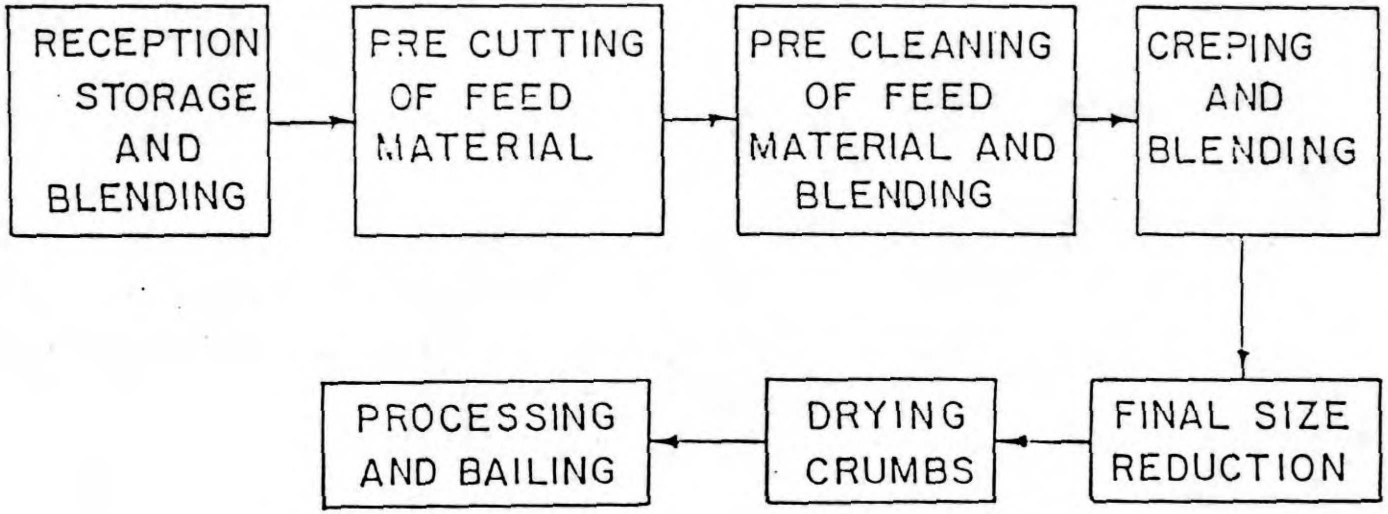
Technically specified rubbers are largly block types made by adopting new methods of processing as described in the FC - 1.5 (a) & (b). The TSR can be prepared from the coagulation from latex and other forms of scrap rubber and these raw materials involve practically the same unit operation as follows:-

TECHNICALLY PROCESSED RUBBER PROCESSING



FLOW CHART No. 1.5 (a) LATEX RUBBER

TECHNICALLY PROCESSED RUBBER PROCESSING



FLOW CHART No. 1.5 (b) FIELD COAGULUM MATERIAL

1. Size reduction
2. De-watering
3. Dirt removal
4. Drying
5. Bailing and
6. Grading

In the processing, the first three operations viz. size reduction, de-watering and dirt removal are accomplished together. A variety of machines which can disintegrate the coagulum or scrap into granules, pellets or crumbs and at the same time able to remove dirt and water to considerable extent can be used for this purpose. A suitable combination of the following machinery is used for each of the different new process at present.

1. Coagulum cutters
2. Slitting knives
3. Granulators
4. Hammer mills
5. Pelletisers
6. Expellers
7. Shredders
8. Chopper and
9. Crumlers

The crumbs, pellets and granules produced in all the new processes for the manufacture of block rubber are dried at a temperature of about 100 deg.C

The dried material is pressed in a hydrolic press, when they are warm. In India usually 25 kg bales are prepared.

Samples were taken from a few representative bales of block rubber produced and which were tested for various parameters according to B.I.S 5440 and graded according to the analysis report to various grades of Indian standard Natural Rubber (ISNR grades)

1.5.14. SPECIAL RUBBERS

There are some special purpose rubbers which are produced using the new processing methods. Some of the special rubbers are:-

1. Constant viscosity and low viscosity rubbers
2. Oil extended natural rubber
3. Tyre rubber
4. General purpose rubber
5. Reclimed rubber

1.6 POLLUTION DUE TO NATURAL RUBBER PROCESSING

During the processing of the natural rubber an enormous quantity of water is required for washing, cleaning and dilutions.

In India, there are 46 centrifuging factories and 15 creaming factories producing Latex concentrates and 31 crumb rubber factories and 101 crepe mills producing dry rubber and all have licence for processing the natural rubber. Each of these factories discharge about 20,000 to 70,000 liters of effluent per day according to the type of the product and capacity.

Field latex normally contains about 30 percent of dry rubber and significant amounts of non latex including proteins, sugars, lipids, carotenoids, inorganic and organic salts. During processing most of the non-rubber constitutent will go to the effluent (49). The survey (50) on the nature of effluent discharge from various types of processing factories showed that the quality and composition of the effluent depends on the type of process employed.

The usual disposal practice is to discharge them into surface waters. This practice may create significant environmental problems such as oxygen depletion of the rivers which will adversely affect aquatic growth as well as survival of marine life and create agricultural problems.

1.6.1 PROPERTIES OF RUBBER EFFLUENT

Physical and chemical properties of the rubber effluent vary with the methods of processing to produce Latex concentrate, Technically specified rubber, Crepe rubber, Ribbed sheet rubber etc.

1.6.2. EFFLUENT FROM LATEX CONCENTRATING FACTORIES

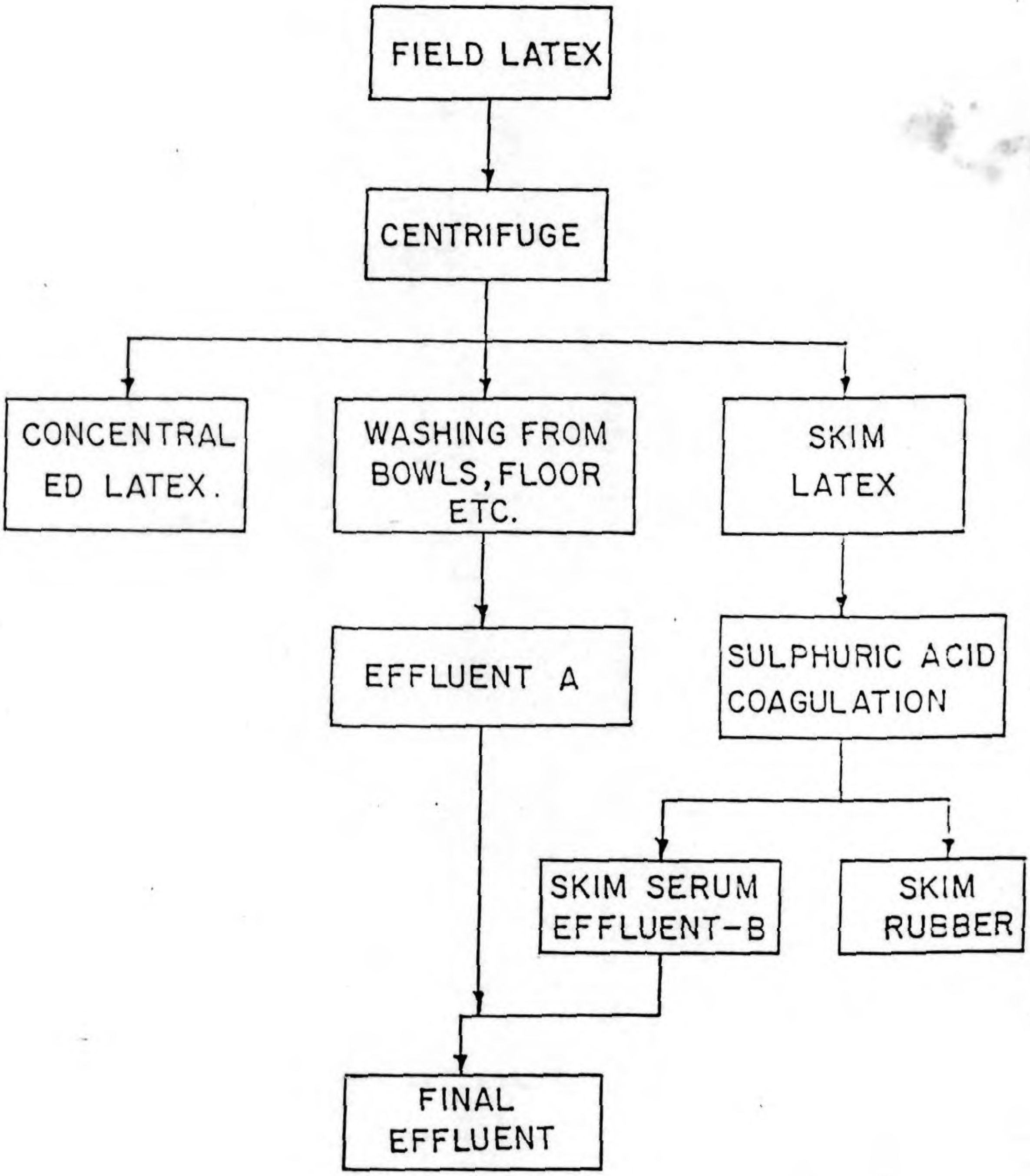
In latex concentrate processing the main source of effluent is from the coagulation of skim latex. Generally the skim serum will contain a very huge amount of pollutants Table - 1.1. The FC - 1.6 shows the source of effluent from the latex centrifuging factrories.

TABLE - 1.1

PROPERTIES OF SKIM SERUM

PARAMETERS	VALUES
pH	4.77
CHEMICAL OXYGEN DEMAND	32 690
BIOCHEMICAL OXYGEN DEMAND	13 670
TOTAL SOLIDS	42 550
TOTAL DISSOLVED SOLIDS	36 680
TOTAL SUSPENDED SOLIDS	2 850
PHOSPHATES AS P	61
SULPHIDES AS S	8
TOTAL KJELDAHL NITROGEN	4 620
AMMONIACAL NITROGEN	3 430
POTASSIUM	620
MAGNESIUM	60
CALCIUM	6
MANGANESE	0.6
IRON	2
COPPER	4
ALUMINIUM	1.6
SODIUM	0.6
SILICA	8
ALBAMINOID NITROGEN	755
NITRATE NITROGEN	3
TOTAL SUGARS	500
REDUCING SUGARS	410

LATEX CONCENTRATE PROCESSING SHOWING DIFFERENT SOURCES OF WASTE WATER



FLOW CHART NO. 1.6

A survey (49) on the chemical and physical properties discharged from rubber/latex factories showed that effluent from latex concentrating factories was the most polluted. High ammoniation of field latex and subsequent auto or acid coagulation of skim latex occuring during the processing of latex concentrate contributes towards the highly polluted effluent. The coagulation of skin latex produces a serum that contains a much higher concentration of protiens, sugars,lipids and inorganic and organic salts compared to the serum obtained by the acid coagulation of field latex in technically specified block rubber production (50-51).

Latex concentrating effluent contains high levels of ammoniacal Nitrogen and Sulphate (51, 52). The ammoniacal nitrogen results from ammonia used in preserving the latex, while sulphate originates mainly from the sulphuric acid used for skim latex coagulation. Their presence gives rise to a number of problems with regard to the effective and acceptable biological treatment (53 , 54).

High amounts of biochemically unstable organic matter and ammoniacal nitrogen cause harm to flora and fauna and render it aesthetically unpleasent (55). It is also argued that a high ammoniacal nitrogen content in drainage water for paddy fields can lead to loading of the paddy plants.

Generally the effluents from the latex concentrating factories are acidic in nature, due to the presence of sulphuric acid used for the coagulation of the skim.

The acidity is measured as pH. A small change in pH corresponds to a large change in hydrogen ion activity and it is perhaps surprising that the tolerance often shown by living systems in aquatic environments to changes in pH between approximately 6.5 and 8.5 corresponding to a change of two order of magnitude of hydrogen ion activity, is so great. It is the pH rather than the titratable acidity or basicity that is of important in aquatic systems (56) and consequently the processes of pH adjustment constitutes one of the key operations in pollution control measures.

Another feature of the effluent from latex concentrating factories is the high total solids content, mainly in dissolved form, along with suspended and settleable forms.

These effluents have high biochemical oxygen demand (BOD) and chemical oxygen demand (COD). Various microorganisms including harmful ones get proliferated using these substances and cause high BOD. The presence of organic matters causes high COD. Both high BOD and COD together cause highly objectionable odour. High oxygen demand also affects the aquatic life.

The latex concentrate effluents contain considerable quantities of heavy metals such as Copper, Iron, Magnesium, Manganese, Zinc, and neutrients like Phosphrous, Pottassium as shown in Table - 1.1.

1.6.3 EFFLUENT FROM TECHNICALLY SPECIFIED RUBBER FACTORIES

The effluent coming out from a technically specified rubber processing factory as explained by the FC - 1.7(a) and (b) is not so polluted as the effluent from an ordinary latex concentrating factory.

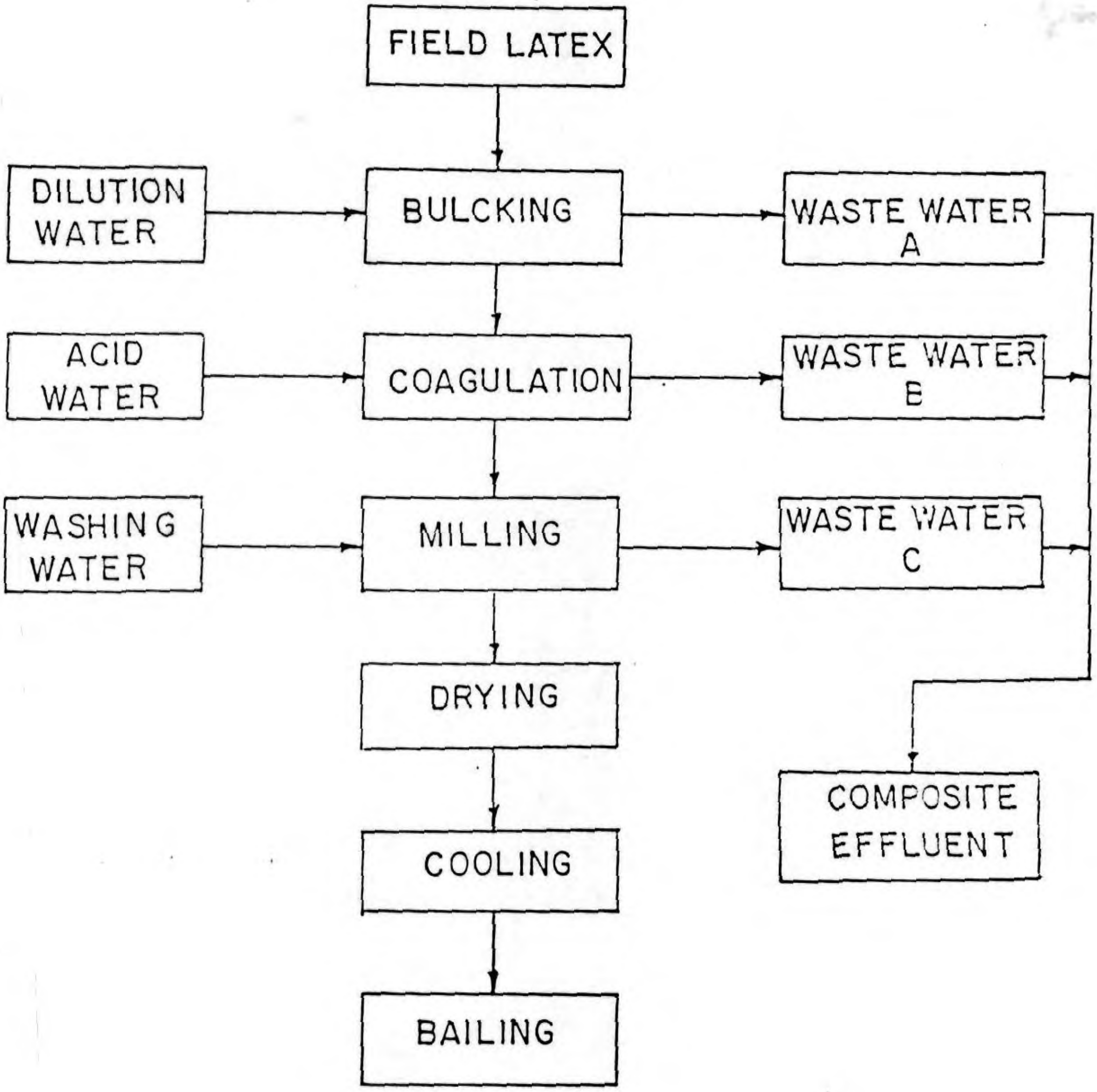
The pH of the effluent is around 6. The acidic nature of the effluent is attributed to the use of formic acid, phosphoric acid or sulphuric acids to aid coagulation in the processing line (57).

Effluents from TSR factories contain fairly large amounts of total solids, suspended, dissolved and settlable solids. The major portion of the total solids content is in the form of dissolved solids.

The BOD value is on the whole high ranging from 1000 mg/l to about 1600 mg/l indicating that the total solids in the effluent are mainly of organic origin with high oxygen requirements for their degradation into non-polluting products. When discharged into river, these solids absorb oxygen, depleting the water of necessary dissolved oxygen content to support marine life or restrict the survival of pathogenic bacteria.

Total nitrogen is a measure of ammoniacal nitrogen combined with organic nitrogen. The main contribution of total nitrogen in ammonical nitrogen is arised from the use of substantial quantities of ammonia for the preservation of latex. Effluents from factories located outside estates generally have ammoniacal nitrogen content that exceed 100 mg/l.

TSR PROCESSING - SOURCES OF EFFLUENT FROM LATEX GRADE RUBBER



FLOW CHART NO.1.7(a)

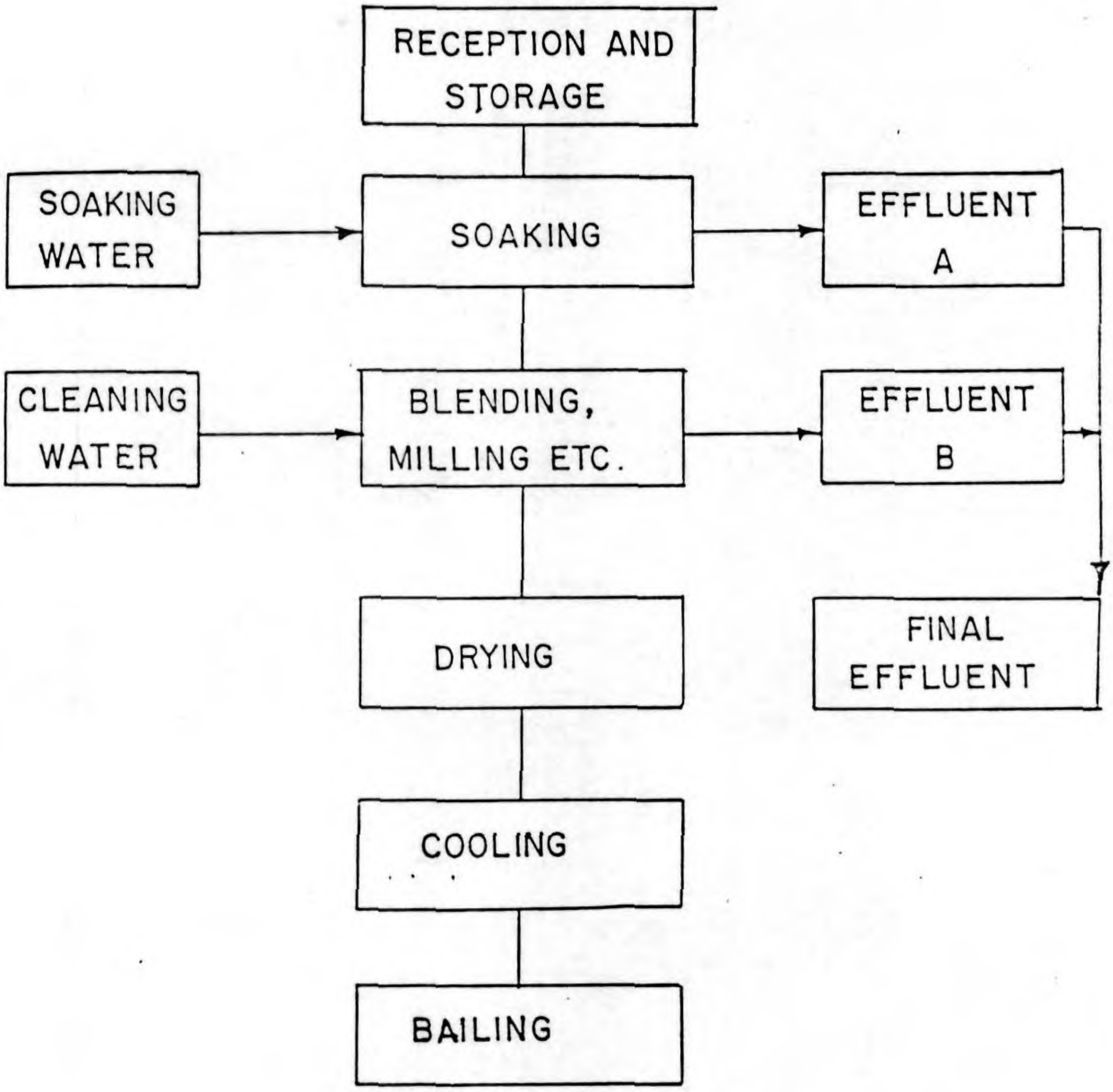
TABLE - 1.2

TYPICAL POLLUTION LEVELS OF LATEX AND SCRAP LINE EFFLUENTS

Parameters	Latex line	Scrap Line
pH	5.11	7.05
Total solids	5020	850
Suspended solids	480	110
Dissolved solids-Inorganic	2060	540
C.O.D.	4870	830
B.O.D	2490	450
Total Nitrogen	215	60
Ammoniacal Nitrogen	120	20
Oil & grease	6	4

All values except pH are in mg/l

TSR PROCESSING - SOURCE OF EFFLUENT - SCRAP GRADE RUBBER



FLOW CHART NO. 1.7(b)

In Technically specified rubber factories there are two distinct processing lines, one processing latex grade rubber and the other scrap grade rubber. The effluent from the scrap processing line is on the whole, less polluting than the effluent from the latex line. This is clear from the Table - 1.2.

1.6.4 EFFLUENTS FROM OTHER PROCESING FACTORIES

Other major types of natural rubber processings are Ribbed sheets and crepe rubber. But the waste water coming out of these factories are not so polluted as the effluents from TSR and Latex concentrating factories. Also the quantity of wastewater discharged is lesser compared to the other factories (58). Table - 1.3 shows typical pollution levels of effluent from different rubber processing factories.

The effluents for ribbed sheet rubber have high contents of pollutants. But these factories discharge very small quantity of wastewater. Also, about 80 percent of ribbed sheet having been produced by small holders, there is no need of a treatment plant for them. The balance 20 percent is from estate sector and the effluent is less polluted compared to other types of processings. Usually this effluent is used for irrigation purpose of the estates. Therefore for the processing of ribbed sheets in the estates there is no need of an effluent treatment.

The crepe mills are producing the wastewater of very low levels of pollution. So elaborate treatments are not necessary for such wastewaters.

Hence the efflunets from latex concentrate which have maximum degree of pollution are chosen for investigation in this work.

TABLE - 1.3

PROPERTIES OF EFFLUENT FROM DIFFERENT TYPES OF FACTORIES

Parameters	Latex Concentrate	Type of factory		
		R.S.S	Block Rubber	Remilling
pH	4.2	4.9	6.3	6.2
Total solids	6040	3750	990	480
Suspended solids	190	140	230	350
COD	4590	3300	1620	900
BOD	2580	2030	1140	740
Ammoniacal Nitrogen	395	10	55	10

(All values except pH are expressed in mg/l)

CHAPTER II

EXPERIMENTAL PROCEDURES

2.1 SAMPLE COLLECTION

The wastewater samples were collected from the latex centrifuging factories situated near Kottayam, Kerala.

After the centrifuging process of the latex the upper layer conaining concentrated latex is removed and the lower layer having 2.5 to 10 percent of dry rubber content (DRC) , known as skim is treated with sulphuric acid for recovering the rubber. The bowl washings and floor washings are also mixed with the serum. After the addition of sulphuric acid the whole waste water becomes acidic. This acidic water is collected at a pooling tank along with other effluents from the factory.

For the study purpose these effluent samples were collected from the pooling tank at a definite time every day for five consicutive days. Thus five sets of samples were collected during the study. The samples were preserved in refrigerator. The chemical parameters of the waste water were determined as described (59,60,61).

All the chemicals used in the analysis are of "ANALAR" grade.

2.2.1 MEASUREMENT OF pH.

pH is the scale of the acidity or alkalinity and measures the concentration of hydrogen ions in water.

The determination was made by the electrometeric method. The sample was taken in a beaker and glass electrode of pH meter was inserted into the sample to get a reproducible reading.

2.2.2 DETERMINATION OF CHEMICAL OXYGEN DEMAND

The chemical oxygen demand (COD) is a measure of oxygen equivalent of that portion of organic matter in a sample that is susceptable to oxidation by a strong chemical oxidant . Most types of organic matter are destroyed by boiling the mixture of chromic acid and sulphuric acid. The sample is refluxed with known amount of potassium dichromate and sulphuric acid along with silver sulphate as catalyst , and the excess dichromate is titrated with ferrous ammonium sulphate using ferroin indicator to get a sharp end point. Using silver sulphate catalyst short chain alcohols and acids are also oxidised . The amount of the organic matter , measured as oxygen equivalent , is proportional to the potassium dichromate consumed . A blank (without sample) with distilled water and all other reagents is refluxed in the same manner . The result was calculated from the equation :-

$$\text{COD (mg/l)} = \frac{(a-b)\ N \times 8000}{v}$$

where a = Volume in ml of ferrous ammonium sulphate used for blank.

b = Volume in ml of ferrous ammonium sulphate used for sample.

N = Normality of ferrous ammonium sulphate ,and

v = Volume in ml of the sample taken for the test

.2.3 DETERMINATION OF BIOCHEMICAL OXYGEN DEMAND

The Biochemical Oxygen Demand (BOD) determination is an mperical test in which standardized laboratory procedures are sed to determine the relative oxygen requirements for polluted aters.

Amount of oxygen demand in the sample will depends on he degree of dilution. It provides a measure of the dissolved xygen, consumed by the aerobic microbiological oxidation of the ample under defined conditions over a specific period . Normally OD is determined by measuring the loss in dissolved oxygen of he sample by incubating it for five days at 20 deg. C has been ccepted as standard.

The dissolved oxygen oxidises the manganous hydroxide manganic hydroxide , which in turn oxidises iodide to free dine in the acid medium. The iodine thus liberated is termined by titrating with standard sodium thiosulphate using tarch as indicator.

BOD (5 days at 20 deg. C) mg/l = Initial dissolved ygen content (mg/l) - Dissolved oxygen content after cubation.

2.4. DETERMINATION OF TOTAL SOLIDS.

Total solids (TS) are the materials left in the vessel ter evaporation of a sample and its subsequent drying in an en at defined temprature. Total solids includes non filterable lids and filtrerable solids.

A well mixed sample is evaporated in a weighed dish and dried to constant weight in an oven at 103 deg.C to 105 deg. C. The increase in weight over that of the empty dish represents the total solids.

$$\text{Total solids (mg/l)} = \frac{(A-B) \times 1000}{v}$$

where A = Weight in mg of the residue and dish

B = Weight in mg of the dish, and

v = Volume in ml of the sample taken for the test.

2.2.5. DETERMINATION OF TOTAL DISSOLVED SOLIDS.

Total dissolved solids (TDS) is the material that passes through a standard glass fiber filter disk and remains after evaporation and drying to constant weight at 103 deg.C to 105 deg.C.

A well mixed sample is filtred through a standard fiber filter and the filtrate is evaporated to dryness in a weighed dish to constant weight at 103 deg.C to 105 deg. C. The increase in dish weight represents the total dissolved solids.

$$\text{Dissolved solids (mg/l)} = \frac{(A - B) \times 1000}{v}$$

where A = Weight in mg of filter with dried residue

B = Weight in mg of the filter, and

v = Volume in ml of sample taken for the test.

2.2.6 DETERMINATION OF TOTAL SUSPENDED SOLIDS.

The total suspended solids (TSS) are the retain materials on a glass disk after filteration of a well mixe sample.

The well mixed sample is filtered through a weighe standard glass fiber filter and the residue retained on th filter is dried to a constant weight at 103 deg.C to 105 deg. C The increase in weight of the filter represents the tota suspended solids.

$$\text{Total suspended solids (mg/l)} = \frac{(A - B) \times 1000}{v}$$

where A = Weight in mg of the filter with dried residue

B = Weight in mg of the filter , and

v = Volume in ml of the sample taken for test.

2.2.7 DETERMINATION OF SULPHIDES

Sulphide is common in waste waters, coming partly from the decomposition of organic matters, sometimes from industrial water, but mostly from the bacterial reduction of sulphate .

A known quantity of well mixed sample is titrated with an excess amount of acidified iodine solution and the amount of untreated iodine is measured by titrating with a standard thiosulphate solution using starch indicator. A blank (without sample) with distilled water and all other reagents including same quantity of iodine is also to be conducted.

$$\text{Sulphides (as } H_2S\text{) (mg/l)} = \frac{17000 \, (A - B) \times N}{v}$$

where A = Volume in ml of standard sodium thiosulphate for blank.

B = Volume in ml of standard sodium thiosulphate for sample.

N = Normality of thiosulphate solution, and

v = Volume in ml of the sample taken for test.

2.2.8 DETERMINATION OF PHOSPHATES

Phosphrous occurs in natural waters and wastewaters almost solely as phosphates. These are classified as orthophosphates, condensed phosphates (Pyro-phosphates, meta-phosphates and other polyphosphates) and organically bound phosphates. These arise from a variety of sources. Small amounts are from the condensed phosphates added to some water supplied during treatment. Larger quantities are from cleansing agents. Some are from fertilizers and organic phosphates are formed by biological process.

The colour and turbidity are removed by treating with activated charcol. Then the solution was neutralised to phenolphathalein using dilute sulphuric acid or dilute sodium hydroxide. From this molybdophosphoric acid is formed and reduced to an intensively coloured complex of molybdanium blue by stannous chloride . The developed colour is measured using spectrophotometer at 690 n m. The blank is conducted with distilled water and all the reagents.

The calibration curve is prepared using standard phosphate solution.

$$\text{Phosphates (as P), (mg/l)} = \frac{w \times 1000}{v}$$

where w = Weight in mg of Phosphates (P) as read from the calibration curve , and

v = Volume in ml of the sample taken for test.

2.2.9 DETERMINATION OF TOTAL KJELDAHL NITROGEN

In wastewaters there are different forms of nitrogen present viz. nitrate, nitrite, ammonia and organic nitrogen. Organic nitrogen is the organically bound nitrogen in the trinegative oxidation state and it doesnot include the organic nitrogen compounds. The total kjeldahl nitrogen (TKN) is a measure of organic nitrogen and ammonia.

In the presence of sulphuric acid, potassium sulphate and mercuric sulphate catalyst, amino nitrogen of many organic materials are converted to ammonium sulphate $[(NH_4)_2SO_4]$ .Free ammonia and ammonium-nitogen also are converted to $(NH_4)_2SO_4$. During digestion mercury ammonium complex is formed and then decomposed by sodium thiosulphate . After decomposition the ammonia is distilled from an alkaline medium and absorbed in boric acid. The amount of ammonia is determined by titrating with a standard mineral acid using methyl red - methylene blue mixed as indicator for a sharp end point.A blank (without sample) with all the reagents is also conducted.

$$\text{Total Kjeldahl Nitrogen (as N) mg/l} = \frac{(A - B) \times N \times 14000}{v}$$

where A = volume in ml of the acid used for sample,

B = volume in ml of the acid used for blank,

N = Normality of the acid , and

v = Volume in ml of the sample taken for test.

2.2.10 DETERMINATION OF AMMONICAL NITROGEN.

The ammonical nitrogen present in the wastewater of the rubber processing factories are from the ammonia gas which was added for the preservation of latex.

A well mixed sample is buffered at pH 9.5 with a borate buffer to decrease hydrolysis of cynates and organic nitrogen compounds and distilled into solution of boric acid. The ammonia in distilled water is measured by titrating with standard mineral acid using methyl red- methylene blue mixed indicator. A blank (without sample) is also conducted with all the reagents and distilled water.

$$\text{Ammonical nitrogen (as N), mg/l} = \frac{(A - B) \times N \times 14000}{v}$$

where A= Volume in ml of standard sulphuric acid used for sample.

B= Volume in ml of standard sulphuric acid used for blank.

N= normality of the sulphuric acid, and

v= volume in ml of the sample taken for the test.

2.2.11. DETERMINATION OF FREE AMMONIA.

Free ammonia present in the rubber effluent is from the ammonia gas added to the latex for preservation. On heating the free ammonia is released and the same can be get absorbed in boric acid. It is measured by titrating with standard mineral acid using methyl red - methylene blue indicator.

$$\text{Free ammonia (as N), mg/l} = \frac{A \times N \times 14000}{v}$$

where A = Volume in ml of the standard acid used for titration

N = Normality of the acid , and

v = Volume in ml of the sample taken for the test.

2.2.12 DETERMINATION OF NITRATE NITROGEN.

Nitrate is an intermediate state of nitrogen generated by the oxidation of ammonia to nitrate and by the reduction of nitrite. Such oxidation and reduction may occur in wastewater treatment plants.

The efffluent sample is treated with sodium salicylate in an acid medium and the mixture is made alkaline , and the yellow colour obtained is measured using a spectrophotometer at 420 nm.. A blank (without sample) with all the reagents and distilled water is also coducted.

A calibration curve is prepared with standard nitrate solution.

$$\text{Nitrate nitrogen (as N) mg/l} = \frac{w}{v}$$

where w = Weight in mg of nitrogen (as N) as read from the calibration curve , and

v = Volume in ml of the sample taken for the test.

2.2.13. DETERMINATION OF METHYLENE BLUE ACTIVE SUBSTANCES.

Surfactants coming to the wastewater through the synthetic detergents.

A surfactant combines in a single molecule of a strongly hydrophobic group with a strongly hydrophillic one. Such molecules tend to congregate at the interfaces between the aqueous medium and the other phase of the system such as air, oily liquids and particulates and imparting forming, emulsification , particle suspension etc.

Methylene blue active substances (MBAS) bring about the transfer of methylene blue, a cationic dye from an aqueous solution into an immiscible organic liquid upon equilibration. This occurs through ion pair formation by the MBAS anion and the methylene blue cation. The intensity of the blue colour in the organic phase is a measure of MBAS. Anionic surfactants are the most prominent of many substances, natural and synthetic, showing methylene blue activity.

The method comprises three successive extractions from acid aqueous medium containing excess methylene blue into chloroform followed by an aqueous backwash and measurement of blue colour in the chloroform by spectrophotometer at 650 nm. A blank (without sample) is conducted using all the reagents and distilled water.

Calibration curve was prepared from a series of standard Linear Alkylbenzene Sulphonate(LAS).

$$\text{MBAS mg/l} = \frac{w}{v}$$

where w = Weight in micro gram of LAS as read from the calibration curve , and

v = Volume in ml of the sample taken for the test.

2.2.14. DETERMINATION OF TOTAL ORGANIC CARBON.

The organic carbon in wastewater is composed of a variety of organic compounds in various oxidation states. Some of these carbon compounds can be oxidised further by biological or chemical process and the biological oxygen demand (BOD) and the chemical oxygen demand (COD) may charaterize these fractions.

To determine the organically bound carbon , the organic molecules must be broken down to single carbon units and coverted to a single molecular form that can be measured quantitatively.

The homogenised water sample is injected to a heatec reaction chamber packed with an oxidative catalyst such as cobalt oxide. The water is vapourised and the organic matter is oxidised to carbon dioxide, which is measured by means of nondispersive type of infrared analyser. A blank (without sample) is conducted by the same method.

A calibration curve is prepared using a series of standard carbon solution.

Total organic carbon (TOC), micro gm / 1 = A - B

where

A = Weight in mg of carbon obtained from the calibration curve for the sample, and

B = Weight in mg of the carbon obtained from the calibration curve for the blank.

2.2.15. DETERMINATION OF HEAVY METALS

Atomic absorption spectroscopy (AAS) was used for the determination of heavy metals. AAS is a method of chemical analysis in which the absorption spectra of isolated atoms are used to obtain information on the kind and number of atoms present in a chemical sample.

In AAS, the flame is illuminated with a primary source of radiation a portion of which is absorbed by ground state atoms. Radiation transmitted by the flame passes through a monochromater and on to a photodetector read out systems of either absorbance or transmittance. One of the principal advantage is that the determiations can be carried out in presence of many other elements without any interference . In the hollow cathod lamp, the source of narrow band radiation , the cathode is made up of or linked with the same element that is to be determined in the flame . It gives out light in a spectrum of sharp lines that are characteristics of the element and have exactly the right wavelength to be absorbed . There is no need to separate the test element, the technique saves a great deal of time and the process eliminates numerous sources of error . In AAS with flame, the sample cell is simply the flame itself. Atomic Absorption Spectroscopy relies upon Beer's law . The sensitivity of the technique depends on the pathlength of primary radiation through the flame . The relation between the absorbance and concentration is near linear over a wide range of spectrum. The use of carbon rod atomizer has greatly extended the range of analytical applications. Although the flame AAS methods are capable of providing high sensibility for very low concentrations,they require at least two milliliters of sample solution for a reliable result, at a detection limit of one part per billion . The high degree of sensitivity, selectivity and convenience of using solution sample have made this technique the most popular current method for elemental analysis.

CHAPTER - III

RESULTS AND DISCUSSIONS

CHAPTER - III

PART - I: ROUTINE ANALYSIS

PART - I : ANALYSIS OF ROUTINE PARAMETERS.

3.1.1 SAMPLE COLLECTION.

The raw effluent was collected from the pooling tank of latex centrifuging factory. The acidified skim serum after the removal of rubber and washings of vessels, centrifuge bowls and floor along with all other wastewater discharged from the factory were mixed in the pooling tank before treatment. This wastewater was collected and analysed for various parameters.

3.1.2. pH

All the samples analysed have the pH value in the acidic range. The values are between 4 to 4.54 (Table - 3.1.1 & Fig. 3.1.1). These low pH values are due to the addition of sulphuric acid to the skim while removing the rubber content.

Highly acidic waters may induce adverse effect on plant growth and may also affect the corrosion of river structures(62).

3.1.3 TOTAL SOLIDS CONTENT.

The effluent contains fairly large amounts of Total Solids (TS), which are mostly in the form of dissolved solids and suspended solids. The TS of the effluent from latex concentrating factories are high, and in the range of 6040 mg/l to 9780 mg/l (Fig. 3.1.2)

These Total Solids of the effluent includes substances such as small amounts of rubber, varying quantites of proteins, sugars, lipids, caroteinoids, organic and inorganic salts in the dissolved and suspended form (63).

The high solid contents also provides favourable conditions for bacterial proliferaion and growth. These conditions will eventually affect the survival of aquatic life and pose a threat to the well being of people who use public waterways for domestic and recreational purpose (64).

3.1.4 TOTAL DISSOLVED SOLIDS .

The major portion of the TS is the form of dissolved solids. From the Table - 3.1.1 the values of Total Dissolved Solids (TDS) ranges from 3890 mg/l to 8370 mg/l (Fig.3.1.2), which are very high compared to that of the maximum limit (2100 mg/l) specified by the Bureau of Indian Standards (BIS) for the discharge of rubber effluent from latex concentrating factories (65).

The TDS of the wastewater are attributed from the organic and inorganic constituents of latex. These high TDS of organic origin required high oxygen demand for their oxidation.

Dissolved solids play a significant role in the salinity of effluent. They affect the mechanism of osmotic pressure regulation thereby controlling the availibility of water to the plant. In addition certain dissolved substances may even cause toxicity to aquatic biota.

Thus the excessive quantity of dissolved solids in an effluent may affect aquatic life and may also make it unsuitable for agricultural purposes.

3.1.5. SUSPENDED SOLIDS.

From the Table - 3.1.1 the Suspended Solids (SS) in the effluent samples are in the range of 1360 mg/l to 200 mg/l. These values are also very high compared to the 200 mg/l , the maximum permissible limit of (Table - 3.1.2) BIS (65). The SS includes mainly rubber particles and other organic and inorganic matters. Waters with high levels of SS may be aesthetically unsatisfactory for such purposes as bathing, washing etc.

3.1.6. CHEMICAL OXYGEN DEMAND.

Table - 3.1.1 shows the Chemical Oxygen Demand (COD) of the wastewater discharged from the latex concentrating factories are very high.The BIS requirement is only 250 mg/l and 100 mg/l respectively for disposal into land water and irrigation. But the observed values are in the range of 2560 mg/l to 3290 mg/l (Fig. 3.1.3). The high value of COD is due to the organic matter present in the effluent. The COD was attributed to the suspended rubber particles and the organic and inorganic dissolved solids present in the effluent.

3.1.7. BIOCHEMICAL OXYGEN DEMAND.

From the Table - 3.1.1, it can be seen that the Biochemical Oxygen Demand (BOD) values of raw effluent are very high. The BOD value of the raw effluent varies in the range of 1430 mg/l to 2100 mg/l (Fig. 3.1.3). These high BOD values are due to the organic and inorganic constituents present in the latex which are soluble in water and accumulate in the serum during the processing of latex concentration. The solid particles present in the concentrated effluent also increase oxygen demand.

The added presence of a significant number of viable and indicative bacteria in the skim serum, the major component of the effluent, makes it a high oxygen absorbing liquor (52). The studies (55, 66 & 67) also indicated that the ammonia present in the effluent can give rise to oxygen demands.

The high BOD cause severe environmental problems such as depletion of dissolved oxygen in water which will adversely affect the aquatic life.

3.1.8. SULPHIDES AND OIL & GREASE.

Sulphides of the raw effluent vary from 5 to 10 mg/l (Fig. 3.1.4) which is very high compared to that of the BIS requirement (2.0 mg/l). Sulphides are poisonous gases which will create severe odour problems. Hydrogen sulphide arises mainly from the sulphuric acid used for the coagulation of skim serum. The oil and grease values are well within BIS limits (Fig.3.1.4).

3.1.9. SULPHATES.

The sulphates present in the effluent are attributed to the sulphuric acid used for the recovery of rubber from skim. The sulphate in the rubber effluent is also very high varying from 4700 mg/l to 6800 mg/l (Fig. 3.1.2).

3.1.10. NUTRIENTS

The effluent discharging from the latex centrifuging factories contains a large number of micro and macro-nutrients required for the plant growth. The cotrolled use of effluent improves the yeild of the crop and saves cost of the fertilizer.

The major contents are Nitrogen, Phosphates, Potassium, Magnesium, Calcium etc. The raw effluent contains Nitrogen in the range of 650 mg/l to 1020 mg/l (Fig. 3.1.3), Potassium in the range of 1100 mg/l to 1260 mg/l (Fig.3.1.3), Phosphorous in the range of 35 mg/l to 60 mg/l (Fig. 3.1.5), Calcium in the range of 180 mg/l to 280 mg/l (Fig.3.1.6) and Magnesium in the range of 350 mg/l to 420 mg/l (Fig. 3.1.6).

Several studies have indicated potential use of effluent as a source of fertilizer and water for crops (68-77).

3.1.11. NITROGEN

Latex concentrate effluent contains high levels of nitrogen, mainly in the form of ammonium ion, resulting from ammonia used in preserving the latex (78). The ammonia content of the skim latex varies from 0.3 - 0.6 % depending on the amount of ammonia added to field latex and the storage period of skim latex before coagulating and subsequent processing. For the recovery of rubber from the skim, Sulphuric acid is added to the serum . As a result ammonium sulphate, which found to be the most polluting meterial in the skim effluent, was formed (77-80).

From the Table - 3.1.1, it can be seen that the 1.1, it nitrogen as Total Kjeldahl Nitrogen present in the sample varies from 650 mg/l to 1020 mg/l (Fig.3.1.3). The major portion of nitrogen present as Ammoniacal Nitrogen are in the range of 550 mg/l to 850 mg/l (Fig. 3.1.6). Also a considerable amount of nitrogen is present as free ammonia.

The effluent contains nitrogen when discharged into the land waters cause severe water problems such as depletion of water and nitrification which lead to the higher oxygen demands. Also as a nutrient, nitrogen promotes algal blooms due to the convertion of ammonia into nitrates by aerobic bacteria.

The nitrogen in the nitrate form is comparatively in less concentration in the rubber effluent (Table - 3.1.1) and it varies in the range of 0.480mg/l to 0.900 mg/l (Fig. 3.1.7).

3.1.12 HEAVY METALS (TRACE ELEMENTS)

A large number of metalic elements are present in the rubber effluent at micro level. The elements found in the wastewater are Manganese, Iron, Zinc, Copper, Lead, Chromium, Aluminium and Molybdenium. Most of these trace metals are toxic and cause severe health hazards. The studies on these trace metals (28-42) brought the attention of the removal of these elements before discharging to public waters. Trace matals like Cadmium and Mercury affect the fish, prowns and crabs. Copper, Zinc and Iron are toxic to fish, plantation and worm. The presence of zinc in fish will affect the growth and reproduction. Cadmium and lead are also toxic to fish and snail.

Many of these are responsible for health hazards in human beings also. Cadium will create high blood pressure and kidney damage, and destruction of testicular tissues and red blood cells. Lead may cause diseases like anemia, kidney and nervous disorders, brain damage and certain types of cancers (81). Chromium (VI) affects the liver and lungs (82) and the Aluminium and Iron create neurological disorders (83) mainly in elders due to the gradual accumulation of these elements in body. Manganese will affect the central nervous system which leads to the headaches , severe behavioural diorders etc (84).

3.1.13. ORGANIC MICROPOLLUTANTS

Pollution by organic micropollutants is one of the most critical problems for drinking water and environmental protection of waterbodies . Toxic organic pollutants (85,86,87) will seriously affect the wastewater if put into the ecosystem. The toxicity due to the organic pollution (88) may be more severe in the real environment, because the system used for isolating chemicals could not give a quantitative recovery of all the potential toxicants occuring in the rivers. It is extremely difficult to quantify the risk associated to xenobiolics as a whole because most of them occur at levels too low to allow by analytical determinations. Some of very toxic pollutants are organic carbon, methylene blue active substances etc. .

These MBAS of the raw effluent are varying in the range of 0.95 mg/l to 1.83 mg/l (Fig. 3.1.8) and TOC in the range of 78.24 mg/l to 93.43 mg/l (Fig. 3.1.5).

Since the raw rubber effluents have high degree of pollutants, it is very essential to give suitable treatments to reduce the degree of pollution before discharging into public waters and irrigation fields.

The albaminoid nitrogen is contributed mainly by the breakdown of proteins and amino acids in the the latex serum. It was observed 55 mg/l to 70 mg/l (Fig.3.1.5) of albaminoid nitrogen present in the raw effluent from latex concentrating factory. The presence of albaminoid nitrogen gives an approximate indication of the more readily decomposible nitrogenous organic matter present in the waste water. As it gives a rough estimation of the relatively easy decomposable organic matter , it is of greater importance than the total organic nitrogen content.

TABLE - 3.1.1

QUALITY OF THE RAW EFFLUENT SAMPLE FROM LATEX CENTRIFUGING FACTORIES

Sl No	Parameters	Sample numbers					
		1	2	3	4	5	Mean
01	pH	4.44	4.00	4.54	4.47	4.42	4.37
02	COD	2680	3070	3230	2560	3290	2970
03	BOD	1600	1430	1780	1730	2100	1740
04	Total Solids	9780	5730	7680	6040	7800	7390
05	T.D.S	8370	4340	6050	3890	6280	5790
06	Suspended Solids	1490	1360	1580	2000	1740	1630
07	Sulphides (as S)	6	8	5	10	6	7
08	Phosphates (as P)	60	45	35	50	50	48
09	Total Kjeldahl Nitrogen	1020	750	740	650	830	800
10	Ammoniacal Nitrogen	850	660	700	550	790	710
11	Free Ammonia	380	360	130	170	160	240
12	Oil & Grease	5	6	5	7	8	6.2
13	Potassium	1080	1100	1260	1120	1180	1150
14	Magnessium	170	150	200	200	180	180
15	Calcium	240	180	200	280	200	220
16	Iron	0.468	0.431	0.402	0.480	0.339	0.432
17	Chromium	0.402	0.376	0.326	0.412	0.388	0.393
18	Copper	0.550	0.532	0.496	0.529	0.578	0.537
19	Lead	0.097	0.160	0.134	0.148	0.171	0.142
20	Manganese	0.561	0.610	0.588	0.545	0.603	0.581
21	Sulphates(as SO4)	5800	4700	6800	6200	5400	5780
22	Nitrate Nitrogen	0.90	0.48	0.52	0.64	0.58	0.62
23	MBAS*	1.70	0.95	1.83	1.36	1.21	1.41
24	Total Organic Carbon	93.43	87.50	97.85	78.24	86.80	88.76

All values except pH and MBAS are in milligrams/litre.

* MBAS is in micrograms/litre.

TABLE - 3.1.2 : BIS SPECIFICATIONS OF NATURAL RUBBER EFFLUENT FROM LATEX CONCENTRATING FACTORIES

PARAMETERS	DISCHARGE	
	FOR IRRIGATION	INTO INLAND WATER SURFACE
pH	6 TO 8	6 TO 8
COD	250	—
BOD	50	100
DISSOLVED SOLIDS	2100	—
SUSPENDED SOLIDS	100	200
TOTAL NITROGEN	200	—
AMMONIACAL NITROGEN	100	—
SULPHIDES	2	—
PHOSPHATES as P	5	—

All values except pH are in mg/l

QUALITY OF RAW EFFLUENT : pH

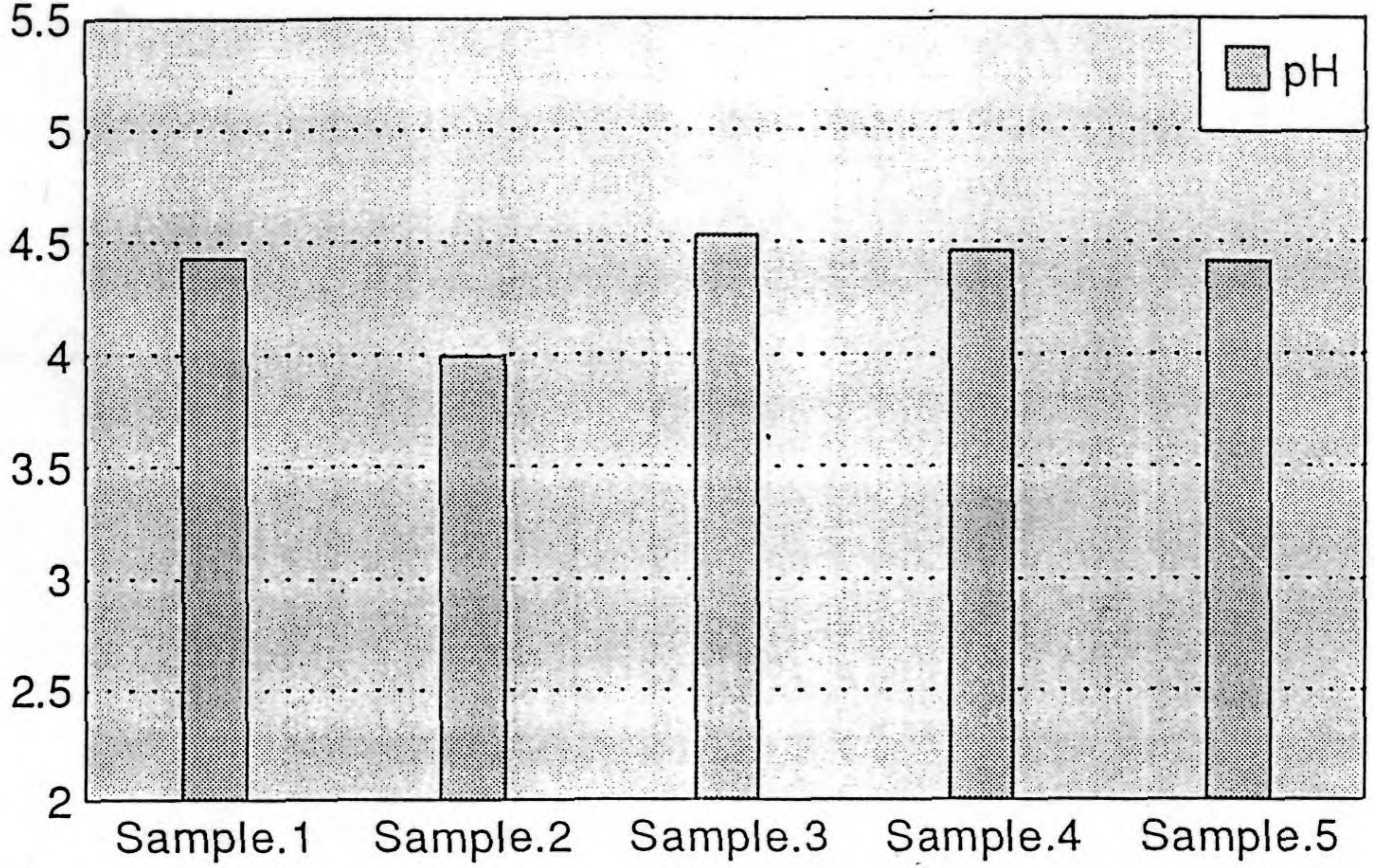


FIGURE - 3.1.1

QUALITY OF RAW EFFLUENT FROM LATEX CONCENTRATING FACTORIES

TOTAL SOLIDS , TOTAL DISSOLVED SOLIDS AND SULPHATES

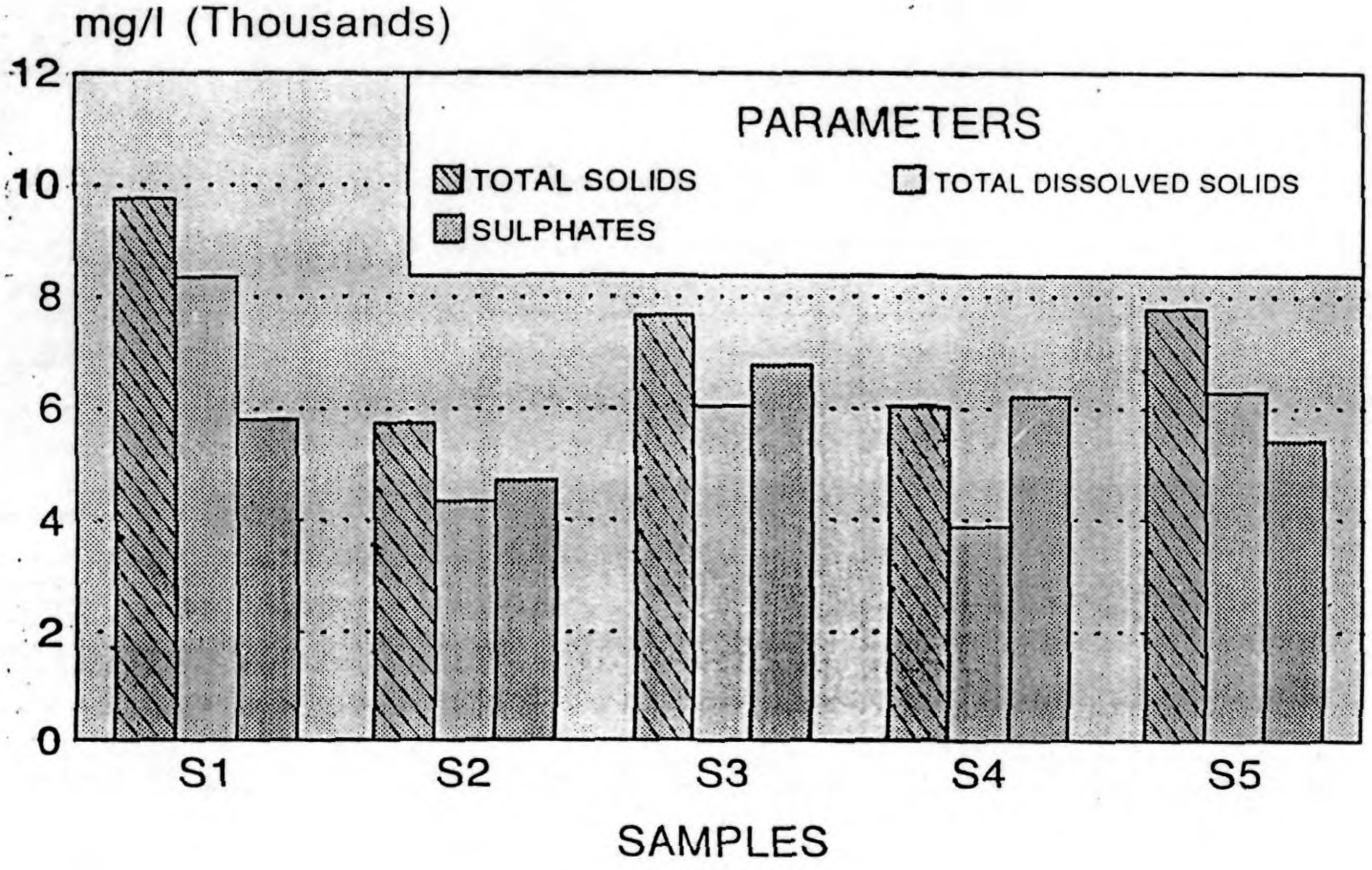
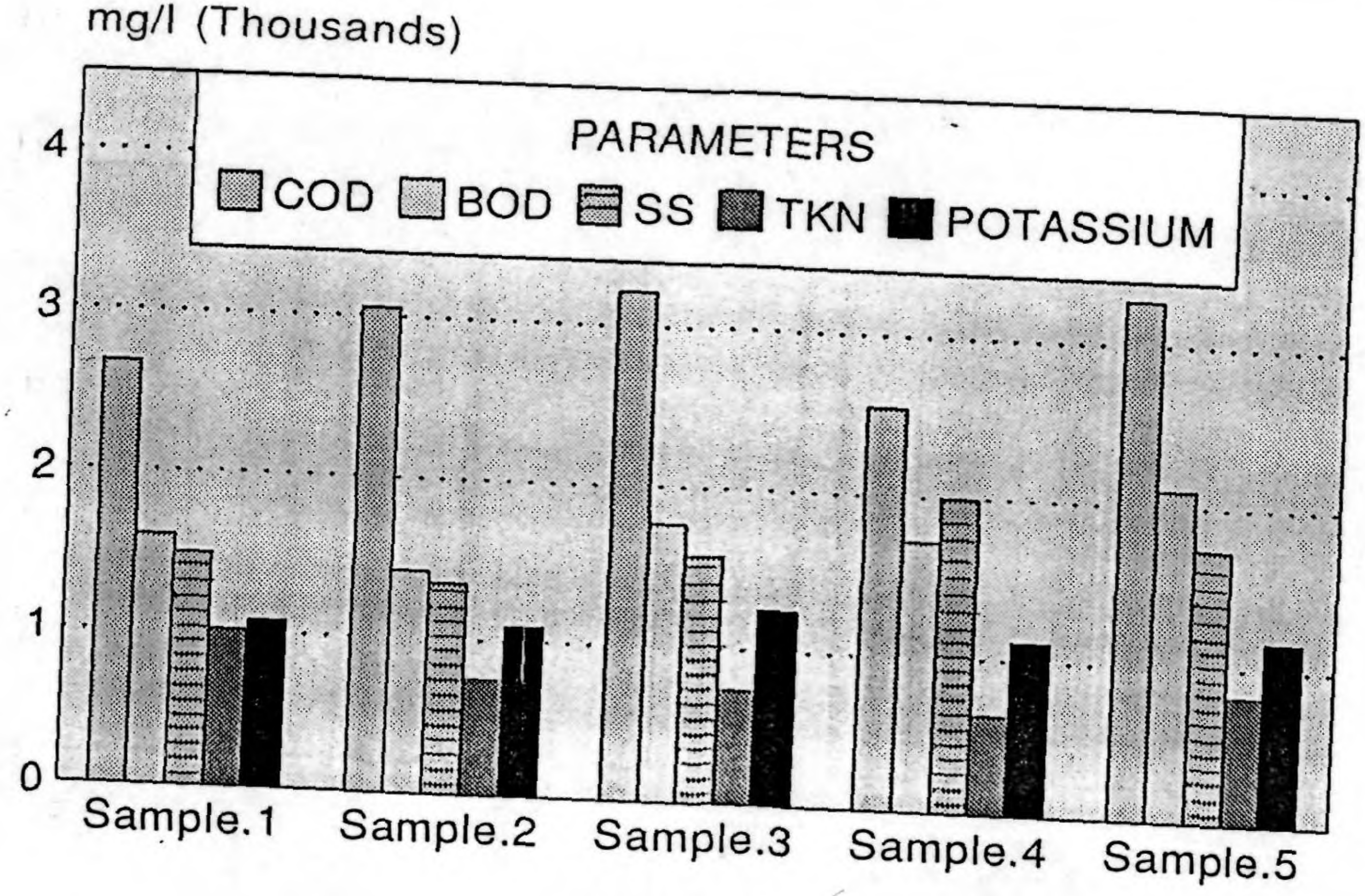


FIGURE - 3.1.2



QUALITY OF RAW EFFLUENT FROM LATEX CONCENTRATE
COD , BOD ,TSS , TKN , POTASSIUM

FIGURE - 3.1 .3

QUALITY OF RAW EFFLUENT FROM LATEX CONCENTRATING FACTORIES

SULPHIDES AND OIL & GREASE

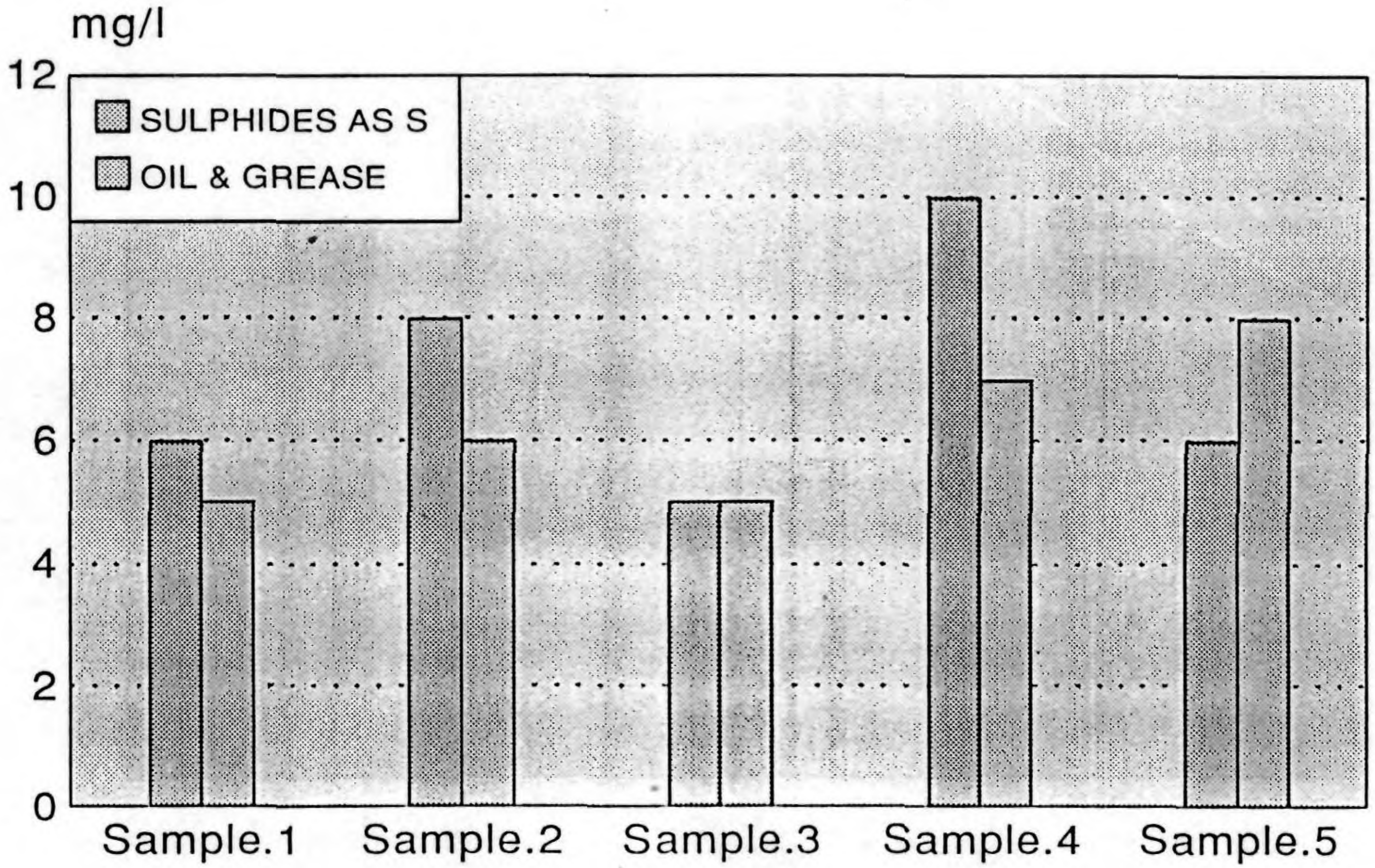


FIGURE - 3.1.4

QUALITY OF RAW EFFLUENT FROM LATEX CONCENTRATING FACTORIES

PHOSPHATES , TOTAL ORGANIC CARBON AND ALBAMINOID NITROGEN

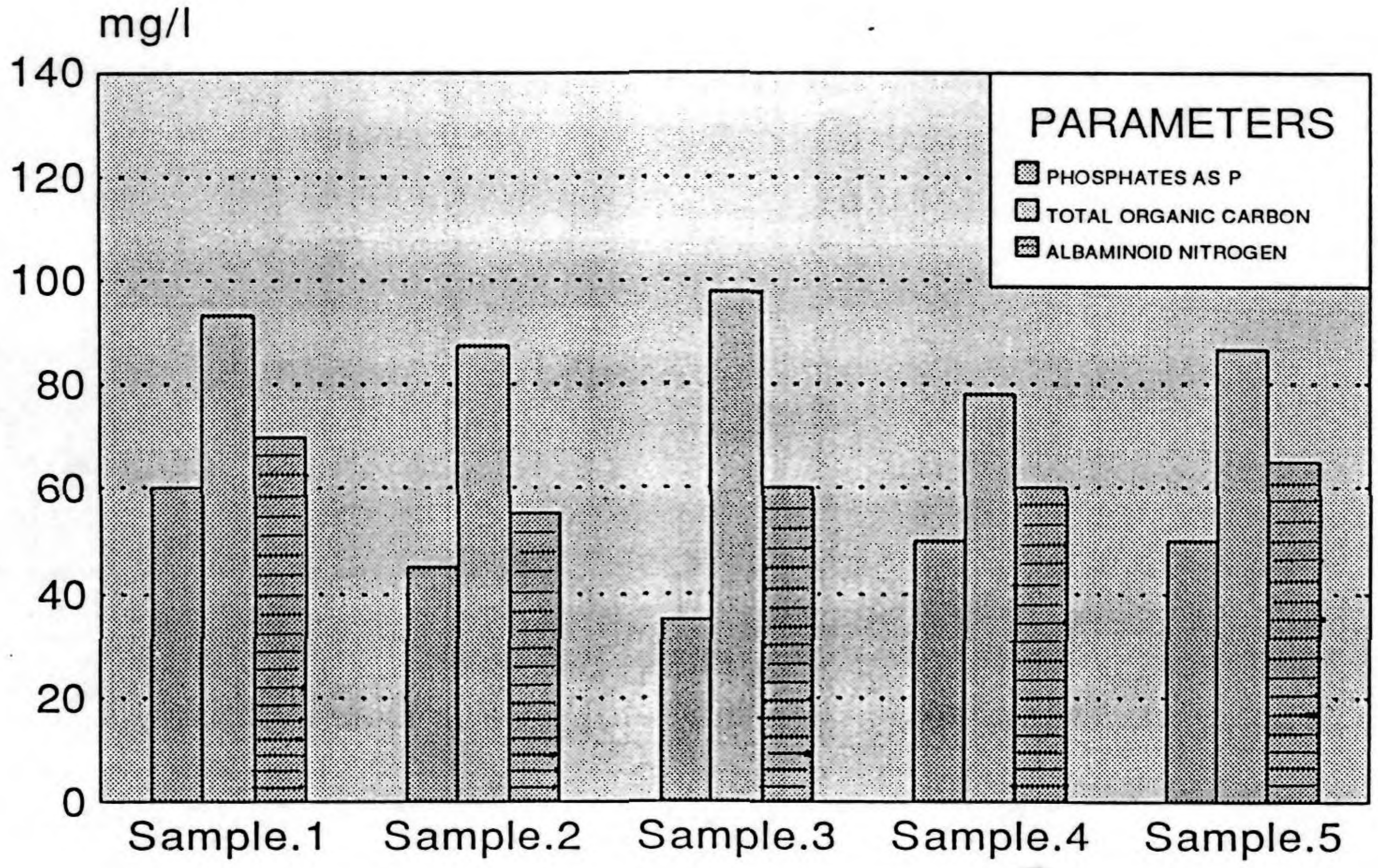


FIGURE-3.1.5

QUALITY OF RAW EFFLUENT FROM LATEX CONCENTRATING FACTORIES

CALCIUM , MAGNESIUM , FREE AMMONIA AND AMMONIACAL NITROGEN

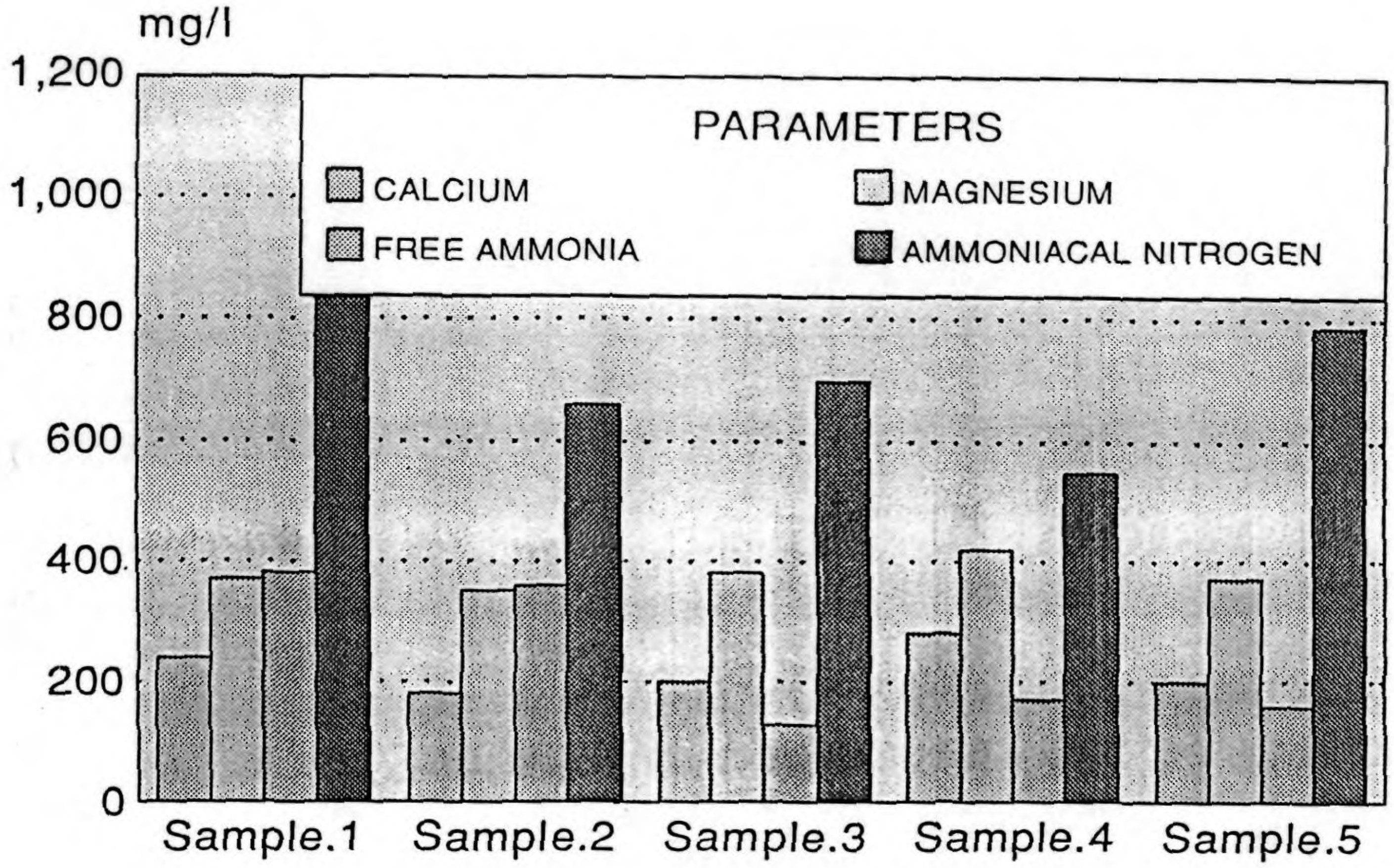


FIGURE - 3.1.6

QUALITY OF RAW EFFLUENT FROM LATEX CONCENTRATING FACTORIES

COPPER , LEAD , NITRATE NITROGEN

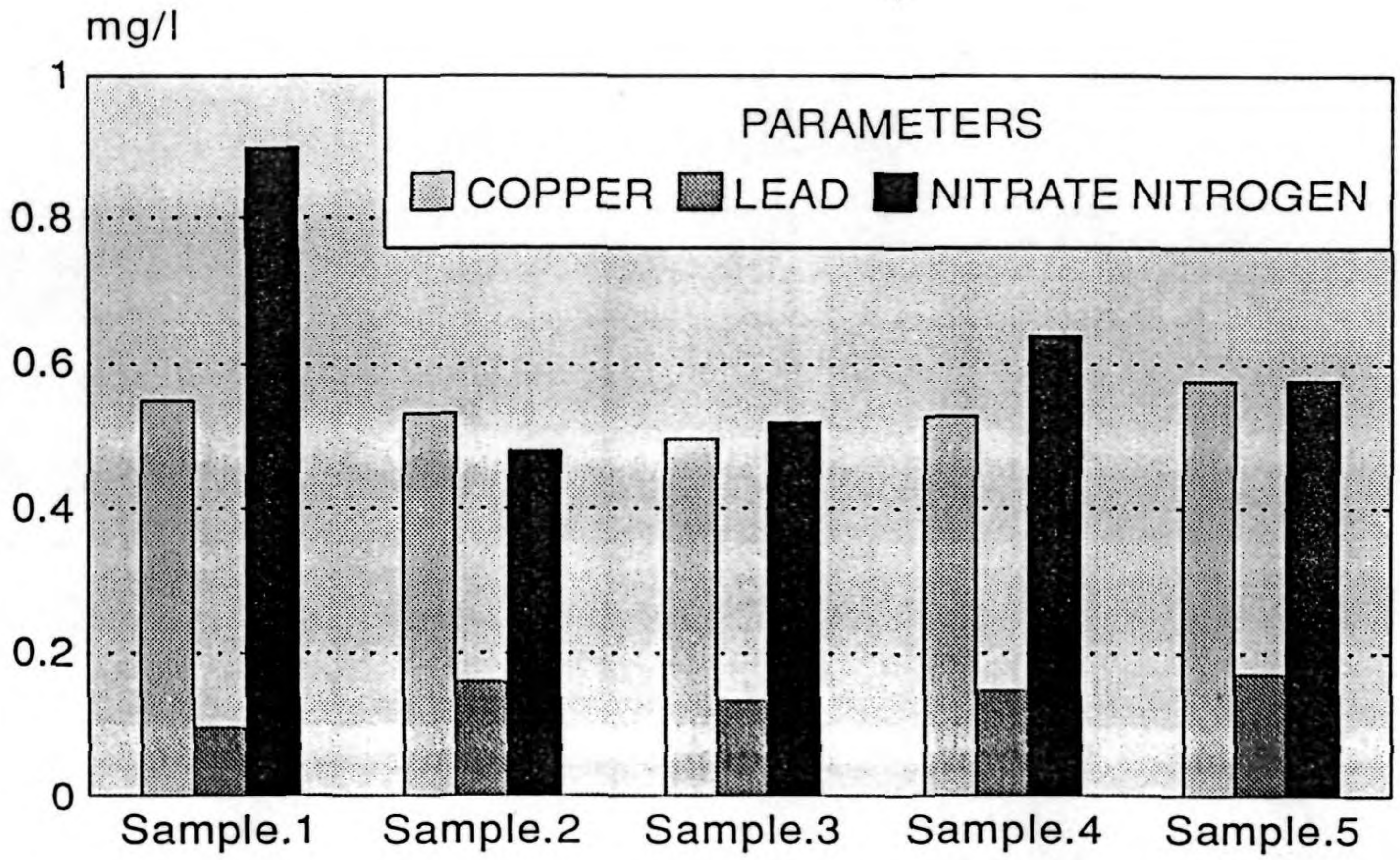


FIGURE - 3.1.7

QUALITY OF RAW EFFLUENT FROM LATEX CONCENTRATING FACTORIES

METHYLENE BLUE ACTIVE SUBSTANCES (SURFACTANTS)

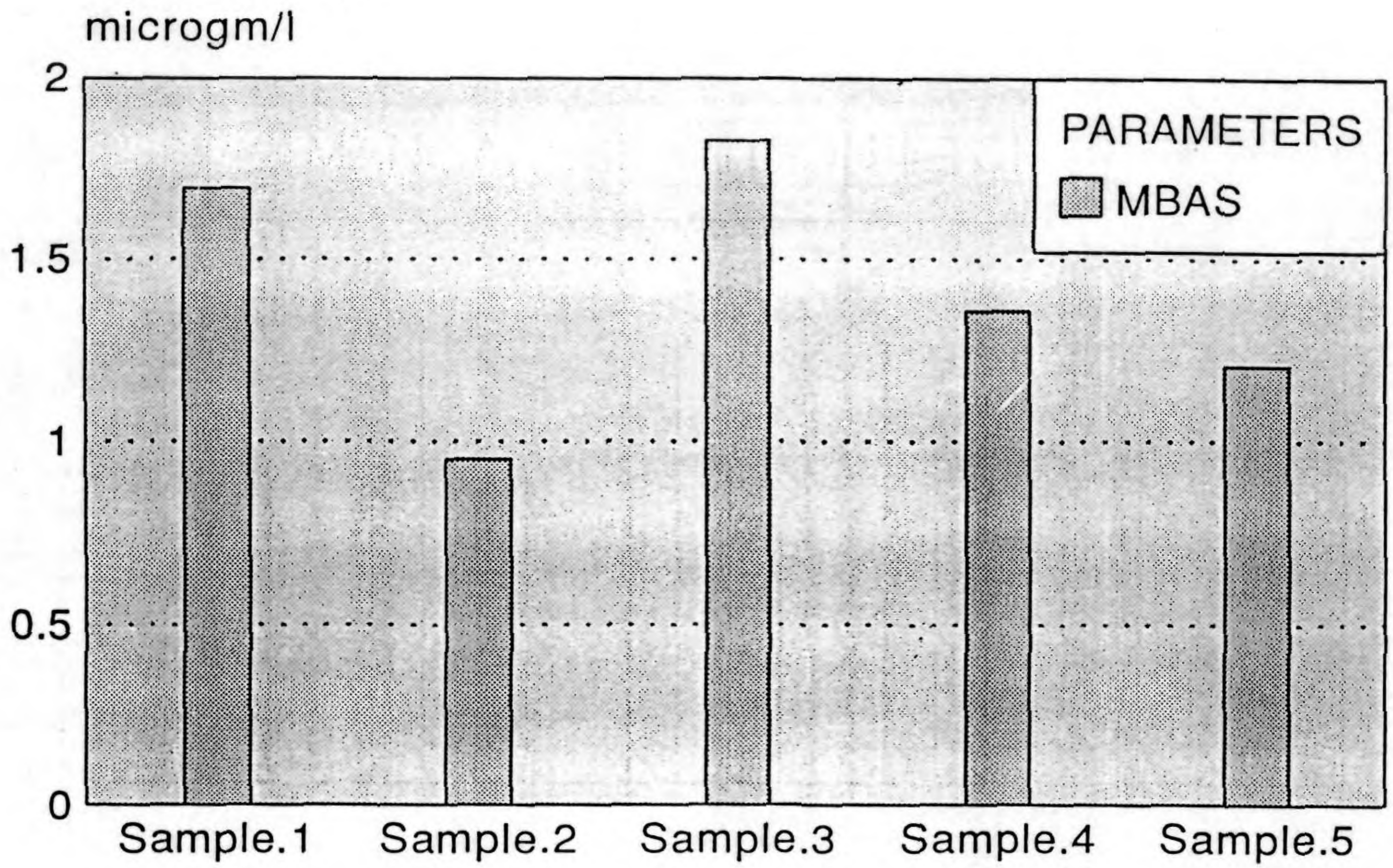


FIGURE - 3.1.8

QUALITY OF RAW EFFLUENT FROM LATEX CONCENTRATING FACTORIES

MANGANESE , IRON AND CHROMIUM

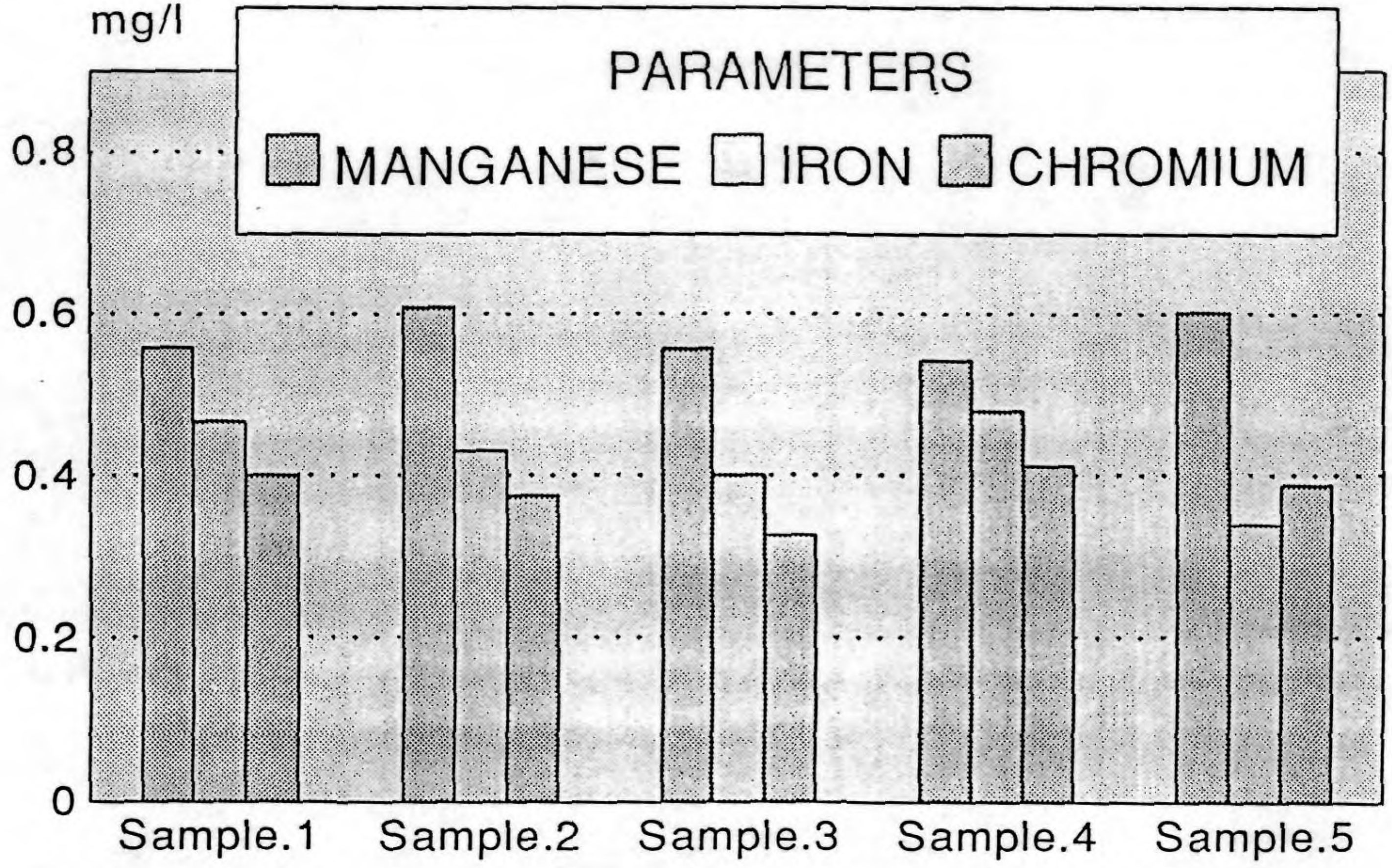


FIGURE - 3.1.9

CHAPTER - III

PART II

TREATMENT OF EFFLUENT FROM RUBBER INDUSTRIES WITH DIFFERENT FLOCCULATING AGENTS

3.2.1. SOURCE OF EFFLUENTS.

In latex concentrate the main source of effluent is from the coagulation of skim latex. The coagulation of the skim latex produces a serum that contains a much higher concentration of proteins, sugars, lipids and inorganic and organic salts (57). Thus wastewaters from latex concentrating factories contain organic matter and nitrogenous substances which make it a polluting liquor (67). Therefore the potential pollutants in rubber effluent are organic carbon and ammoniacal nitrogen (88).

3.2.2. DIFFERENT TREATMENT METHODS

Many methods of effluent treatment have been described and are applied by industries. These are generally divided into three basic types: physical, chemical and bilogical.

3.2.2.1. PHYSICAL TREATMENTS.

In these processes, impurities are separated from water without any chemical treatment. Some of the important method under this category are filtration, sedimentation, underground discharge, reverse osmosis etc. .

3.2.2.2. FILTERATION.

In this method, the effluent is subjected to either pressure or gravity to be severed in to units containing graded sand, calcite, magnetite, anthracite, charcoal or finely divided relatively insoluble materials such as diatomaceous earth.

3.2.2.3. SEDIMENTATION.

In sedimentation method the force of gravity sets or particle heavier than water and causes them to settle. The physical charateristics such as particle size, weight, frictional resistance and viscosity are important criteria in the design of the sedimentation tank because many industrial effluents contain organic and inorganic settleable solids.

Effluents are normally kept in sedimentation tank for 2 - 3 hours.

3.2.2.4. UNDERGOUND DISCHARGE.

In underground discharge, the effluent is discharged into permeable strata in the earth so located that the effluent pumped into them will not contaminate stratum used for other water supplies. These permeable layers are usually 1220 - 1525 meters deep. Extensive pretreatment is essential to remove silt, suspended solids and micro - organisms.

3.2.2.5. REVERSIBLE OSMOSIS.

It is a membrane process. It is based on the principle that when the solutions of different concentrations are separated by a semi - permiable membrane, water will move through the membrane in the direction of higher concentration. The process can be reversed by applying pressure to the more concentrated solution. The concentration of dissolved solids will then tend to increase on that side of the membrane.

3.2.2.6. CHEMICAL TREATMENTS.

In chemical treatments, the separation process of impurities from the wastewater involves chemical alterations. This include precipitation, flocculation, ion-exchange, carbon adsorption, oxidation and reducton reactions.

3.2.2.7 PRECIPITATION.

In this process chemicals are added to the effluents which can precipitate the polluting materials present in it. Then the precipitate is removed by filteration or sedimentation.

3.2.2.8. FLOCCULATION.

The flocculating agents are added to the effluents and the precipitated flocs are the seprated by settling. Common flocculating agents are ferric chloride, ferric sulphate, copper chloride, aluminium sulphate, sodium aluminate etc.

3.2.2.9. ION-EXCHANGE.

The principle of ion-exchange is widely used to soften or de - minerlise water and to recover useful byproducts from industrial effluents. De - mineralised water produced by ion-exchange is usually of much higher quality than required in effluent treatment.

3.2.2.10. BIOLOGICAL TREATMENTS.

Biological treatment methods involve the breakdown of organic matter in effluents by microbial flora. Some times inorganic matter can also be removed. There are two distinct types of operation associated with these treatment methods : aerobic and anaerobic treatments.

When sufficent dissolved oxygen is present in the effluent, the aerobic bacteria attack and breakdown complex compounds into simple ones such as carbon dioxide water etc.

In the absence of dissolved oxygen, anaerobic bacteria attack the complex organic compounds and break them into noxious chemical compounds.

Both in aerobic and anaerobic operations, complex compounds are converted into simple molecules by liberating energy that is utilised for synthesising new bacterial cells which then continue to further degradation of organic matter. Trickling filteration, activated sludge, oxidation ditch and anaerobic / aerobic ponding are some biological treatment methods used for treating industrial effluents.

3.2.2.11 TRICKLING FILTERATION.

This method is based on a counter current principle. The effluent is uniformally trickled on to a circular bed of 1.2 - 3.1 m depth of broken stones, log, coal, coke, chucker or other materials that are hard, durable, weather resistant, free from dust and of fairly uniform grinding . This process is assisted by a rotating four-arm distributer usually driven by the liquor head. The effluent passes through the bed by trickling in drops from one stone to the other and is ultimately removed from the bottom of the bed by suitable drains which also allow passage of air upwards through the bed.

When the filteration proceeds, the bed gradually acquires a sling , zoological film bacteria, protozoa, algae and fungi. This is the medium to which oxidisable organic matter and other substances are transfered from the effluent as they pass through the filter in the course of about half an hour. The end products of the decomposition - nitrates, carbon dioxide, sulphate - are then returned to the effluent.

3.2.2.12. ACTIVATED SLUDGE PROCESS.

The activated sludge process is an aerobic process similar in principle to the trickling filter except that the activate contact surface consists of zoological microbial growths or flocs produced within settled effluents and which are kept aerobic and in continuous circulation by maechanical or pneumatic stirring.

The effluent flows first into the aeration tank where mechanical agitation causes colloidal and suspended matter to aggregate into larger flocs which settle in the sedimentation tank and are drawn out from the bottom by a pump which returns it to the inlet of the aeration tank.

Purification in the activated sludge system occurs in two stages. During the first biosorption stage, colloidal and fine solids are adsorbed by the flocs and stored for sometime before assimilation takes place and the carbonous materials are converted into nitrate and nitrite.

3.2.2.13. OXIDATION DITCH.

Oxidation ditch method consists of a simple process of oxygenation in a tank of simple construction, usually an earthern ditch. The plant consists of a ring-shaped circuit or ditch with an aeration rotor mounted on it. The effluent in the circuit is made to flow at a displacement velocity of 30 cm per sec. and ply the aeration rotor regularly at brief intervals during which it becomes aerated.

3.2.2.14. ANAEROBIC / AEROBIC PONDING.

In this method the effluent is made to flow into two main ponds connected in series. The effluent is retained in both ponds for a specified period before it is discharged into a local stream or river.

The anaerobic pond is usually deep. Under certain conditions saprophylic bacterias can break down complex organic molecules into intermediates such as organic acids and alcohols. Methanogenic bacteria, then convert the intermediate organic compounds into carbon dioxide and methane.

In the aerobic pond, the aerobic bacteria decompose organic matters in the presence of oxygen into carbon dioxide and water. Carbon dioxide is then taken up by algae which in turn releases oxygen.

The removal of BOD, COD and Total Kjeldahl Nitorgen are efficient with optimal conditions of tratment (67) but, the presence of sulphate in the effluent gives rise to extensive evolution of hydrogen sulphide causing malodour and corrosion of the parameter fencing (54).

3.2.3. SELECTION OF THE TREATMENT METHOD.

Since the wastewaters discharged from the latex centrifuging factories are highly polluted (88), the effluent have enormous quantity of total solid contents both in the dissolved and suspended form along with many other pollutants. Rubber Research Institutes all over the world had conducted studies on these effluents and tried many methods for an effective treatment. A pilot plant scale trickling filter showed that 80 % of the inherent BOD could be removed; however the removal of nitrogen and sulphates were rather poor (89). The laboratory scale oxidation study (90) revealed that the acidified skim serum may be effectively treated to bring down the BOD and total nitrogen to level below 100 ppm with pH adjustment of the raw effluent. But the capital and running cost of the process could be quite high, which was documented by Gale in the preliminary design studies (91).

Studies have indicated that the treatment of rubber effluent using anaerobic facultive ponding system (54, 64 & 66) is an effective method for tratment of effluents from block rubber factories. Chick (92) reported that application of the ponding system method with retention period of thirty days in an aerobic facultive system reduce the BOD concentration of raw latex concentrate effluent to 100 ppm. However total nitrogen values remained high. Ponniah et. al. (51) reported that the anerobic three stage facultive system is capable of purifying effluents from latex concentrating factories effectively with a retention period of sixty days.

The main disadvantage of the anaerobic facultive system is that it requires a large area of land and longer retention period to achive an effective treatment. Also, the presence of the sulphate in the effluents from the latex centrifuging factories gives rise to extensive evolution of hydrogen sulphide resulting malodour and corrosion to the fencing (53). Thickly populated state like Kerala, the major rubber producing state and having most of the processing factories, the availability of wastelands for effluent tratment using anaerobic faculty tratment system is difficult and is not advisable also.

A large number of studies (93 - 106) had been reported about the efficiency of the effluent treatment with different folcculating agents. Lick et al. (107) showed the removal of pollutants by differencial setteling, Ives et al. (108) and Croue et al. (109) explained the removal of organic materials from the effluents by flocculation. Nashima et al. (1992) (110), Hsu et al. (1993) (111), Snowden et al. (1992 & 1993) (112 & 113), Peltan et al. (1989) (114), and Packman (1992) (115) explained the removal of polymer and latex particles from the effluent by flocculation treatment. Flocculation studies followed by oxidation (116) showed that it is an effective method of treatment for latex concentrate effluents. But oxidation is essential for getting maximum removal of pollutants especially for nitrogen.

The wastewater discharged from the latex concentrating factories not only have high degree of pollutants (Table - 3.1.1) but are highly turbid also. The turbidity is due to the suspened rubber particles. In order to get an effectively treated effluent, it is essential to remove these solid particles present in it. These solids are having very small particle size which are mostly in colloidal form and can be removed by settiling after flocculation.

In this study wastewater from latex concentrating factory was treated with different inorganic flocculants which are common, easily available and economical.

3.2.4. FLOCCULATION TREATMENT.

3.2.4.1. FLOCCULANTS.

Impurities may be reduced by the application of flocculants. Flocculating agents may be of inorganic or organic compounds based on their chemical composistion.

3.2.4.2. INORGANIC FLOCCULANTS.

Inorganic flocculants are mostly hydrolyzble salts of Aluminium and Iron (3). Generally used inorganic flocculants are Alum and its derivatives, Poly Aluminium Chloride (PAC), Sodium Aluminate, Silicon derivatives and Lime (117,118).

3.2.4.3 ORGANIC FLOCCULANTS.

Organic floculants are water soluble polymers of very high molecular weight ranging from 10 to 5 x 10 (119). Water solubility is referred to by the pressure of ionic and nonionic polar functional groups (117). Water soluble polymers may be synthesised or derived from natural sources. Synthetic polymers have changed subsists, termed as polyelectrolytes which are classified based upon the change in the sign of their ionic groups that is cationic, anionic and nonionic (118 - 120). Polysaccharide gums, Starch derivatives, Align derivatives, Chetin derivatives, Nucleoprotein etc. are some common natural organic flocculants.

3.2.5. FUNCTION OF FLOCCULANTS.

In general the function of flocculants is to aggregate or to bind small particles of suspension into a larger masses known as flocs.

It is also defined as the process of particle destabilization and collection into large aggregates (9 & 121). The main functions of flocculants are to create rapid separation of liquid phase from suspended phase, minimise the solic concentration in the liquid phase and maximise the solid content in the solid phase.

Each type of floc has a characteristic strength. If the shear rate increases the floc breaks up into small but stronger units. Likewise floc growth conditions are ultimatelly limited by the shear stress on water surface of the settling particles which increases as the particle grows to limitless size (122 - 124).

Hydroxides of trivalent ions such as $Al(OH)_3$ or $Fe(OH)_3$ join together with less of water to form dimers $(OH)_2Al\text{-}O\text{-}Al(OH)_2$ and higher polymers extending in three diamensions.

3.2.6. SAMPLE COLLECTION.

Samples were collected from the latex centrifuging factory near Kottaym , Kerala . They were collected from the bulking tank. These collected samples had huge quantity of total solid contents and were treated with various inorganic flocculants which are easily available and cheap. In this study the flocculants used are alum, lime, ferric chloride and mixtures containing these flocculants in various proportions.

3.2.7. DOSAGE.

Trials were made on raw effluent by adding various quantities of lime to get a visually clear solution. It is found that with 0.25% of lime the solution was clear and the flocculants were settling in a minimum period of time. Hence dosage of 0.25% of lime has been used throught the study.

Trials were also made with combination of lime 0.25% and various quantities of Aluminium alum and it was found that with 0.05% visually clear solution could be obtained at a minimum settling time. Hence 0.05% of flocculants has been added through out the experiment. The following are the compositions of different flocculants used:

Sl. No	Composition	Treatment No
1.	Lime 0.25%	A
2.	Lime 0.25% + Aluminium alum 0.05%	B
3.	Lime 0.25% + Ferric chloride 0.05%	C
4.	Lime 0.25% + Pickle liquor 0.05%	D
5.	Aluminium alum 0.05%	E
6.	Ferric chloride 0.05%	F

Pickle liquor is a by-product from elecrto chemical factories which contains ferric/ferrous salts.

After the addition of the chemicals, the effluent was mixed well and allowed to settle. It was then filtered through using Whatman-No.1 filter paper and was analysed for various parameters such as pH, Chemical Oxygen Demand (COD), Biochemical Oxygen Demand (BOD) at 20 deg C for 5 days, Total Solids (TS), Total Kjeldahl Nitrogen (TKN) and Ammoniacal Nitrogen (AN). The determinations were made according to the procedures described in the Standard Method for the Examination of Water and Wastewater (59), the Methods of Sampling and Test for Water used in Industry (60), and Mannual of Laboratory Methods of Chemical Analysis of Rubber Effluent (61).

3.2.8. EFFECT OF DIFFERENT FLOCCULANTS ON POLLUTANTS.

Table - 3.2.1 and 3.2.2 give the effect of different flocculants on the raw effluents from the latex concentrating factories and the percentage removal of pollutants from effluents when treated with various flocculating agents. Results of five samples are discussed here.

3.2.8.1 EFFECT ON pH

The raw effluent has a pH 4.8 only. This is due to the addition of acid while coagulating the rubber from the skim. By adding lime (A), the pH has risen to 9.1 which is more than the limit specified by BIS (Table - 3.1.2).

By the treatments B and C the pH has risen to 8.6 and 8.4 respectively, which are also slightly above the limit. But in E and F there is not much rise in pH. By treatment D, the pH has risen to 7.7 which is within the limits (Figure - 3.2.1). Thus treatment D appears to be best suited for maintaining proper pH of the effluent.

3.2.8.2. CHEMICAL OXYGEN DEMAND (COD).

The Chemical Oxygen Demand (COD) of the raw sample is 5250 mg/l. Figure - 3.2.2 & 3.2.3 depicts the COD values and their percentage reduction. It is clear that tratments C and D are giving almost same amount of percentage reduction viz. 95.43 and 95.62 respectively. The actual COD values with treatment C and D are 240 mg/l and 230 mg/l which are well within the permissible limit. Treatments A, B, E and F gave COD values of 2160 mg/l, 440 mg/l, 3190 mg/l and 2620 mg/l respectively which are above the permissible limit.

3.2.8.3. BIOCHEMICAL OXYGEN DEMAND (BOD).

The Biochemical Oxygen Demand (BOD) of raw effluent has a value of 2870 mg/l. Treatments A, B, C, D, E and F gave the values of 990, 180, 80, 74, 1290 and 1270 mg/l respectively (Figure - 3.2.2 & 3.2.3). Thus the BOD values reported for A, B, D and F are high and above the limit. But the values for C and D (80 and 74 mg/l) respectively are well within the limit.

3.2.8.4. TOTAL DISSOLVED SOLIDS (TDS).

The treatments C and D could remove the TDS contents to the extent of 83.80 % and 84.18 % respectively (Figure - 3.2.4 & 3.2.5). The TDS values for C and D of 2050 mg/l and 2000 mg/l respectively are within the limit. As in the case of other parameters the treatments A, B, E and F are not much effective for the removal of TDS (Tables - 3.2.1 & 3.2.2).

3.2.8.5. TOTAL KJELDAHL NITROGEN (TKN).

The Total Kjeldahl Nitrogen (TKN) content of the raw sample is 840 mg/l. The maximum reduction of TKN is obtained by treatment C and D (Figure - 3.2.6 & 3.2.7) and the actual values obtained after treatment C and D of 420 mg/l and 410 mg/l respectively are much high.

3.2.8.6. AMMONIACAL NITROGEN.

Also in the case of Ammoniacal Nitrogen(AN), the maximum reduction of 56.14% was obtained by both the treatment C and D (Figure - 3.2.6 & 3.2.7) and the actual value of Ammoniacal Nitrogen obtained (250 mg/l) was very high.

3.2.8.7. FREE AMMONIA.

The raw effluent has free ammonia content of 250 mg/l. In the treatments A, B, C, D, E and F (Figure - 3.2.6 & 3.2.7), the maximum reduction of 59.99% was obtined by the treatment C though the actual value (110 mg/l) is very high.

3.2.8.8. SULPHIDES.

The treatments C and D could remove the sulphides completely from the effluent (Figure - 3.2.8 & 3.2.9). The treatments A, B, E and F are not so effective as C and D though they removed the sulphides to 75.0, 83.33, 75.0 and 75.0 percentages respectively.

3.2.8.9. PHOSPHATES.

The phosphate content of the raw sample is 60 mg/l. The maximum removal of the phosphate was obtained by the treatments C and D (Figure - 3.2.8 & 3.2.9). The actual values obtained after treatments C and D (28 mg/l and 27 mg/l respectively) are much above the limit.

Since none of the above treatment is effective in the removal of phosphate, it is studied separately and discussed in the next part.

TABLE-3.2.1: EFFECT OF DIFFERENT FLOCCULANTS ON LATEX CONCENTRATE EFFLUENTS

PARAMETERS	TREATMENTS						
	CONTROL	A	B	C	D	E	F
pH	4.8	9.1	8.6	8.4	7.7	5.5	5.3
COD	5250	2160	440	240	230	3190	2620
BOD	2870	990	180	80	74	1290	1270
TDS	12640	3470	3090	2050	2000	4790	4590
TKN	840	680	490	420	410	660	660
AN	570	410	310	250	250	430	430
FA	250	200	60	110	120	190	180
S	12	3	1	0	0	3	3
P	60	30	37	28	27	46	44

All values except pH are in mg/l

A = LIME

B = LIME + ALUMINIUM ALUM

C = LIME + FERRIC ALUM

D = LIME + PICKLE LIQUOR

E = ALUMINIUM ALUM

F = FERRIC CHLORIDE

TABLE - 3.2.2: PERCENTAGE REMOVAL OF DIFFERENT FLOCCULANTS

PARAMETERS	TREATMENTS					
	A	B	C	D	E	F
COD	58.86	61.92	95.43	95.62	39.24	50.11
BOD	65.51	93.73	97.21	97.42	55.05	55.75
TDS	72.55	75.55	83.81	84.18	62.11	63.69
TKN	19.05	41.67	50.04	51.14	21.43	21.43
AN	28.07	45.61	56.14	56.14	24.56	23.81
FA	20.02	36.01	59.99	52.02	23.99	27.99
S	75.04	83.33	100	100	75.01	74.99
P	50.01	38.31	53.02	49.98	23.33	26.67

A = LIME
B = LIME + ALUMINIUM ALUM
C = LIME + FERRIC ALUM
D = LIME + PICKLE LIQUOR
E = ALUMINIUM ALUM
F = FERRIC CHLORIDE

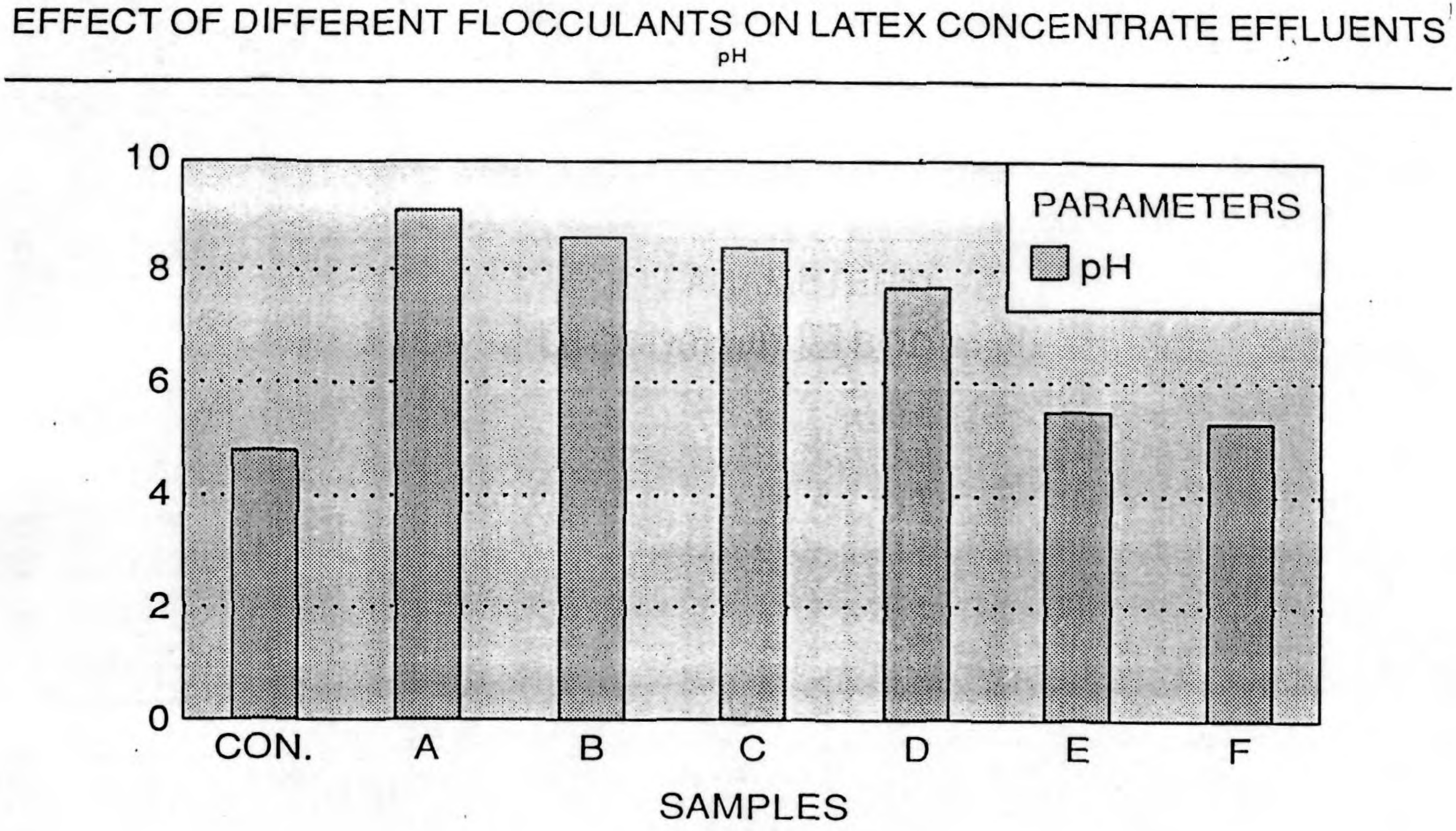


FIGURE - 3.2.1
A = LIME , B = LIME + Al. ALUM , C = LIME + FERRIC ALUM
D = LIME + PICKLE LIQUOR , E = Al. ALUM , F = Fe Cl3

EFFECT OF DIFFERENT FLOCCULANTS ON LATEX CONCENTRATE EFFLUENTS
COD AND BOD

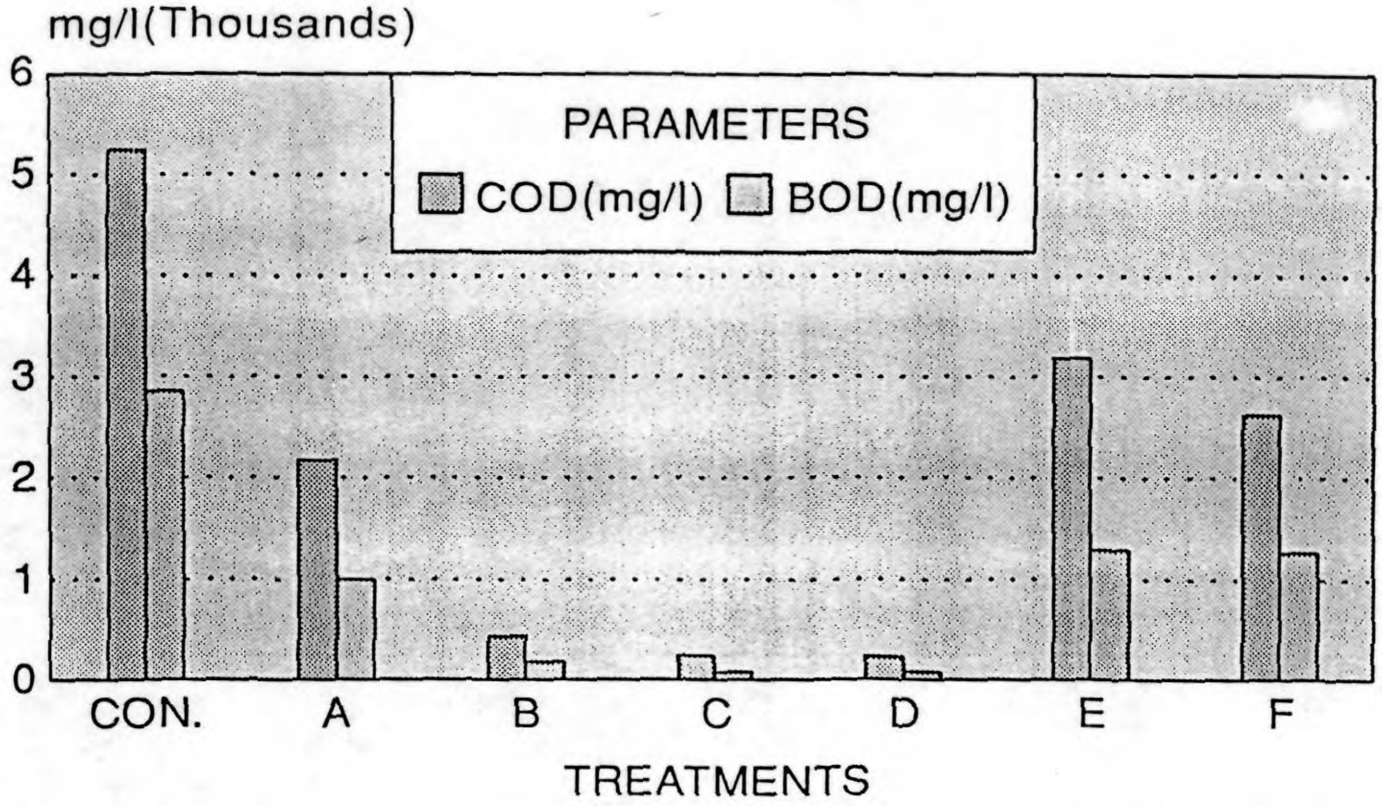


FIGURE - 3.2.2
A = LIME, B = LIME + AL. ALUM, C = LIME + FERRIC ALUM,
D = LIME + PICKLE LIQUOR, E = AL. ALUM, D = FECl3

EFFECT OF DIFFERENT FLOCCULANTS ON LATEX CONCENTRATE EFFLUENTS

COD AND BOD : PERCENTAGE REMOVAL

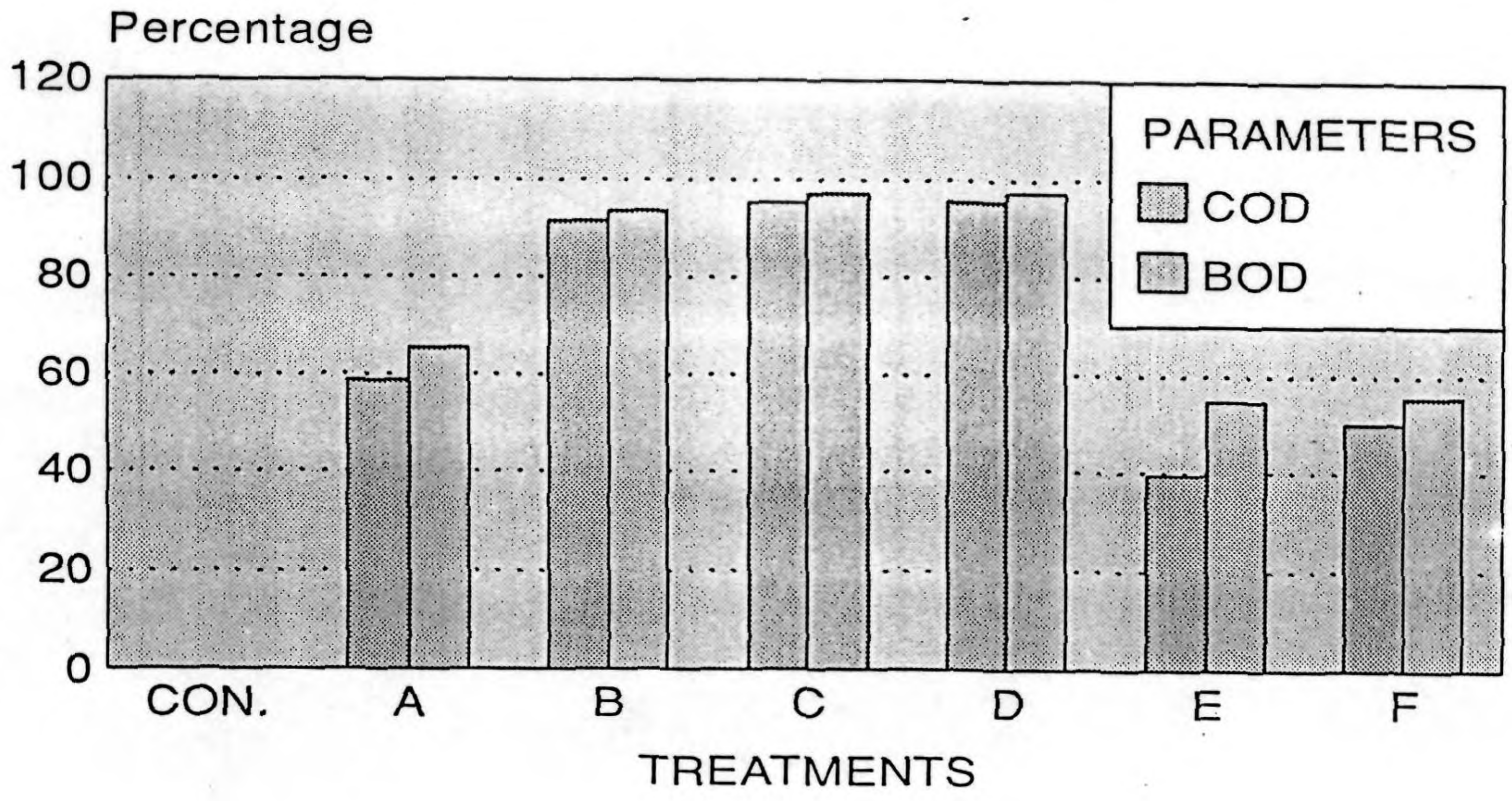


FIGURE - 3.2.3
A = LIME, B = LIME + Al .ALUM, C = LIME + Fe. ALUM,
D = LIME + PICKLE LIQUOR, E = Al. ALUM, D = FeCl3

EFFECT OF DIFFERENT FLOCCULANTS ON LATEX CONCENTRATE EFFLUENTS

TOTAL DISSOLVED SOLIDS (TDS)

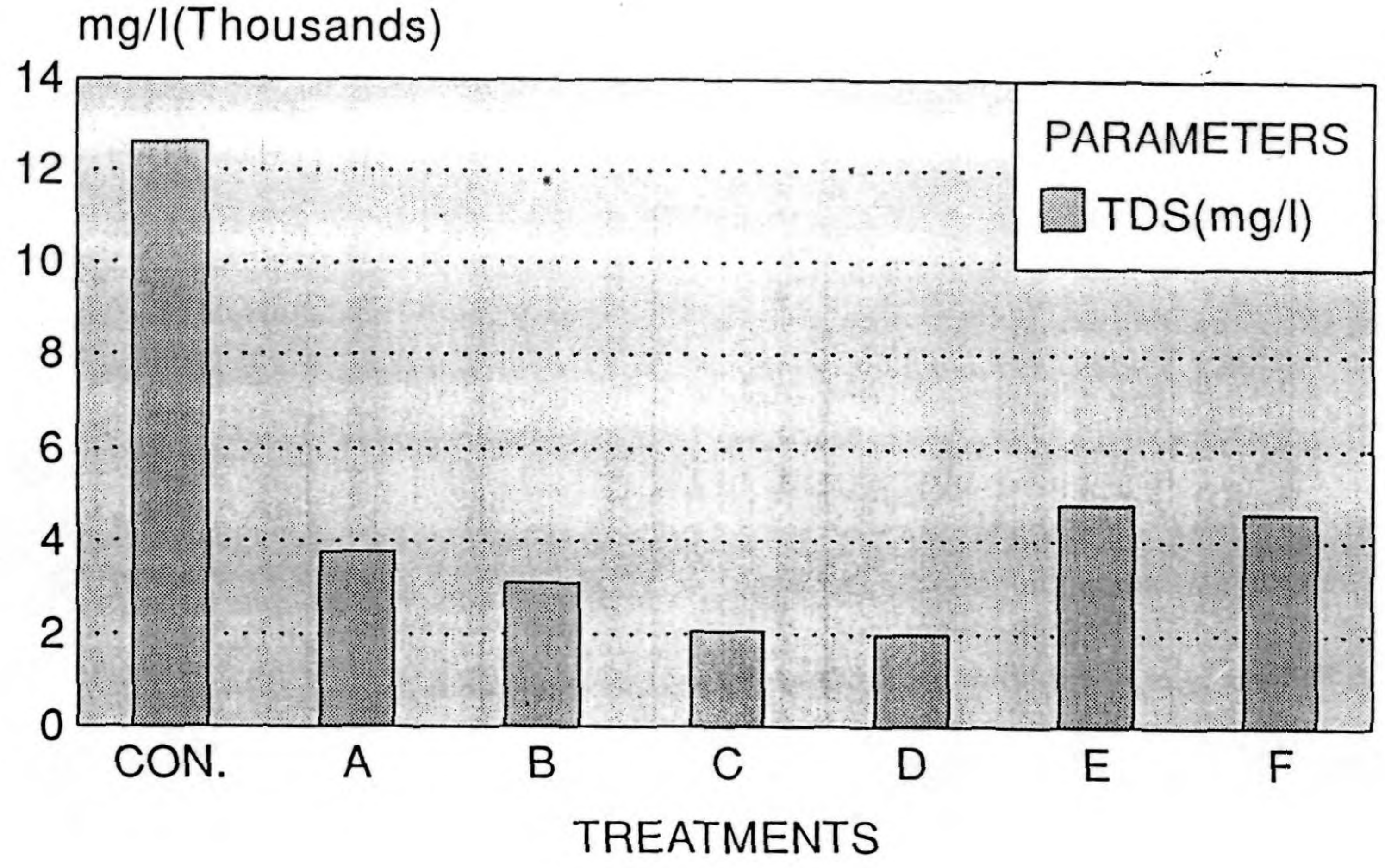


FIGURE - 3.2.4

A = LIME , B = LIME + Al. ALUM , C = LIME + FERRIC ALUM

D = LIME + PICKLE LIQUOR , E = Al. ALUM , F = Fe Cl3

EFFECT OF DIFFERENT FLOCCULANTS ON LATEX CONCENTRATE EFFLUENTS

PERCENTAGE REMOVAL : TOTAL DISSOLVED SOLIDS (TDS)

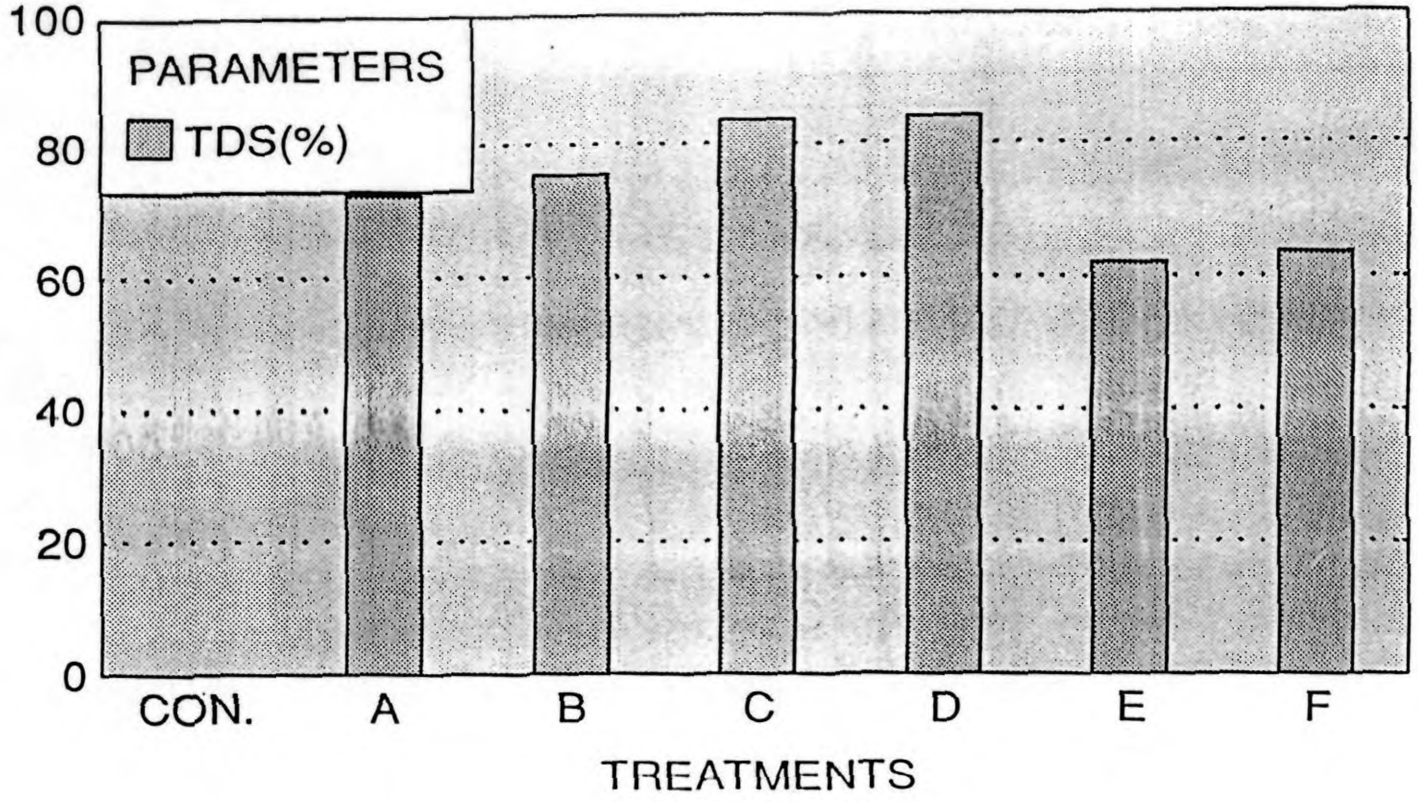


FIGURE - 3.2.5

A = LIME, B = LIME + Al. ALUM, C = LIME + Fe. ALUM,
D = LIME + PICKLE LIQUOR, E = Al. ALUM, F = FeCl3

EFFECT OF DIFFERENT FLOCCULANTS ON LATEX CONCENTRATE EFFLUENTS
TOTAL KJELDHAL NITROGEN(TKN),AMM. NITROGEN(AN) AND FREE AMMONIA(FA)

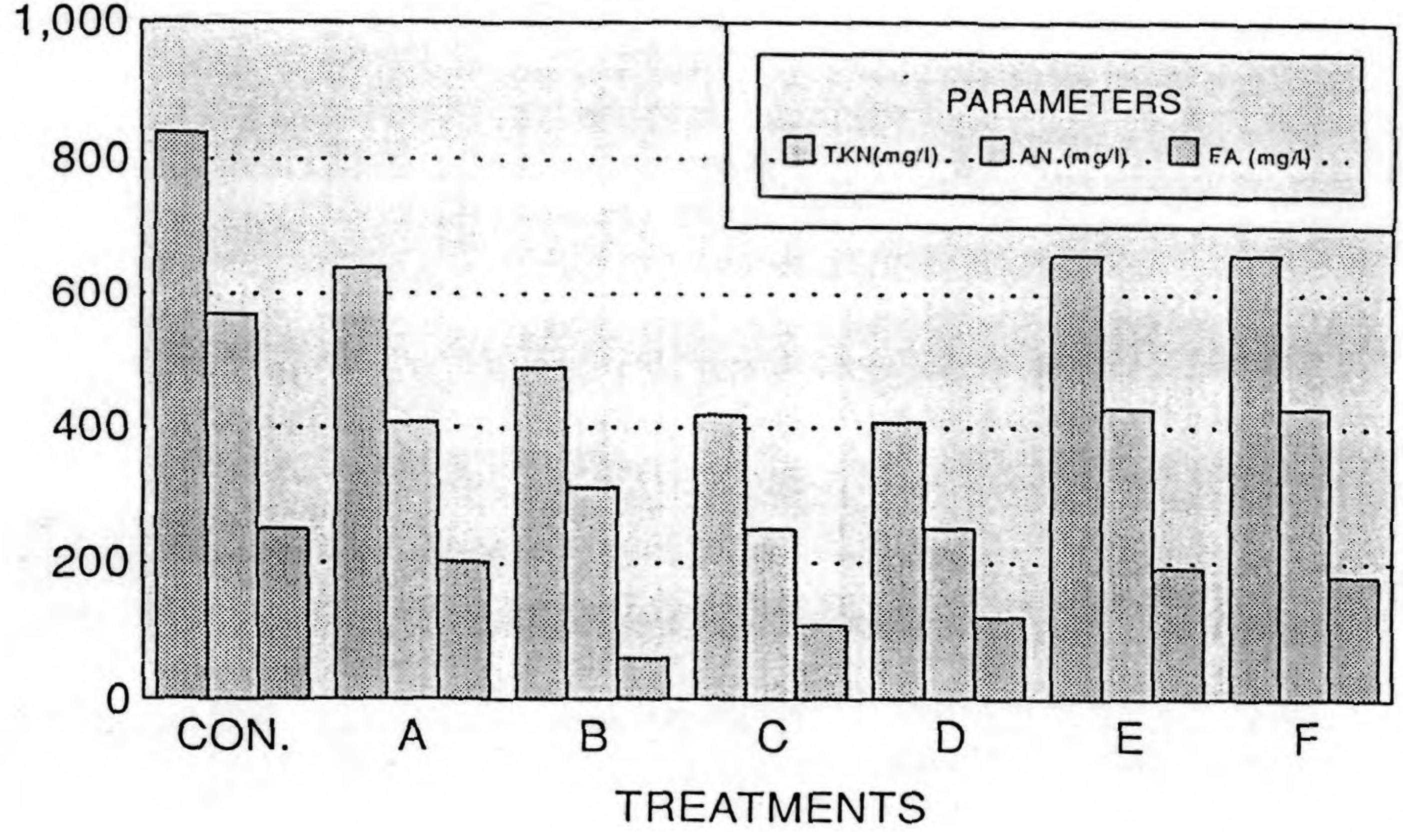


FIGURE - 3.2.6
A = LIME, B = LIME + Al ALUM, C = LIME + Fe ALUM
D = LIME + PICKLE LIQUOR, E = Al ALUM, F = FeCl3

EFFECT OF DIFFERENT FLOCCULANTS ON LATEX CONCENTRATE EFFLUENTS

PERCENTAGE REMOVAL : TKN, AN AND FA

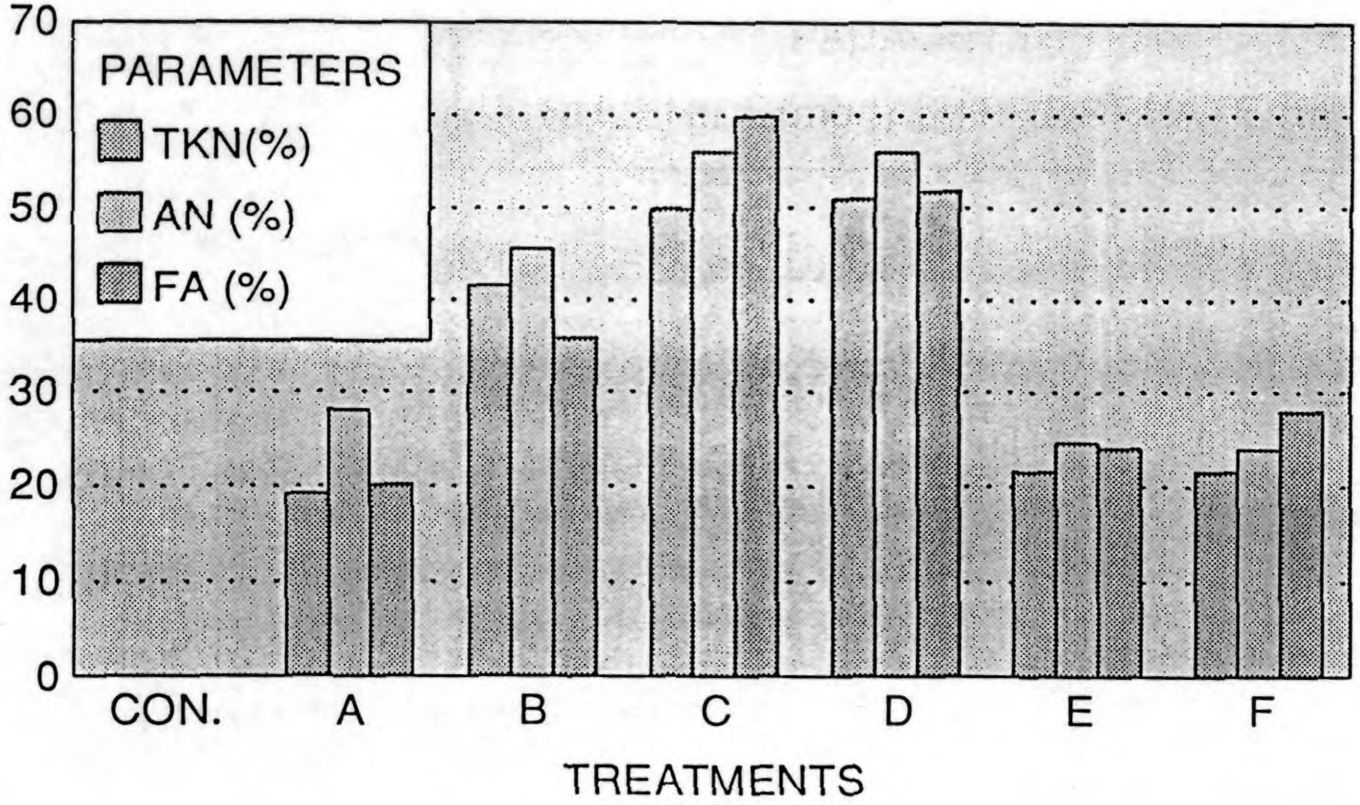


FIGURE - 3.2.7

A = LIME, B = LIME + Al. ALUM, C = LIME + Fe. ALUM
D = LIME + PICKLE LIQUOR, E = Al. ALUM, F = $FeCl_3$

EFFECT OF DIFFERENT FLOCCULANTS ON LATEX CONCENTRATE EFFLUENTS

SULPHIDE AND PHOSPHATE

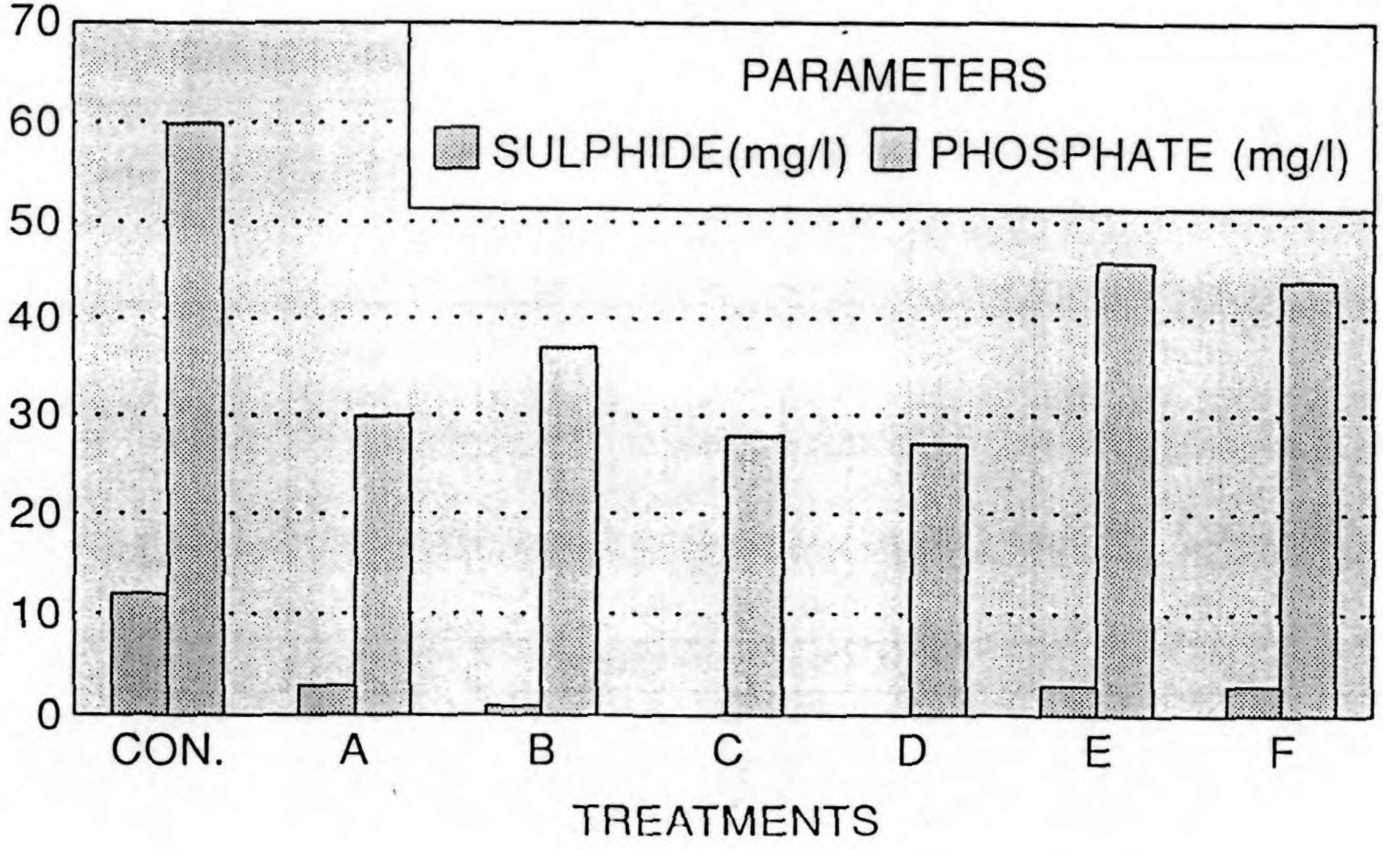


FIGURE - 3.2.8

A = LIME , B = LIME + Al. ALUM , C = LIME + Fe. ALUM
D = LIME + PICKLE LIQUOR , E = Al. ALUM , F = Fe Cl3

EFFECT OF DIFFERENT FLOCCULANTS ON LATEX CONCENTRATE EFFLUENTS

PERCENTAGE REMOVAL : SULPHIDES AND PHOSPHATES

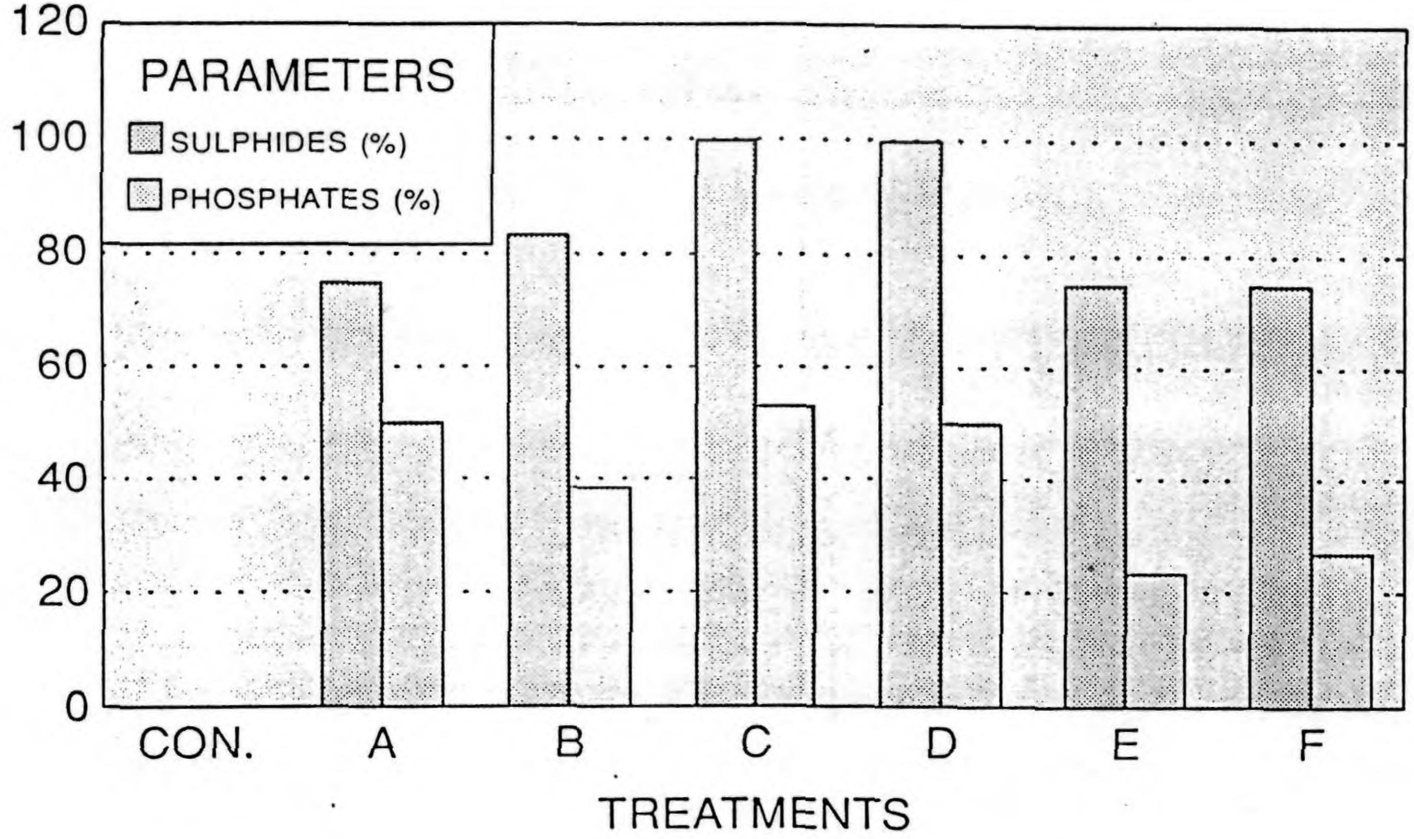


FIGURE - 3.2.9

A = LIME , B = LIME + Al. ALUM , C = LIME + Fe. ALUM
D = LIME + PICKLE LIQUOR , E = Al. ALUM , F = Fe Cl3

CHAPTER - III

PART-III

REMOVAL OF PHOSPHATES

3.3.1 EFFICIENCY OF DIFFERENT FLOCCULANTS.

Ecological interest in phosphrous has arisen because of its major role in biological metabolism and relatively small amount of phosphrous found in hydrosphere. The importance of phosphate in natural waters has been stressed by several authors (125 - 126).

Wastewater discharged from rubber factory contains substantial amount of phosphates (Table - 3.2.1). Several studies conducted on the feasibility of the application of these effluents on land (68 - 75) have shown that it is environmentaly acceptable and economicaly viable. Studies also indicated that it can be used.as a source of fertilizer and water for crops (66 - 77) Karim et al. (1989) (127) showed that the nitrogen content present in the rubber is high and plants may take more nitrogen. Grunebaum et al. (1992) (103) and Thomas et al. (1992) (128) explained the effect of precipitation and flocculation on the removal of phosphates from industrial effluents.

3.3.2. FLOCCULATING AGENTS AND THEIR REACTIONS.

In this study the removal efficiency of different flocculating agents was studied. The different flocculating agents are Lime, Ferric Alum, Ferric Chloride, Ferrous sulphate, Alumina and Poly aluminium Chloride.

Lime precipitates phosphates as calcium dihydrogen phosphate (129) at an optimum pH of 6 to 7.

$$2H_3PO_4 + Ca(OH)_2 \longrightarrow Ca(H_2PO_4) + 2H_2O$$

Also Calcium phosphate precipitation will take place at pH 9 to 10 (129).

$$Ca(H_2PO_4)_2 + 2Ca(OH)_2 \longrightarrow Ca_3(PO_4)_2 + 2H_2O$$

With Ferric and Ferrous salts, phosphates form complex of ferric hydroxo phosphate (129) which are insoluble in water and settle down in setteling tanks.

Aluminium precipitates phosphates as aluminium phosphate which is sparingly soluble and can be removed by adsorption on an excess of metallic hydroxide.

3.3.3. TREATMENT

The effluent samples colleced from latex centrifuging factory were treated with the flocculating agents and the effect of removal of phosphates was studied. Different quantites of flocculating agents were added to the effluent during treatment, because same doseage was not sufficent for getting a clear solution. This became obvious while conducting trials.

The following are the different flocculating agents added to the effluent.

Flocculating agents	Amount(gm/l)
1. Lime	2.000
2. Ferric alum	0.100
3. Ferric chloride	0.100
4. Ferrous sulphate	0.100
5. Poly aluminium chliride	0.020
6. Alumina	0.500

The flocculating agent was added to the effluent after adjusting the pH above 9 by adding lime. The efficient floccuation will take place with the above flocculants in the solutions of alkaline range of pH only which was observed during the expriment.

3.3.4. REMOVAL OF PHOSPHATES BY FLOCCULANTS.

In the control samples the phosphate is in the range of 238 mg/l to 640 mg/l (Table - 3.3.1). These values are very high and are attributed to the effluent from the diammonium hydrogen phosphate added to the latex while removing the magnesium.

3.3.4.1. EFFECT OF LIME.

After the treatment with lime the phosphate content of the effluent was reduced to the range varying from 0.82 mg/l to 2.25 mg/l. The rate of removal is almost proportional to the concentration. The phosphate removal (Table - 3.3.2) of above 99% varies from 99.56% to 99.96% (Fig. 3.3.1). The maximum retained phosphate content was 2.25 mg/l observed with the effluent having 640 mg/l which is highest among the reported values.

3.3.4.2. EFFECT OF FERRIC ALUM.

With ferric alum, phosphate reduction varies from 99.62% to 99.87% (Fig. 3.3.1). The phosphate content after treatment was observed in all cases except the 5th one (having 640 mg/l of phosphate), are well below 1 mg/l. In the 5th sample the retained phosphate content is 2.25 mg/l, which is very well below the maximum limit of 5 mg/l prescribed by BIS (Table - 3.1.2) and the removal is 99.66%.

3.3.4.3. EFFECT OF FERRIC CHLORIDE.

Ferric chloride also gave an avrage removal of 99.76% varying from 99.66% to 99.95% (Fig.3.3.1). In this case also the removal tendency is almost same as that of the previous cases.In the case no.5 the retained phosphate content of 3.0 mg/l was the highest value observed with the treatment with ferric chloride. All other values were bellow 1 mg/l in the range of 0.20 mg/l to 0.80 mg/l.

3.3.4.4. EFFECT OF FERROUS SULPHATE.

With ferrous sulphate, the reduction of phosphate is slightly better. The removal is in the range of 99.70% to 99.92%. For sample 5 there is only 1.95 mg/l was found after treatment with ferric chloride. In all other samples the retained phosphate was in the range of 0.32 mg/l to 0.60 mg/l.

3.3.4.5. EFFECT OF POLY ALUMINIUM CHLORIDE.

Poly aluminium chloride was showing a removal of phosphate in the range of 99.74% to 99.98%, and the values were from 0.16 mg/l to 5.65 mg/l. Similar to the previous cases the highest observed value of 5.65 mg/l was obtained for the sample 5 and for all other four samples the retained quantity was in the range of 0.16 mg/l to 0.40 mg/l. The lower values were lower than that of other treatments, and the removal was 99.80% and above.

3.3.4.6. EFFECT OF ALUMINA.

Alumina gives a reduction of phosphate almost same as that of ferric sulphate. The removal is in the range of 99.68% to 99.90% (Fig.3.3.1) and the retained values of phosphate vary from 0.43 mg/l to 2.05 mg/l. As in the earlier cases, the highest value was observed with the sample 5 which also showed the highest concentration 640 mg/l of phosphate in the control.

From the observations it became apparent that, the floccuating agents used in this study are capable of removing phosphates from wastewater (Fig. 3.3.1). However poly aluminium chloride is the most efficient among them, and the quantity of the chemical required for the treatment (0.020 gm/l) is also less compared to the ferric salts, ferrous salts (0.1 gm/l each) and of alumina (5.0 gm/l).

3.3.5. EFFECT OF pH ON REMOVAL OF PHOSPHATES.

The pH of the reacting medium has a very important role in flocculation. The different types of flocculants required different pH for attaing the optimum removal of pollutent by coagulation/ flocculation (129).

3.3.6. TREATMENTS.

The effluent samples collected from latex centrifuging factory were first treated with the flocculating agent and pH was adjusted by adding lime solution or dilute hydrochloric acid. The flocculants used are ferric alum, ferric chloride, ferrous sulphate, alum and poly aluminium chloride. The quantities of flocculants used are as in the previous study.

3.3.7.1 EFFECT WITH LIME

Table - 3.3.3. shows the effect of pH on the removal of phosphates with lime as flocculant. The control sample had 280 mg/l of phosphate content, and it decreased gradually to a minimum of 0.20 mg/l at pH 12. The maximum reduction observed at pH 12 was 99.92 %. The Figure - 3.3.2. shows that the removal effiency increases with rise of pH. However the reduction of phosphate after the pH 9 is not so sharp, where the removal is 99.5179% and it can be considerded as the optimun efficiency for lime.

3.3.7.2. EFFECT WITH FERRIC ALUM.

With ferric alum, removal of phosphate increases with rise of pH (Table - 3.3.4) and complete removal was observed with pH 10 and above (Fig - 3.3.2).

3.3.7.3. EFFECT WITH FERRIC CHLORIDE

The initial phosphate content of the untreated wastewater was 232 mg/l (Table -3.3.5). On treating with the flocculating agent (Ferric chloride) at different pH , a sharp decrease in the concentration upto pH 8 was observed and thereafter the removal was almost steady (Figure - 3.3.2). 0.28 mg/l of phosphate was retained at pH 12 with the maximum reduction of 99.93% . 99.74% removal obtained at pH 9 can be considered as the optimum codition for ferric chloride for removal of phosphate from wastewater from latex concentrating factories.

3.3.7.4. EFFECT WITH FERROUS SULPHATE

For ferrous sulphate also, same trend was observed as in previous cases, for the removal of phosphate at different pH ranges (Table - 3.3.6.). The 230 mg/l of phosphate was reduced sharply upto pH 9 and then the decrease was slow (Figure - 3.3.2). The highest reduction obtained at pH 12 was a removal of 99.89% with a retention of 0.25 mg/l. At pH 9 the removal obtained was 99.78% with retention of 0.50 mg/l. Thus pH 9 can be considered as the optimum pH for the removal for phosphate because above that pH, the Figure - 3.3.2 shows very slight removal.

3.3.7.5. EFFECT WITH ALUMINA.

The initial concentration of 220 mg/l of the phosphate content of the raw effluent was decreased sharply upto the pH 10, with alumina as flocculant with increase of pH. At pH 10 the observed value was 0.30 mg/l and the reduction was 99.86% (Table - 3.3.7.). On further rise of pH, no more removal had been observed, which was clearly indicated by the straight line after the pH 10 (Fig. - 3.3.2). Hence the optimum pH for the removal of phosphate with alum flocculant was 10.

3.3.7.6 EFFECT WITH POLY ALUMINIUM CHLORIDE.

On raising the pH, with poly aluminium chloride floccculant, the removal of phosphate became effective from pH 9 onwards only. At pH 10 the removal was 98.85% (Table - 3.3.8) with a retention of 2.60 mg/l of phosphate. A removal of 99.86% with a retention of 0.32 mg/l of concentration was obtained at pH 10 and the reduction was on increase till it attained a maximum of 100% removal at pH 12 (Fig. 3.3.2).

The differerent flocculating agents required different pH of the reacting medium for the effective removal of posphates from wastewater of latex concentrating factories.However at pH 10 and above, all the flocculants studied are giving an efficent removal of phosphate.

TABLE - 3.3.1 : EFFECT OF DIFFERENT FLOCCULANTS ON PHOSPHATES

TREATMENTS	PHOSPHATES AS P (mg/l)				
	Sample.1	Sample.2	Sample.3	Sample.4	Sample.5
CONTROL(RAW)	365	517	238	430	640
LIME	0.88	0.82	1.0	0.9	2.25
Fe.Alum	0.72	0.74	0.9	0.5	2.20
Fe.Chloride	0.20	0.72	0.8	0.7	3.00
Fe.Sulphate	0.32	0.45	0.4	0.6	1.95
PAC	0.16	0.18	0.4	0.2	5.65
Alumina	0.47	0.77	0.4	0.2	2.06

TABLE-3.3.2: PERCENTAGE REMOVAL OF PHOSPHATE WITH DIFFERENT FLOCCULANTS

TREATMENTS	PHOSPHATES AS P (PERCENTAGE)					
	Sample.1	Sample.2	Sample.3	Sample.4	Sample.5	Average
LIME	99.96	99.84	99.56	99.79	99.65	99.72
Fe.Alum	99.80	99.85	99.62	99.87	99.65	99.76
Fe.Chloride	99.95	99.86	99.66	99.82	99.50	99.76
Fe.Sulphate	99.91	99.92	99.81	99.86	99.70	99.85
PAC	99.96	99.98	99.83	99.95	99.74	99.89
Alumina	99.87	99.85	99.80	99.90	99.68	99.82

TABLE - 3.3.3 : EFFECT OF LIME ON PHOSPHATE REMOVAL AT DIFFERENT pH

pH	PHOSPHATE (mg/l)	PERCENTAGE REMOVAL
4.8 (CONTROL)	280.00	-----
6.0	15.76	94.37
7.0	8.84	96.84
8.0	3.42	98.77
9.0	1.35	99.51
10.0	0.88	99.68
11.0	0.32	99.88
12.0	0.20	99.92

TABLE - 3.3.4 : EFFECT OF Fe.ALUM ON PHOSPHATE REMOVAL AT DIFFERENT pH

pH	PHOSPHATE (mg/l)	PERCENTAGE REMOVAL
4.8 (CONTROL)	470.00	-----
6.6	13.76	99.07
7.0	11.84	97.48
8.0	5.84	98.76
9.0	2.64	99.44
10.0	1.00	99.79
11.0	0.54	99.89
12.0	0.40	99.91

TABLE - 3.3.5 : EFFECT OF FERRIC CHLORIDE ON PHOSPHATE REMOVAL AT DIFFERENT pH

pH	PHOSPHATE (mg/l)	PERCENTAGE REMOVAL
3.7 (CONTROL)	232.00	-----
6.0	156.00	32.76
7.0	128.00	44.83
8.0	1.80	99.22
9.0	0.61	99.74
10.0	0.40	99.83
11.0	0.33	99.88
12.0	0.28	99.93

TABLE - 3.3.6 : EFFECT OF FERROUS SULPHATE ON PHOSPHATE REMOVAL AT DIFFERENT pH

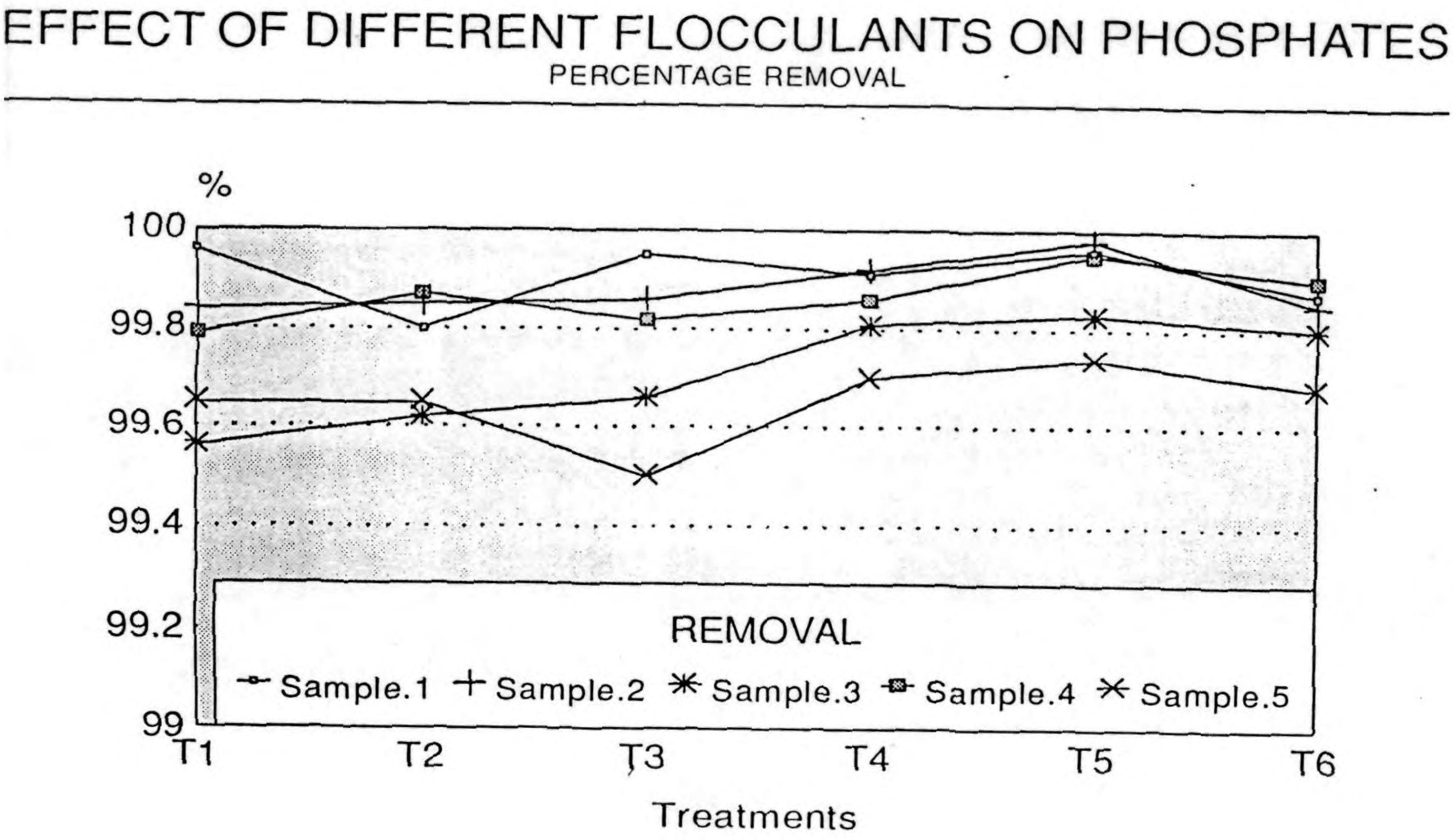
pH	PHOSPHATE (mg/l)	PERCENTAGE REMOVAL
3.7 (CONTROL)	230.00	-----
6.0	132.00	43.48
7.0	1.81	97.91
8.0	0.70	99.26
9.0	0.50	99.78
10.0	0.32	99.87
11.0	0.25	99.89
12.0	0.25	99.89

TABLE - 3.3.7 : EFFECT OF ALUMIA ON PHOSPHATE REMOVAL AT DIFFERENT pH

pH	PHOSPHATE (mg/l)	PERCENTAGE REMOVAL
3.4 (CONTROL)	220.00	-----
6.0	84.00	61.81
7.0	20.00	90.51
8.0	15.00	93.18
9.0	2.61	98.82
10.0	0.30	99.86
11.0	0.25	99.86
12.0	0.04	99.98

TABLE - 3.3.8 : EFFECT OF POLY ALUMINIUM CHLORIDE ON PHOSPHATE REMOVAL AT DIFFERENT pH

pH	PHOSPHATE (mg/l)	PERCENTAGE REMOVAL
3.4 (CONTROL)	226.00	-----
6.0	220.00	2.66
7.0	210.00	7.08
8.0	115.00	49.12
9.0	7.80	96.54
10.0	2.62	98.85
11.0	0.32	99.86
12.0	0.00	100.00



EFFECT OF DIFFERENT FLOCCULANTS ON PHOSPHATES
PERCENTAGE REMOVAL

FIGURE - 3.3.1
T1 = LIME, T2 = Fe ALUM, T3 = FeCl3,
T4 = FeSO4, T5 = PAC, T6 = ALUMINA

EFFECT OF pH WITH DIFFERENT FLOCCULANTS ON PHOSPHATES

PERCENTAGE REMOVAL

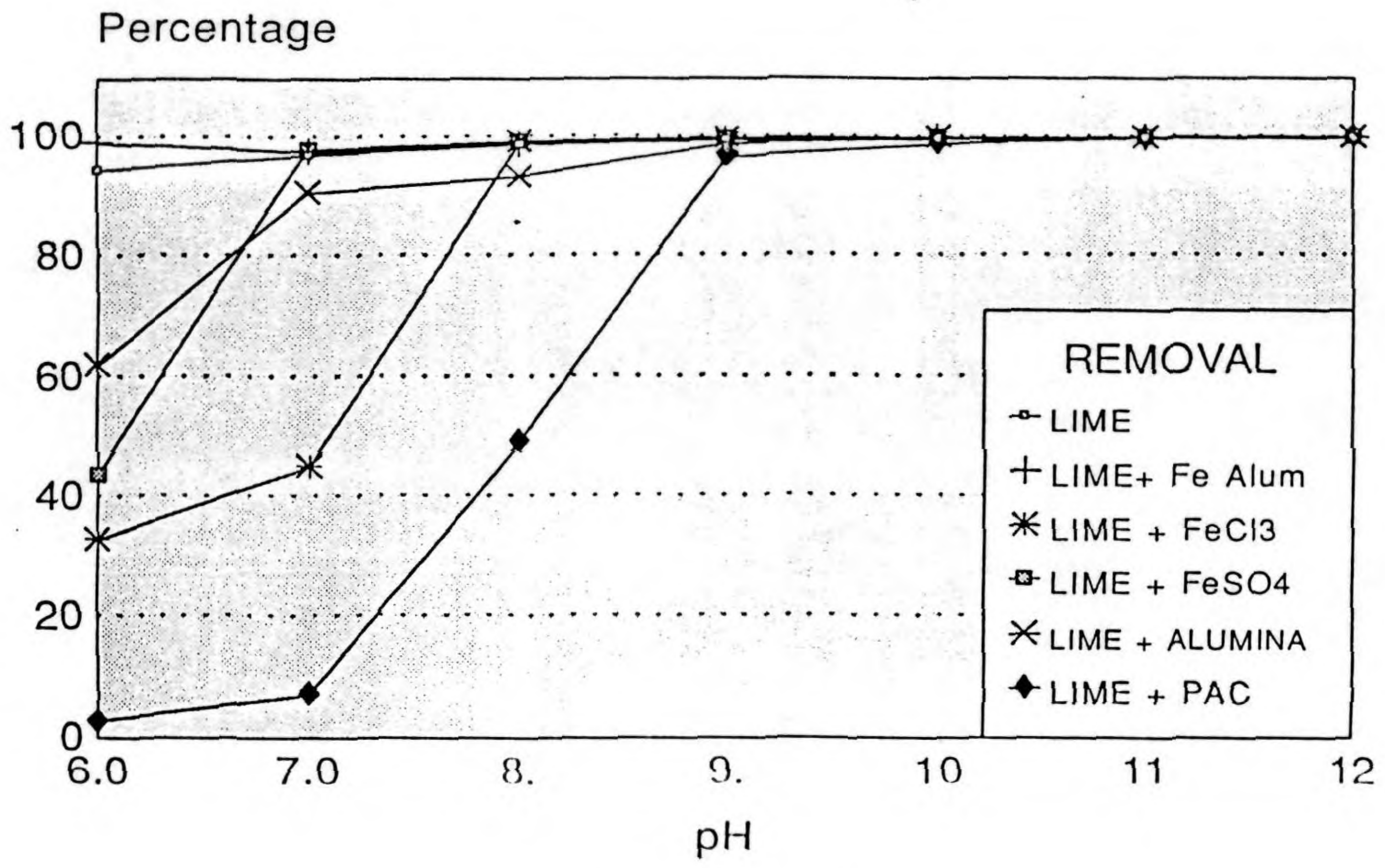


FIGURE - 3.3.2

CHAPTER - III

PART - IV

REMOVAL OF NITROGEN

3.4. EFFICIENCY OF DIFFERENT FLOCCULANTS.

The raw effluent from the latex centrifuging factory having enormous quantity of nitrogen (Table - 3.1.1) in the form of free ammonia, ammoniacal nitrogen and organic nitrogen which was attributed to the effluent mainly from the ammonia added to the latex as a preservative during the processing.

Several studies have been conducted by the the Rubber Research Institutes from all over the world for the removal of nitrogen from rubber factory effluents. Experience has shown that adequate removal of organics from the effluent can be achieved, but removal of nitrogen is poor (130). Laboratory studies have demonstrated the applicability of oxidation ditch process to remove ammonical nitrogen (67, 131 & 132). Full scale areation with oxidation ditch system have also found to be less effective in removing nitrogen from the latex concentrate effluents (130). Laboratory investigations have shown that if this oxidation ditch treatment is given for a longer time more efficiency can be achieved (132). Feasibillity of the application of these effluents on land (68 - 73) and utility of these as a fertilizer (73 - 76) were also investigated by various researchers and it was shown by Karim et al (1989) (127) that the leachneates contained significantly higher ammoniacal nitrogen, and ground water may affect the nitrogen. Nitrification is an effective method for the removal of nitrogen, and the studies (130) have shown that sufficent agitation is required to shear the large flocs in order to provide more surface area though it will increase the requirement of power.

The effect of some flocculants are studied on the efficiency of removal of nitrogen (Table - 3.2.1 & 3.2.2) and the maximum removal obtained was 51.14% with pickle liquor and 50.00% with ferric alum. Hence study of other flocculating agents such as Poly Aluninium Chloride, Alumina, and Non Ionic Poly Electrolyte were conducted on the removal of nitrogen for their optimum conditions like pH and concentration.

3.4.1. EFFECT OF POLY ALUMINIUM CHLORIDE

3.4.1.1. TREATMENTS

The effluents collected from latex concentrating factory was first adjusted to pH 10 using lime and then it was treated with various quantities of Poly aluminium chloride solution. The quantites of PAC added were 1.0 mg/l, 2.5 mg/l, 5.0 mg/l, 10 mg/l, 20 mg/l, 30 mg/l, 40 mg/l and 50 mg/l. pH 10 was selected because it was found that a clear solution was obtained at pH 10 with rubber effluent on trials (130).The precipitate was filted through whatman no.1 filter paper and determined the nitrogen content.

For finding the optimum pH, the amount of PAC was fixed at 5.00 mg/l, the value obtained from the above and pH was adjusted using lime solution and dilute hydrochloric acid.

3.4.1.2. EFFECT OF DIFFERENT CONCENTRATIONS.

Table - 3.4.1 shows the effiency of removal of nitrogen from latex concentrate effluents with varying quantites of PAC. The raw effluent had a nitrogen content of 1120 mg/l. With 1.0 mg/l of PAC the nitrogen was reduced to 1032 mg/l and the reduction was only 7.84 % . On treating with 2.5 mg/l of PAC the reduction was slightiy high (10.00% with a retention of 1008 mg/l of nitrogen) . With 5.00 mg/l of PAC, it gave a reduction of 17.86% and the nitrogen retained was 920 mg/l. With 10.00 mg/l of PAC, there was no more removal of nitrogen, but a slight decrease was observed. The removal was 16.96% with a retention of 940 mg/l. On further increase of the concentration of PAC, it was found that the removal was decreasing slightly.

The Fig. 3.4.1 shows that the optimum concentration for the removal of nitrogen from the effluent is with 5.00 mg/l of PAC. The Fig. 3.4.1 shows a steady rise upto the concentration of 5.00 mg/l and thereafter a silght decrease in the removal of nitrogen from the effluent.

3.4.1.3. EFFECT OF PAC AT DIFFERENT pH.

Table-3.4.2 explains the effect of pH with fixed amount of PAC on the removal of nitrogen from the latex concentrate wastewaters. The raw effluent has a pH of 6.6 and 1790 mg/l of nitrogen content.On addition of PAC the pH was raised to 6.8, and nitrogen was reduced to 1540 ml/l with a removal of 13.97 %. At pH 8 the value decreased to 1520 mg/l with a removal of 15.08%. At pH 9 futher reduction was taken place to a value of 1486 mg/l with a reduction of 16.98% and the removal was 31.96% at pH 10. At pH 11 the removal was 36.65% which obviously higher than the previous value, and at pH 12 a reduction of 42.91% was observed. Hence it can be concluded that PAC can remove the nitrogen from latex concentrate effluent at a higher pH (Figure - 3.4.2).

3.4.2.EFFECT OF ALUMINA.

3.4.2.1. TREATMENT.

Alumina was added to the effluent as a suspention of 10% solution at a pH about 10. The raw effluent was first treated with lime , and the same solution was used for treatment with alumina. The concentrations of alumina used were 1.0 gm/l, 2.5 gm/l, 5.0 gm/l, 10.0 gm/l, 20.0 gm/l, 30.0 gm/l, 40.0 gm/l and 50.0 gm/l.

In order to find out the optimum pH the quantity of alumina was fixed as a constant at 5.0 gm/l and adjusted the pH by adding lime solution/ dilute hydrochloric solution.After the treatment, the solution was filtered through whatman no.1 filter paper and nitrogen was determined.

3.4.2.2. EFFECT OF DIFFERENT CONCENTRATIONS.

The Table - 3.4.3, shows the effect of the removal of nitrogen with various concentrations of alumina. The initial value of nitrogen was 1120 mg/l. On treating with 1.0 gm/l of alumina the value has reduced to 930 mg/l and the reduction was 16.96%. On increasing the concentration of alumina to 2.5 gm/l the reduction was raised to 27.68%. With 5.0 gm/l of alumina the removal was 38.39% with a retention of 690 mg/l of nitrogen. On further rise in the quantity of alumina the reduction was less than that of the previous case, and the value was 890 mg/l with 20.54% of removal along with 10.0 gm/l of alumia . This trend of removal can be clearly identified from the Figure - 3.4.3. Hence the optimum concentration of alumina required for the removal of nitrogen from latex concentrat effluent is 5.0 gm/l.

3.4.2.3. EFFECT OF ALUMINA AT DIFFERENT pH.

Table - 3.4.4 shows the effect of treatment of alumina at various pH. The initial 1790 mg/l of nitrogen was reduced to 1666 mg/l by raising the pH from 6.8 to 8.0 and the removal was 6.93%. On raising the pH to 9 the reduction was more, 64.80% . At pH 10 the nitrogen value was 174 mg/l with a removal of 89.88% . When the pH was again raised to 11 a decrease in the removal was observed . The value was 441 mg/l and the reduction was 74.33% only. At pH 12 the removal was again reduced to 782 mg/l and 56.31% . So the optimum pH for alumina to remove the nitrogen from latex concentrate wastewater can be fixed at 10 as seen clearly from the Figure - 3.4.4.

3.4.3. NON IONIC POLY ELECTROLITE.

3.4.3.1. TREATMENT

The raw effluent collected from the latex concentrating factory was first treated with lime to a pH around 10, and the same alkaline solution was treated with various quantites of Non Ionic Poly Electrolytes (NIPE). The NIPE was added as a 1% aqueous solution, and the quantites added during the experiment were 10.0 mg/l, 25.0 mg/l, 50.0 mg/l, 100.0 mg/l, 200 mg/l, 300.0 mg/l, and 400.0 mg/l.

To find out the optimum pH for the reaction of NIPE, the raw effluent was first treated with 100.0 mg/l of NIPE and pH was varied by adding lime suspension and dilute hydrochloric acid. The treated samples were filtered through Whatman no.1 filter paper and the nitrogen content was determined.

3.4.3.2. EFFECT OF CONCENTRATIONS.

The Table - 3.4.5 describes the effect of various concentrations of NIPE on the removal of nitrogen from latex concentrate effluent.The initial value of nitrogen was 1120 mg/l.

On treating with 10.0 mg/l of NIPE the value was reduced to 1010 mg/l and removal was 9.82% . With 25.0 mg/l of NIPE the reduction was 18.75% and the value was 910 mg/l. There was a 25.0% removal of nitrogen with 50.0 mg/l of NIPE. With 100.0 mg/l of NIPE the value was reduced to 790 mg/l with a removal of 29.46 % . On further increase of the quantity of NIPE gave the same percentage of reduction as that of 100.0 mg/l (Figure - 3.4.6) . Thus the optimum concentration of NIPE for the removal of nitrogen from the wastewater of latex concentrating factory was 100.0 mg/l.

3.4.3.3 EFFECT OF NIPE AT DIFFERENT pH.

The raw effluent had a pH of 6.8 and its nitrogen content was 1790 mg/l (Table - 3.4.6). With 0.01 % of NIPE there was no removal when the pH was 6.8. When the pH was raised to 8, then the value reduced to 1450 mg/l with a reductuon of 18.99 % . At pH 9 the value was 962 mg/l and removal was 46.26 % . The removal of 86.26 % with a retension of 246 mg/l could be achived at pH 10. On further increase of pH, it was observed that the values were the same as that for pH 10. The Figure - 3.4.6 explains it clearly. Thus the optimum pH for the removal of nitrogen from latex concentrating facroy can be fixed at 10.

3.4.4. EFFECT OF ACTIVATED GRANULATED CARBON ON REMOVAL OF NITROGEN.

Apart from metal salts and polymers, other materials such as activated carbon, activated silica etc. have been employed primerly as floc structure improvement aids(133).

Organic matter in the effluent may impart colour, odour and taste to waters. It may also include some carcinogenic substances. Removal of most of the organic matter may be done by adsorption on activated carbon. Adsorption is a processes by which molecules are transferred from solution to a fixed position on the surface of a solid. The quantity that can be adsorbed thus depends upon the surface area, as well as the chemical structure of the substance (134).

The efficiency of Granulated Activated Carbon (GAC) on the removal of nitrogen from effluent from latex concentrate factories have been studied. Various quantites of GAC was added to effluent and measured the quantity of nitrogen retained.

3.4.4.1. TREATMENT

The latex concentrate effluent collected was treated with different quantites of GAC inorder to asses the optimum quantity of GAC required for the removal of nitrogen. 100 ml of effluent was treated with 2 gm of GAC for twenty four hours and it was then filtered through Whatman No.1 filter paper and determined nitrogen concentration. Similarly effluent was treated with 4, 6, 8, 10, 15, 20, 25, 30, 35, and 40 gms of GAC and determined the retained nitrogen after treatment.

In order to asses optimum time, the effluent sample was treated with constant quantity of GAC and subjected to different time of treatment. The treatment periods given were 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, and 15 days. The treated samples were then filtered through Whatman No.1 filter paper and determined the nitrogen retained after treatment.

3.4.4.2. EFFECT OF DIFFERENT COCENTRATIONS OF GAC.

The control has a nitrogen content of 538 mg/l. On treating with 2% GAC the nitrogen was reduced to 494 mg/l with a reduction of 8.19% (Table -3.4.7 and Fig. - 3.4.7). With 4% GAC it was again reduced to 477 mg/l and 11.34% respectively . On addition of 6% GAC the removal was slightly increased to 17.29 % and the value was 445mg/l. With 8% GAC the Nitrogen removal again increased to 23.42 % and the value was 412 mg/l. With 10 % GAC, it showed a maximum removal of nitrogen of 39.03 % and the value was 328 mg/l . On further increase of the quantity of GAC to 15% a revere effect in removal of Nitrogen from the previous cases was noticed with the percentage removal being 21.19 and the value being 424 mg/l respectively. This trend was followed on with further increase of GAC (Figure - 3.5.1).

3.4.4.3 EFFECT OF TIME WITH GAC ON NITROGEN.

The Nitrogen contents in the control samples were in the range of 570 mg/l to 3037 mg/l (Table - 3.4.8). After treatment with GAC for one day there was a removal in the range of 10.32 to 31.21% (Table - 3.4.8) and the values were in the range of 511 mg/l to 2635 mg/l. On 2nd day the value was again reduced to the range of 468 mg/l - 2570 mg/l. On 3rd day it was observed in the range of 453mg/l - 2508 mg/l, and the removal varied from 17.42 % to 36.70 %.

At the 4th day the values were in the range of 433 mg/l to 2470 mg/l and 5th day they were in 389 mg/l - 2440 mg/l. 6th day the reduction varied from 25.08% to 47.93% and on 7th day it was in 48.55% - 55.96%. On 8th day the values were in the range of 182 mg/l - 1367 mg/l, and the corresponding reductions are in the range of 54.99% - 68.07%. On 9th day it was observed a further reduction in the values which were in the range of 90 mg/l - 910 mg/l. On the 10th day the reduction was further more, the values were in the range of,46 mg/l - 460 mg/l and the *percentage removal were from 84.85 % to 91.93% . In general* it could be seen that while on increasing the treatment time there was a corresponding drop in the Nitrogen content.

It is also clear from the Figure - 3.4.8, that the removal of nitrogen is more effective in effluents containing less qunatity of nitrogen. The 570 mg/l of nitrogen was removed by GAC to 182 mg/l with a removal of 68.07 % by 8 days treatment, and the 1256 mg/l (86.86 %) of nitrogen was reduced to 165 mg/l with 10 days which were well bellow the limits specified by the BIS (Table - 3.1.2). But the sample having the highest nitrogen content of 3037 mg/l was reduced to 460 mg/l with a removal of 84.85 % by the treatment for 10 days only.

Hence the effluent having high nitrogen content should be given more time to react with GAC, for efficient removal.

TABLE - 3.4.1 : EFFECT OF PAC ON NITROGEN REMOVAL AT DIFFERENT CONCENTRATIONS

Qty. of PAC (mg/l)	NITROGEN (mg/l)	REMOVAL (%)
CONTROL	1120.0	-----
1.0	1032.0	07.84
2.5	1008.0	10.00
5.0	920.0	17.86
10.0	930.0	16.96
20.0	940.0	16.07
30.0	940.0	16.07
40.0	960.0	14.29
50.0	970.0	13.39

TABLE - 3.4.2 : EFFECT OF PAC ON NITROGEN REMOVAL AT DIFFERENT pH

pH	NITROGEN (mg/l)	REMOVAL (%)
Con. 6.6	1790	0.00
6.8	1540	13.97
8.0	1520	15.08
9.0	1486	16.98
10.0	1218	31.96
11.0	1134	36.65
12.0	1022	42.91

TABLE - 3.4.3 : EFFECT OF ALUMINA ON NITROGEN REMOVAL AT DIFFERENT CONCENTRATIONS

Qty. of AL.(gm/l)	NITROGEN (mg/l)	REMOVAL (%)
CONTROL	1120.0	-----
1.0	1032.0	7.84
2.5	1008.0	10.00
5.0	920.0	17.86
10.0	930.0	16.96
20.0	940.0	16.07
30.0	940.0	16.07
40.0	960.0	14.29
50.0	970.0	13.39

TABLE - 3.4.4 : EFFECT OF ALUMINA ON NITROGEN REMOVAL AT DIFFERENT pH

pH	NITROGEN (mg/l)	REMOVAL (%)
Con. 6.6	1790	0.00
6.8	1790	0.00
8.0	1666	6.93
9.0	630	64.80
10.0	174	89.88
11.0	441	74.33
12.0	782	56.31

TABLE - 3.4.5 : EFFECT OF NIPE ON NITROGEN REMOVAL AT DIFFERENT CONCENTRATIONS

Qty. of NIPE (mg/l)	NITROGEN (mg/l)	REMOVAL (%)
CONTROL	1120	0.00
10.0	1010	9.82
25.0	910	18.75
50.0	840	25.00
100.0	790	29.46
200.0	790	29.46
300.0	790	29.46
400.0	790	29.46

TABLE - 3.4.6 : EFFECT OF NIPE ON NITROGEN REMOVAL AT DIFFERENT pH

pH	NITROGEN (mg/l)	REMOVAL (%)
Con. 6.6	1790	0.00
6.8	1790	0.00
8.0	1450	18.99
9.0	962	46.26
10.0	246	86.26
11.0	246	86.26
12.0	246	86.26

TABLE - 3.4.7 : EFFECT OF GAC ON NITROGEN REMOVAL AT DIFFERENT CONCENTRATIONS

Qty. of GAC (% by wt)	NITROGEN (mg/l)	REMOVAL (%)
CONTROL	538	0.00
2.00	494	8.19
4.00	477	11.34
6.00	445	17.29
8.00	412	23.42
10.00	328	39.03
15.00	424	21.19
20.00	449	16.54
25.00	451	16.17
30.00	456	15.24
35.00	460	14.50
40.00	463	13.94

TABLE - 3.4.8 : EFFECT OF GAC ON NITROGEN REMOVAL AT DIFFERENT INTERVELS OF TIME

TIME	NITROGEN (mg/l)			REMOVAL (%)		
(DAYS)	SAMPLE-1	SAMPLE-2	SAMPLE-3	SAMPLE-1	SAMPLE-2	SAMPLE-
CONTROL	3037	1256	570	0.00	0.00	0.00
1	2635	856	511	13.24	31.21	10.32
2	2570	820	468	15.37	34.71	17.89
3	2508	795	453	17.42	36.70	20.53
4	2470	763	433	18.67	39.25	24.04
5	2440	697	389	19.66	44.97	31.71
6	2275	654	324	25.08	47.93	43.16
7	1562	569	251	48.55	54.71	55.96
8	1367	440	182	54.99	64.97	68.07
9	910	326	90	70.04	74.05	84.21
10	460	165	46	84.85	86.86	91.93

EFFECT OF PAC ON NITROGEN REMOVAL AT DIFFERENT CONCENTRATIONS

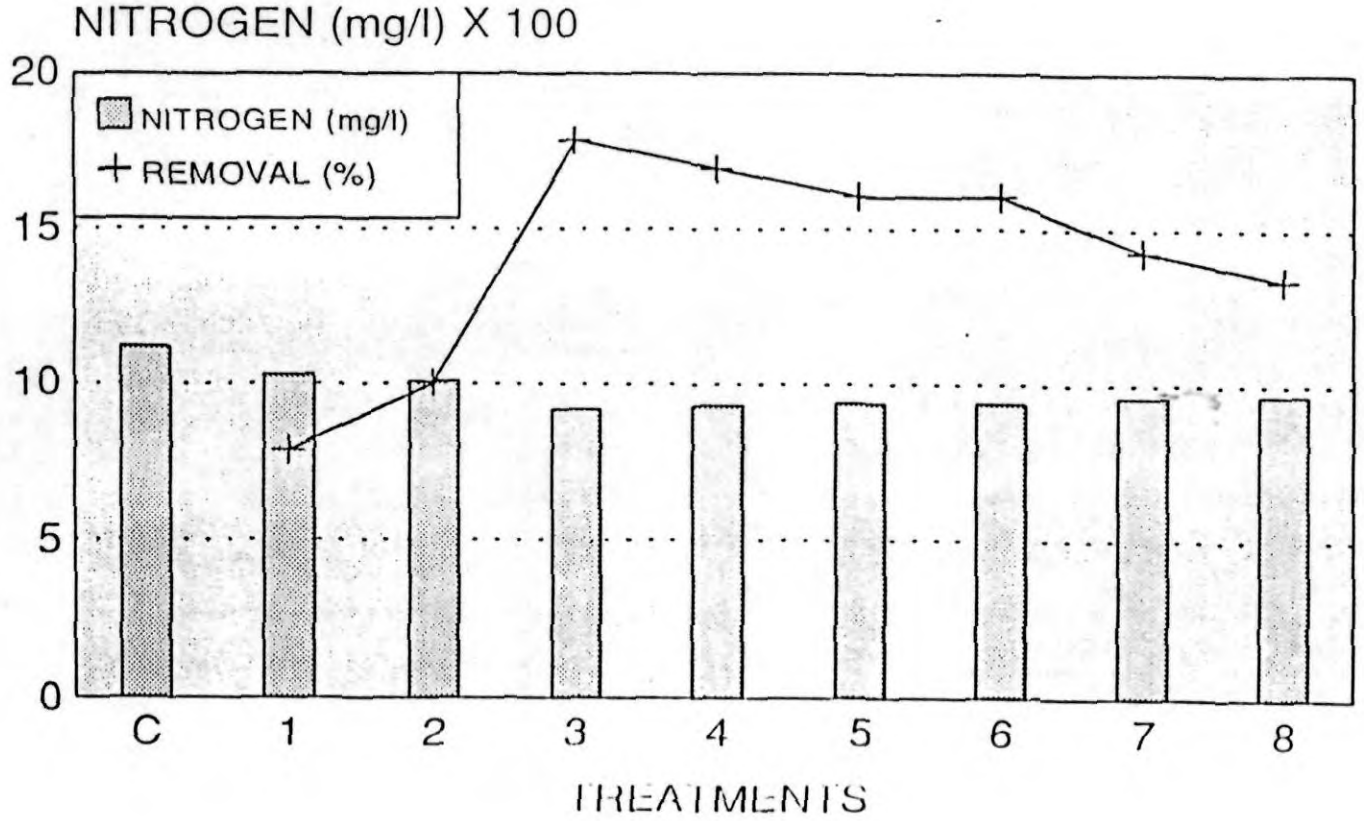


FIGURE - 3.4. 1

1 = 0.001 gm/l, 2 = 0.0025 gm/l, 3 = 0.005 gm/l, 4 = 0.01 gm/l , 5 = 0.02 gm/l, 6 = 0.03 gm/l, 7 = 0.04 gm/l and 8 = 0.05 gm/l

REMOVAL OF NITROGEN WITH PAC AT DIFFERENT pH

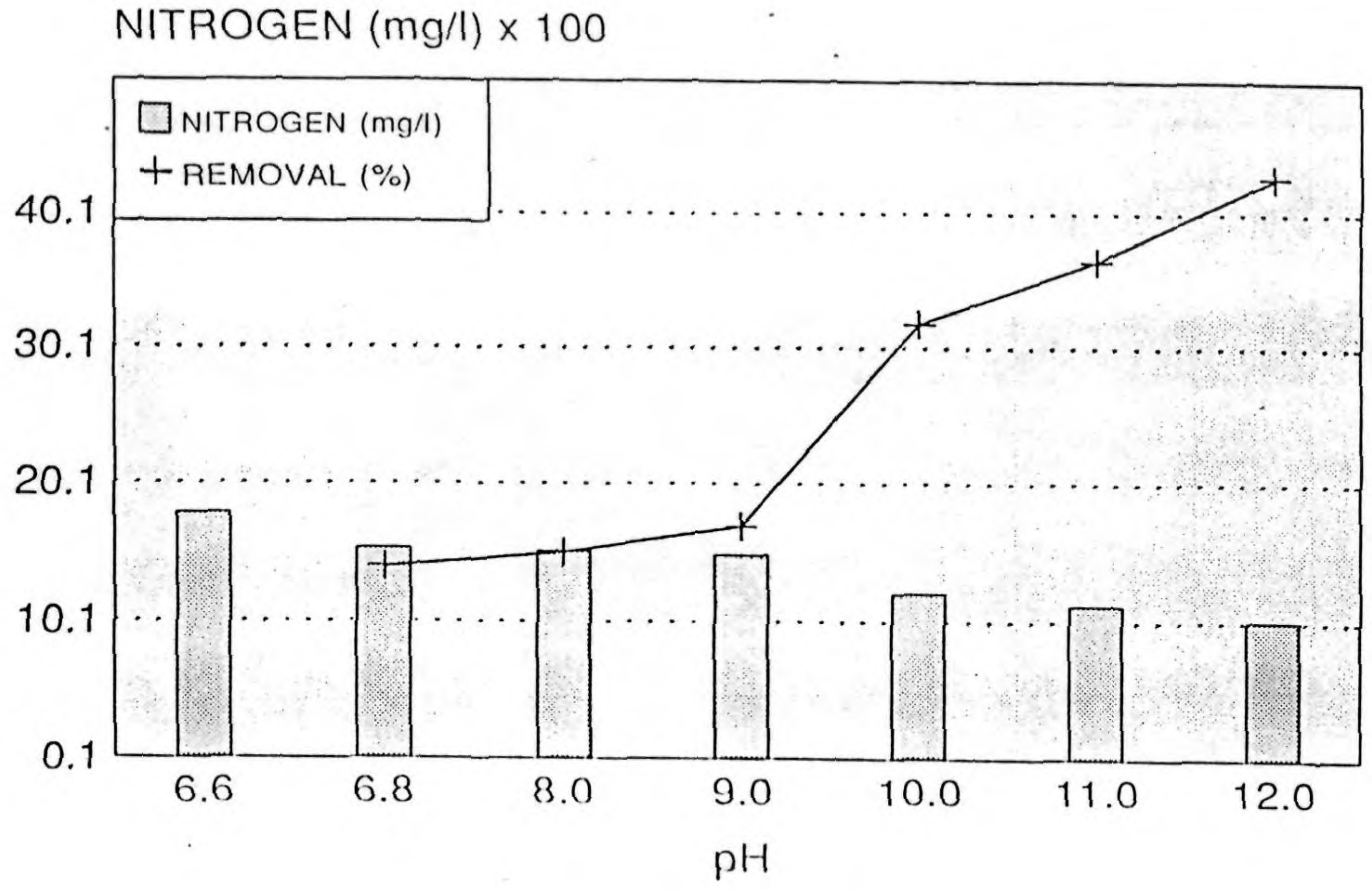


FIGURE - 3.4.2

EFFECT OF ALUMINA ON NITROGEN REMOVAL AT DIFFERENT CONCENTRATIONS

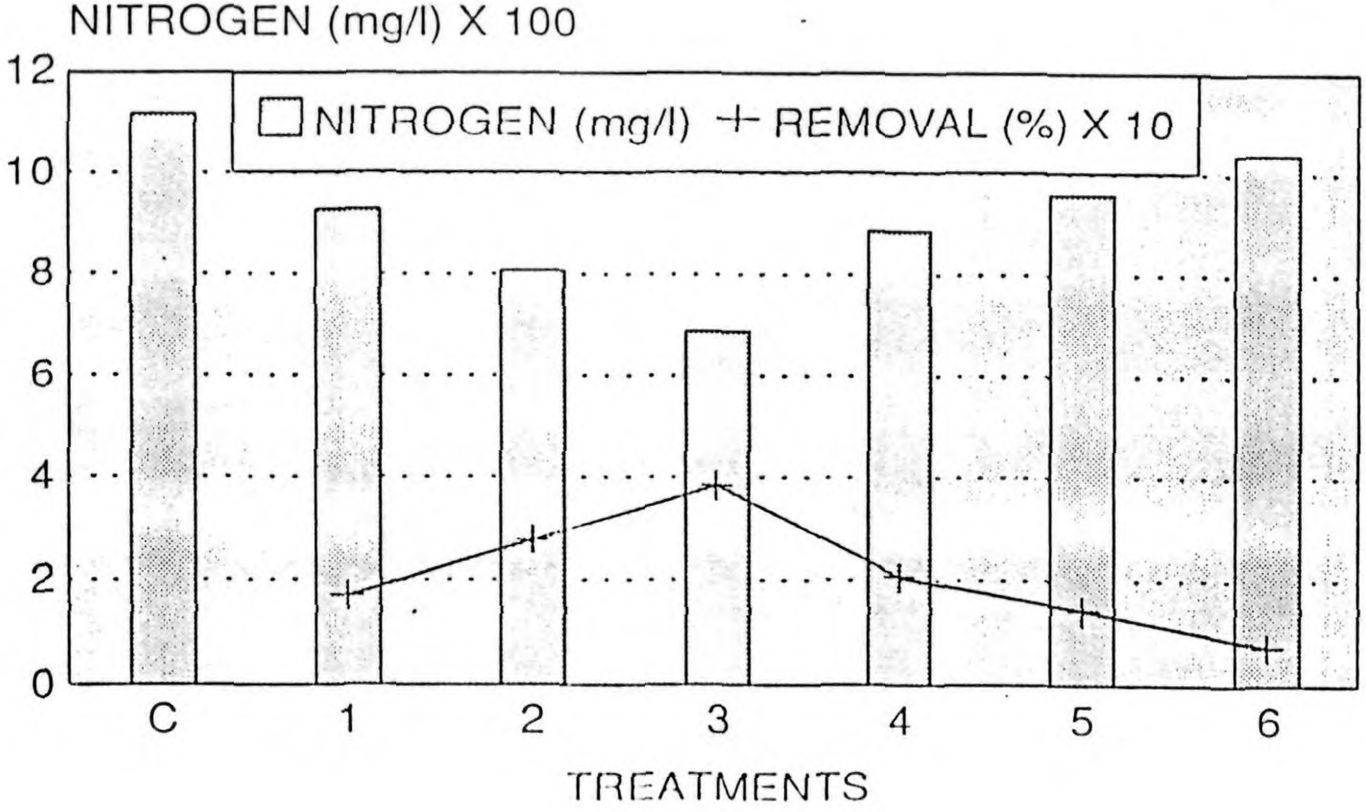


FIGURE - 3.4.3

C= Control , 1 = 1.25 gm/l , 2 = 2.5 gm/l , 3 = 5.0 gm/l
4 = 10.0 gm/l , 5 = 15.0 gm/l and 6 = 20.0 gm/l

EFFECT OF ALUMINA AT DIFFERENT pH ON NITROGEN REDUCTION

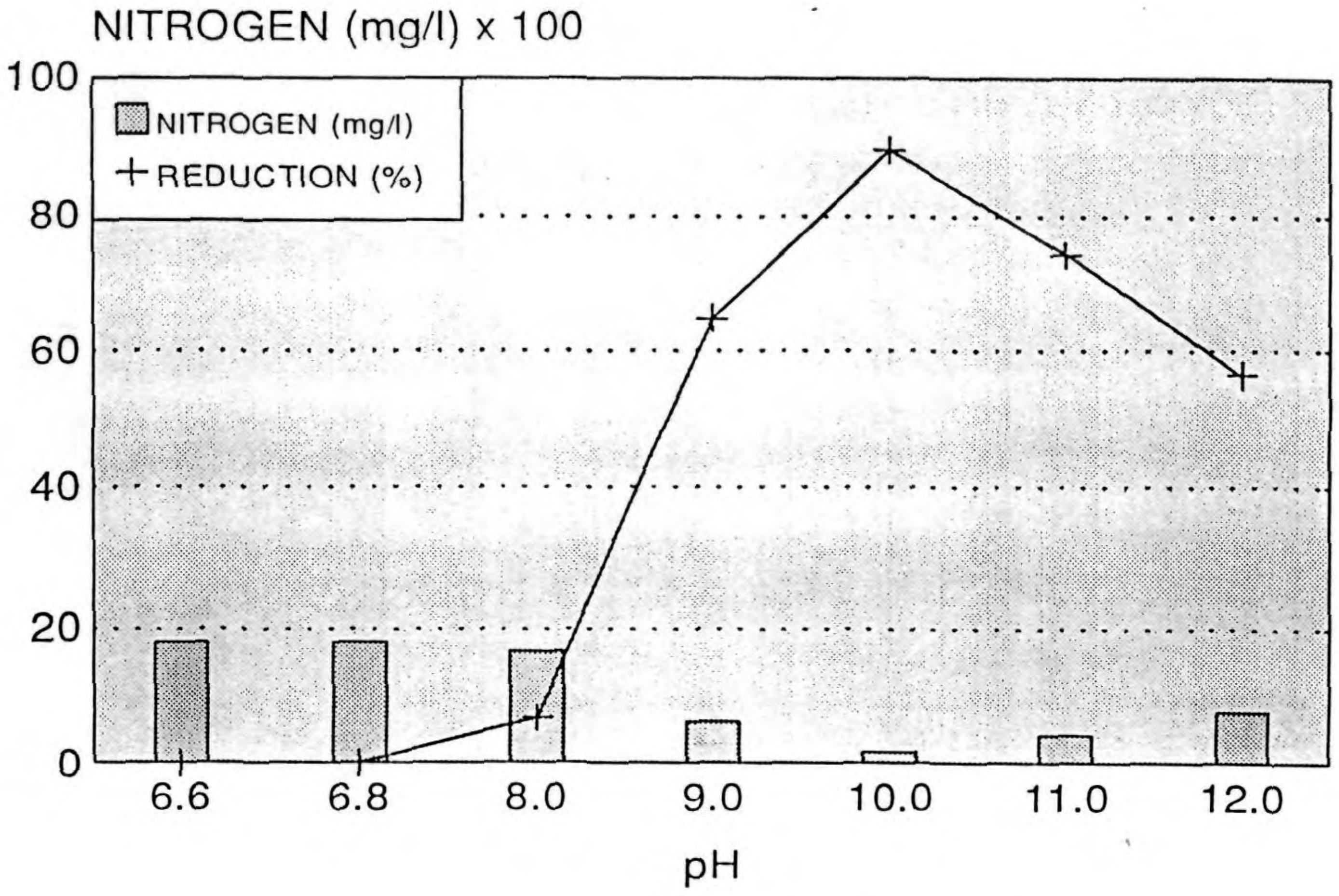


FIGURE - 3.4.4

EFFECT OF NIPE ON NITROGEN REDUCTION AT DIFFERENT CONCENTRATIONS

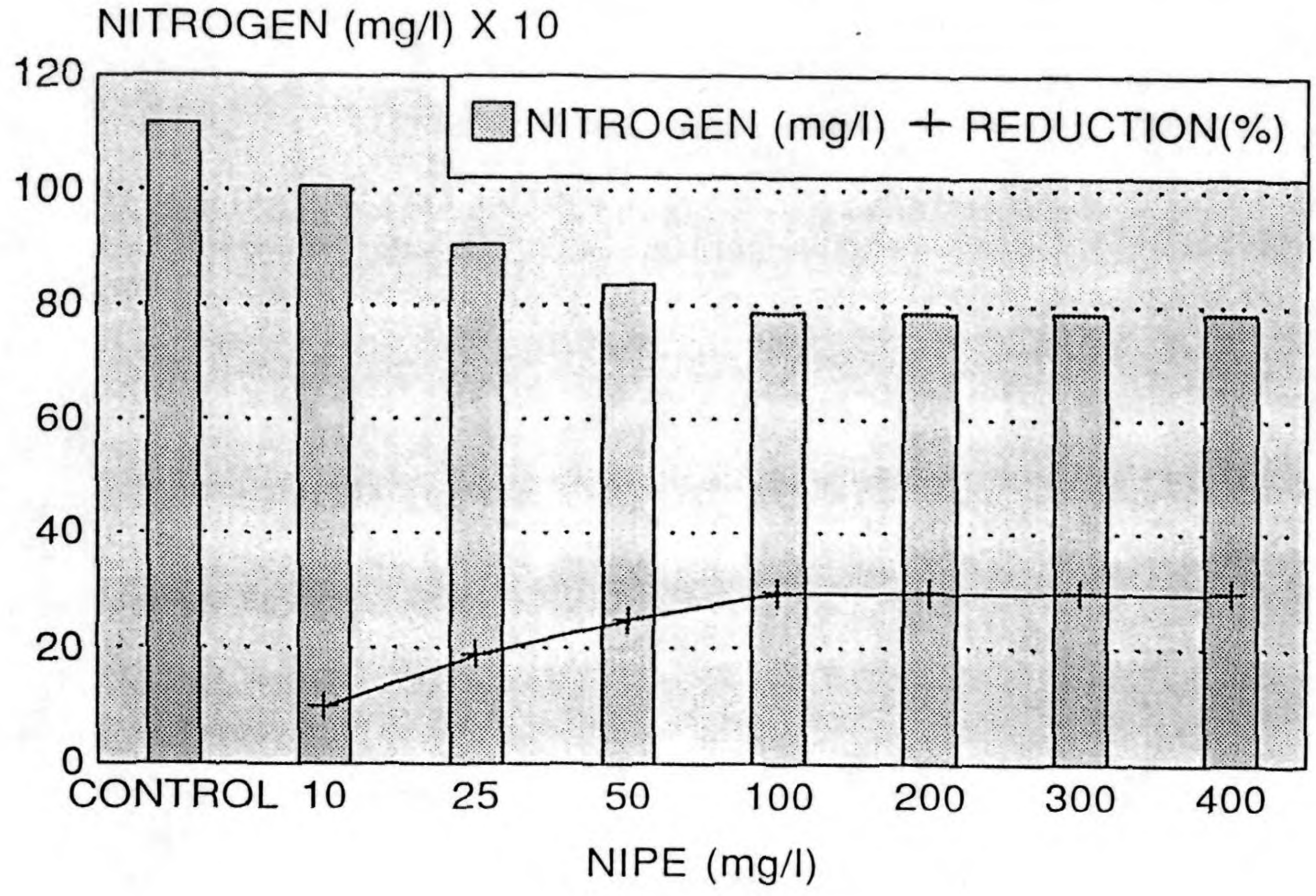


FIGURE - 3.4.5

EFFECT OF NIPE AT DIFFERENT pH ON NITROGEN REDUCTION

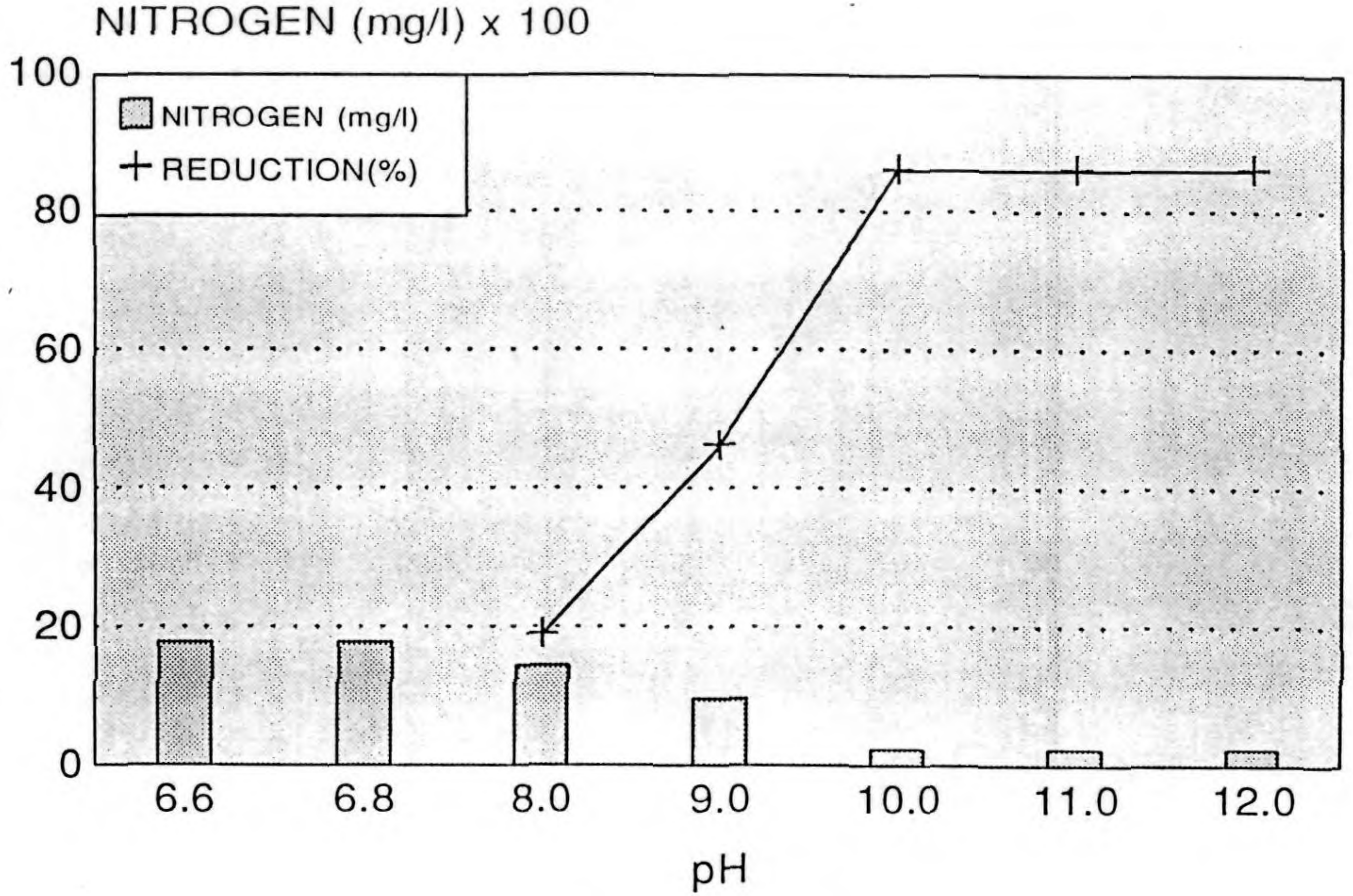


FIGURE - 3.4.6

EFFECT OF DIFFERENT CONCENTATION OF GAC ON NITROGEN REDUCTION

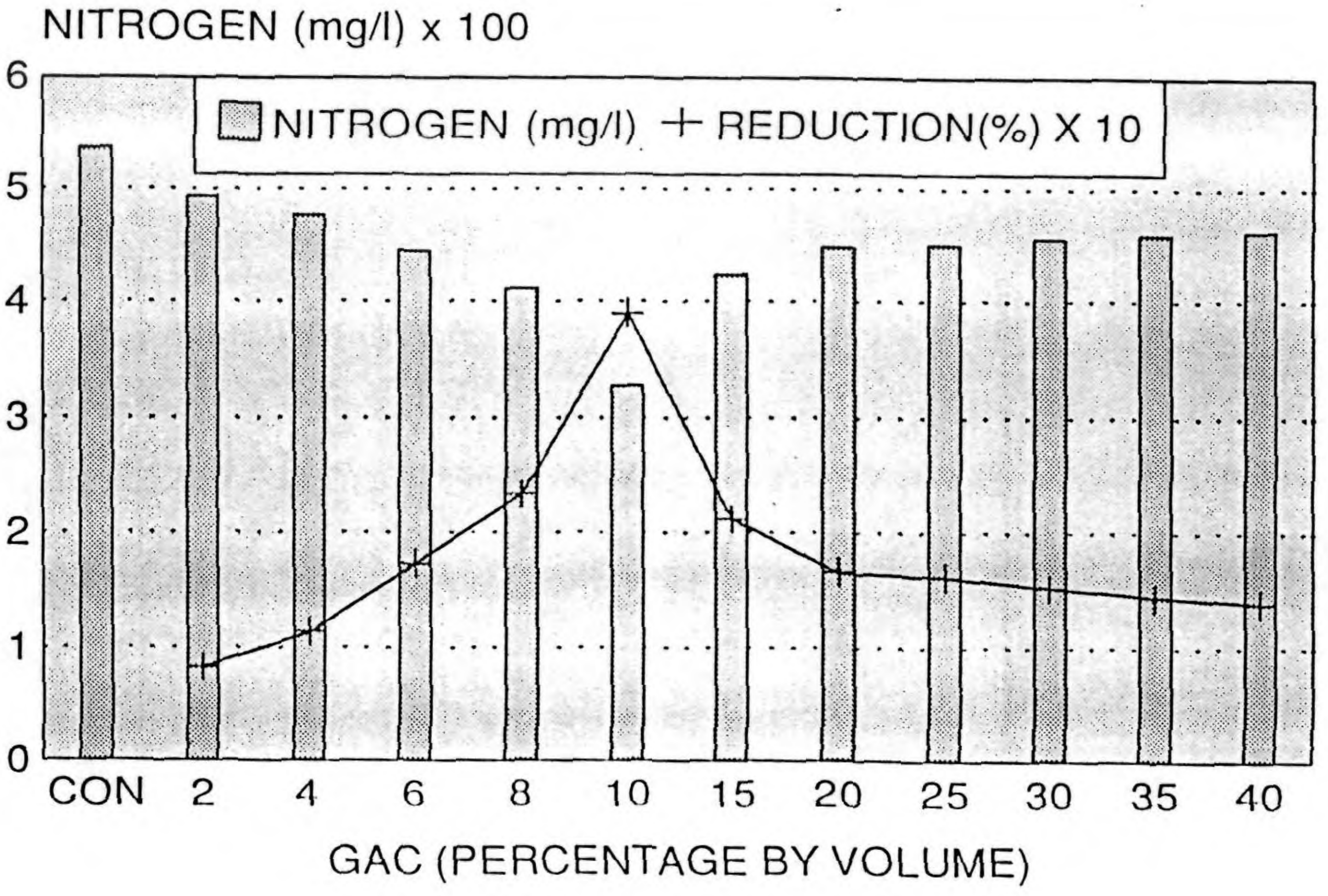


FIGURE - 3.4.7

EFFECT OF TIME ON REDUCTION OF NITROGEN WITH GAC

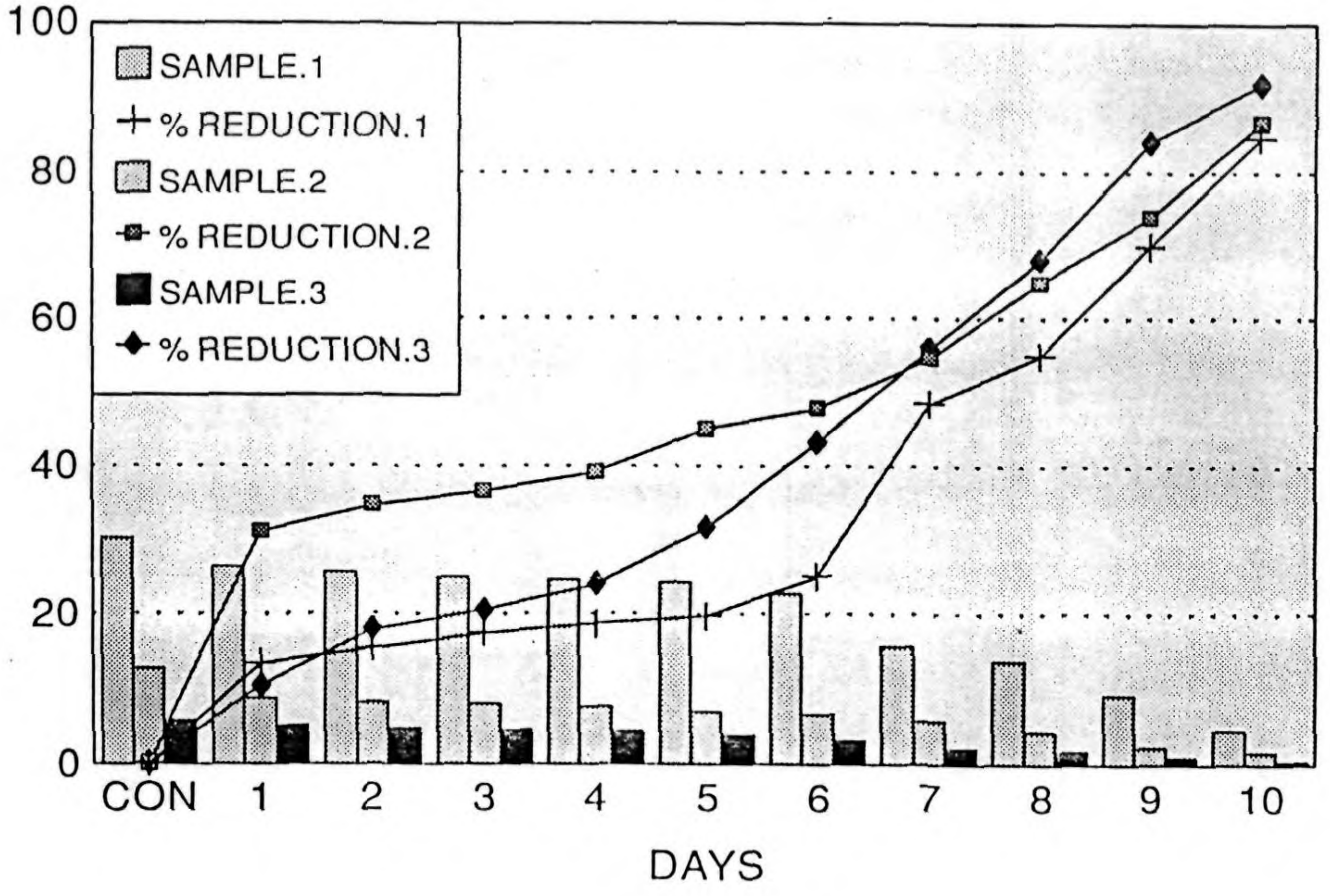


FIGURE - 3.4.8

CHAPTER - III

PART - V: UV IRRADIATION TREATMENTS

PART-V

TREATMENT OF RUBBER PROCESSING WASTEWATER WITH ULTRAVIOLET IRRADIATION AND OXIDISING AGENTS.

3.5.1. INTRODUCTION.

The direct application of UV irradiation as a means of disinfecting water was cosidered to be a practicable possibility as early as in 1901 (134). It was known that UV radiation by itself could result in the organic matter in the seawater (135, 136). By the end of 1960s the use of UV light to catalyse chlorine oxidation of organics in wastewater had been proposed and investigated (137, 138) and in the early 1970s the work on photo-oxidation of organics in water using UV radiation with other oxidising agents such as hydrogen peroxide and ozone was carried out in a number of countries including USA, Canada, Japan, Austalia, and Russia (139 - 144).

UV irradiation alone would attack and decompose some organic molecules to free radicals, but usually the rate of reaction is very slow. The combination of UV light and various oxidants regarding water and wastewater treatment are attracting extensive attention in treating some refractory organics. In these light induced oxidation processes, oxidants are excited to yeild high oxidation potential species (such as free radicals) which can decopose pollutants very effectively. The decomposition of various organic pollutants using hydrogen peroxide as oxidant under appropriate UV illumination has been proven to be very effetive in several studies (145 - 155). The OH' radicals produced by the UV irradiation, posses rather high energy potential (156) and can attack organics by inducing serial oxidation reactions. The decomposistion can be significantly accelerated by the UV irradiaton in the wave length range of 190 and 280 nm:

$$H_2O_2 \text{ ------------------> } 2\ OH'$$

The strong oxidising effect of the radicals can be used for elimination of pollutants in the wastewater (157 - 158). In the process the inorganic and organic compounds in the waste water are attacked by these radicals and often intermediate hydroxilated compounds are formed. The organic sulphide compounds and sulphur are converted into sulphate, and halogen compounds are transformed into halide ions . Cyanide is oxidised to cyanate, nitite to nitrate, and phosphorous-III to phosphorous-V.

It should be noted that the above mentioned hydroxilated intermediate products, which are formed by partial oxidation of organic substances in wastewater, are normally better biodegradable than non-oxidised original substances. By utilising the UV-catalysed oxidation process for wastewater treatment no solid or liquid wastes remain after the treatment. By the use of hydrogen peroxide as oxidation agent the amount of reaction gas or waste gas mainly oxygen from the decomposition of hydrogen peroxide and carbon dioxide as an oxidation product is technically unimportant.

The studies (158 - 163) describe the effect of UV - oxidant combine in the elimination of Adsorbable Organic Halogens, Cyanides, and reduction in Chemical Oxygen Demands (COD), Total Organic Carbon (TOC) and destruction of other hazardous water components such as Surfactants.

In this study, the effluent from latex concentrate factory was treated with different UV - oxidant system and various parameters such as COD, TOC, Methylene Blue Active Surfactant(MBAS): a cationic surfactant, Nitrate phosphates and pH are determined .

3.5.1.1. METHODS OF TREATMENT.

The rubber processing effluent was allowed to undergo UV irradiation for different span of time such as 1, 2, 3, 4 and 8 hours to asses the optimum time required for the effective treatment. Then definite quantity of oxidant was added followed by different quantites of Granulated Activated Carbon (GAC). Finally UV light was passed through it. For assesing the optimum quantity of oxidant, the effluent sample was treated with GAC and different quantites of oxidant and irradiated with UV light. The effect of various oxidants is also studied on the treatment of latex concentrate effluents. In all experiments, 100 ml of the sample was treated with chemicals and irradiated for 2 hours and they were filtred through Whatman No.1 filterpaper and analysed for pH, COD, TOC, MBAS Phosphates and Nitrates.

3.5.1.2. SOURCE OF UV LIGHT.

The UV light used for irradiation purpose was a Phlips make 25 Watt UV bulb of 110 Volt.

3.5.1.3. EFFECT OF IRRADIATION TIME.

The sample was treated with UV irradiation for different periods such as 0.5 , 1, 2, 4, and 8 hours time, and samples were tested for the parameters pH, COD, TOC, MBAS,Nitrate and phosphate. Table - 3.5.1 & 3.5.2 shows the effect of UV irradiation time on these properties.

3.5.1.4. EFFECT ON pH

Generally, pH is insignificantly affected by UV irradiation. The 3.6 pH of the control was slightly reduced with 0.5 and 1 hour UV irradiation to 3.58 and 3.56 respectively. But with 2, 4, and 8 hrs. treatment the value was slightly raised to 3.69, 3.68 and 3.70 respectively (Fig. 3.5.1).

3.5.1.5. EFFECT ON COD.

There was a gradual reduction of COD values with increase of UV irradiation time (Table - 3.5.1). With 0.5 hrs. irradiation the COD value reduced from 2952 mg/l to 2465 mg/l, and the removal was 17.50 %. After 1 hr. treatment the value was 1954 mg/l with a removal of 33.80% (Table - 3.5.2). On treating for 2hrs. the value was further reduced to 1844 mg/l.With 4 hrs UV radiation the value reduced to 1830 mg/l and the removal was 38.01 % . With 8 hrs treatment with UV light there was again a reduction observed in the value to 1824 mg/l of COD . From the Figure - 3.5.1, it could be seen that the rduction was sharp upto 2 hours and it was slow after that time.

3.5.1.6. EFFECT ON TOC.

The initial TOC present in the control sample was 85 mg/l, which reduced to 78 mg/l with 0.5 hr UV irradiation. With 1 hr irradiation the value reduced to 50.00 mg/l and the removal was 41.18 % . On treating for 2 hrs. the value was again reduced to 32.00 mg/l and the removal was 62.35 % . The *removal was again increased to 76.47 % with 4 hrs treatment and* with 8hrs UV irradiation the value reduced to 18.00 mg/l and the removal was 79.82 %. Thus on increase of treatment time a corresponding increase in the removal of TOC was noticed (Figure-3.5.2).

3.5.1.7. EFFECT ON MBAS.

The 0.755 mg/l of MBAS in the control was reduced to 0.680 mg/l in 0.5 hrs. of UV irradiation. With 1 hr. irradiation the value dropped to 0.230 mg/l and the percentage removal of MBAS was 68.87 %. On giving an irradiation treatment for 2 hrs. there was further reduction in the value (0.160 mg/l) and the removal was 78.81 %. With 4 hrs. of UV irradiation the value further reduced to 0.134 mg/l with a removal of 82.25 % and on giving irradiation for 8 hrs. further reduction in MBAS observed was 0.210 mg/l with 84.11% of removal . Though the removal increased with increase in UV irradiation time, the reduction was not so sharp (Fig. - 3.5.2).

3.5.1.8. EFFECT ON PHOSPHATE.

The control had a phosphate content of 285 mg/l. On treating with UV irradiation for 0.50 hrs. there was no effect on phosphate. However with an increase in treatment time of 1 hr. the value was reduced to 275 mg/l and the removal was only 3.51%. With 2 hrs. irradiation the value reduced to 255 mg/l and the percentage removal was 10.53. The removal reached 15.79 % with 4 hrs. irradiation. On applying irradiation for 8 hrs, the removal was only 26.32 mg/l. Eventhough there was a reduction in the phosphate values with increase of irradiation time, the rate of removal of the phosphates from the effluent sample was not satisfactory (Figure - 3.5.2) .

3.5.1.9. EFFECT ON NITRATES.

The nitrate nitrogen of the control sample was 0.600 mg/l. On irradiation for 0.50 hr. the value reduced to 0.304 mg/l with a removal of 49.32 % . With 1 hr. radiation the value again reduced to 0.224 mg/l and the removal was 62.67 %. With treatment time of 2 hrs. there was further removal in the nitrate value to 0.120 mg/l and the percentage removal was 80.00. With 4 hrs irradiation the value came down to 0.116 mg/l and the removal was 80.57 % . Further the value reduced to 0.110 mg/l for 8 hrs. UV treatment. The Fig. - 3.5.2 shows clearly that the removal of nitrate nitrogen is sharp upto 2 hrs. treatment and afterwords the removal slows down very much.

From the above it can be observed that the optimum time of UV irradiation required for an effective treatment of rubber effluent is 2 hrs.

3.5.2. UV IRRADIATION WITH OXIDANT AND VARYING QUANTITY OF GAC.

3.5.2.1. TREATMENT OF SAMPLES.

The effluent sample collected from latex concentrating factory was treated with definite quantity of oxidant (0.1 % of potassium permanganate - PPM) and different amounts of GAC then passed the UV light for 2 hours. The quantities of GAC added during the experiment were 0.5 gm, 1.0 gm, 2.0 gm, 3.0 gm, 4.0 gm and 5.0 gm to each 100 ml of effluent. The irradiated samples were then filtered through Whatman No.1 filter paper and determined the parameters such as pH, COD, TOC, MBAS, Phosphates and Nitrate nitrogen.

3.5.2.2. EFFECT ON pH.

The control samples having a pH varying from 3.71 to 4.10 (Table - 3.5.3) were very well in the acidic range. The first treatment given for the effluent was without GAC. UV light when passed through the sample having a 0.1 % of PPM, a pH rise in the range of 4.20 to 4.72 was noticed. With 0.50 % of GAC the rise in pH was in the range of 5.22 to 5.33. A further rise in pH was also observed with 1.0 % GAC and UV irradiation, to the range of 5.38 to 5.67. With 2% GAC a slight reduction in the pH value of sample - 1 was noticed from 5.67 to 5.50, but for the other two samples there was an increase in pH to the range of 5.55 to 5.68. With 3 % of GAC a slight reduction in the pH in the range of 5.15 to 5.66 was observed. On treatment with 4.0 % and 5.0% GAC the pH was further reduced to the range of 5.01 to 5.65 and 4.95 to 5.62 respectively.

The Figure - 3.5.3 shows that highest value of pH was observed with 2.0 % GAC.

3.5.2.3. EFFECT ON COD.

The COD of the control varies in the range of 1390 mg/l to 2456 mg/l (Table - 3.5.4). No considerable reduction in the value of COD was noticed on irradiation with oxidant. On adding 0.50 % of GAC and applying UV irradiation, the COD values had reduced to the range of 1044 mg/l to 1290 mg/l and the percentage removal varies from 7.19 % to 57.49 %. With 1.0 % of GAC for the first sample there was a slight rise in the value of COD from 1044 mg/l to 1145 mg/l, but for the other two samples the COD values were reduced to the order of 1220 mg/l and 1146 mg/l respectively. With 2 % GAC all the three samples showed less reduction in COD than with 1 % GAC. On increasing the quantity of GAC to 3 %, 4 % and 5 % there was no increase in the reduction of COD, but a slight decrease in the values noticed (Figure-3.5.4).

3.5.2.4. EFFECT ON TOC.

Total Organic Carbon (TOC) of the controls were in the range of 68.60 mg/l to 98.30 mg/l (Table - 3.5.5). On treating with oxidant without GAC, the values were slightly reduced to the range of 62.75 mg/l to 83.40 mg/l and reduction varied from 5.75% to 15.16% . With 0.50% of GAC the reduction was again increased to the range of 8.09 to 16.03% . On addition of 1.0 % GAC the reduction was considerably increased to the range of 10.24 % to

16.76 % . With 2.0 % of GAC it was observed a slight rise in the values than with 1.0% . On increasing the quantity of GAC the reduction was in the inverse direction as could be seen from the Figure - 3.5.5. There was an optimum removal of TOC with 2.0 % GAC for the effluent sample from latex concentrate factory.

3.5.2.5. EFFECT ON MBAS.

The controls have MBAS in the range of 0.26 to 1.70 micro gm/l (Table - 3.5.6) . Without GAC, the UV irradiation tratment with oxidant gave a reduction in the range of 17.65 % to 30.77 %. On addition of 0.50% GAC there was not much difference. On addition of 1.0 % GAC the values decreased to the range of 0.18 to 0.68 micro gm/l and the reduction were 26.92% to 60.00%. With 2.0 % GAC the reduction increased to the range of 57.69 % to 69.41 %. On further addition of GAC, there observed a rise in the MBAS values which Figure - 3.5.6 depicts very clearly. Hence the optimum reduction of MBAS from rubber effluent on UV irradiation with oxidant was on adding 2.0 % of GAC.

3.5.2.6. EFFECT ON PHOSPHATES.

The controls had a phosphates contents in the range of 238 mg/l to 275 mg/l. With UV irradiation in presence of oxidant, a slihgt reduction in the values in the range of 210 mg/l to 260 mg/l were noticed. But on addition of GAC the values raised and showed an increase of phosphates in the treated samples (Table - 3.5.7). Hence the reduction efficiency is poor with further addition of GAC.

3.5.2.7. EFFECT ON NITRATE NITROGEN.

The control samples had a nitrate content in the range of 0.44 mg/l to 0.62 mg/l (Figure - 3.5.8). On the treatment without GAC there was a reduction in the value in the range of 0.37 mg/l to 0.60 mg/l. With 0.50 % of GAC the values were considerably reduced and the range was 48.39 % to 50.00 %. On addition of 1.0 % GAC the nitrate value of the first sample was slighty raised to 0.36 mg/l from the previous value of 0.32 mg/l, but the other two samples showed a further reduction of values in the range of 0.19 mg/l to 0.20 mg/l and the reduction of 56.82 % and 58.33 % . With 2.0 % of GAC the removal again reduced for sample - 1 and for other two it was again increased to the range of 0.15 mg/l and 0.16 mg/l and percentage reduction was 65.91 and 66.67. But with 3.0 % GAC all the samples showed a rise in the nitrate values. With 4.0 % GAC there was a negative trend in the reduction of nitrogen. On adding 5.0 % GAC the samples showed little more reduction, but it was not as much as that of the maximum reduction. Hence for nitrate nitrogen also, the 2.0 % of GAC can be considered as the optimum quantity (Fig. - 3.5.8).

For pH, TOC, MBAS, and nitrate nitrogen the maximum reduction was observed with 2.0 % GAC for rubber effluent on UV irradiation along with oxidant. In the case of COD the maximum removal was with 0.50 % GAC and for Phosphates there was not much effect in using GAC.

3.5.3. UV IRRADIATION WITH VARYING QUANTITY OF OXIDANTS.

3.5.3.1. TREATMENTS.

The wastewater collected from the latex concentrating factories were treated with 2.0 % GAC and varying quantites of oxidant. The oxidant studied here was potassium permanganate (PPM) and the quantites used in the experiment were 0.025 %, 0.05 %, 0.10 %, 0.20 %, 0.40 %, 0.80 %, 1.00 %, and 1.50 % . After the addition of GAC and oxidant the sample was irradiated for 2 hrs. They were filtered through Whatman No.1 filter paper and analysed for pH, COD, TOC, MBAS, and Nitrate Nitrogen.

3.5.3.2. EFFECT ON pH.

The Table - 3.5.9 shows the effect of oxidant on UV irradiation of rubber effluent with 2.0 % GAC. The controls had the pH ranging from 4.03 to 4.96. Without oxidant the pH increased to the range of 4.10 to 5.26. On adding 0.025 % oxidant the value increased to the range of 4.28 to 5.26. With 0.050 % oxidant the values were again raised to the range of 4.35 to 5.48. Thus on increasing the addition of oxidant, the pH also increased gradually (Fig. - 3.5.9), and the maximum pH observed with the highest quantity of PPM, ie. 1.50 %, was in the range of 6.14 - 6.41. Thus the increase in pH is directly proportional to the quantity of oxidant.

3.5.3.3. EFFECT ON COD.

The COD of the controls were in the range of 4310 mg/l to 6450 mg/l (Table - 3.5.10). Without oxidant the COD values reduced to the range of 3800 mg/l to 5680 mg/l and the reductions varied from 13.04 % to 22.63 % . With 0.025 % PPM the values again reduced to the range of 2840 mg/l to 4220 mg/l . On addition of 0.050 % of PPM the values were further reduced to the range of 2760 mg/l to 4110 mg/l and reductions were 36.41 % to 37.16 % . The reduction further increased to the range of 37.43 % to 37.99 % with 0.100 % of PPM. On addition of 0.200 % PPM , the COD values were again reduced to the range of 2660 mg/l to 4040 mg/l and the reduction was 38.08 % to 38.23 %. With 0.400 % PPM the COD values were slightly increased to the range of 2750 mg/l to 4100 mg/l, and the removals were 36.60 % to 37.31 % only. On further addition of 0.800 %, 1.00 % and 1.50 % PPM, the values increased with the addition of oxidant (Figure - 3.5.10). The maximum reduction in COD was observed with 0.20 % of PPM.

3.5.3.4. EFFECT ON TOC.

The TOC of the controls were in the range of 83.42 mg/l to 93.75 mg/l (Table - 3.5.11). Without oxidant using only UV irradiation there was reduction in TOC in the range of 2.59 % to 3.54 %. On addition of 0.025 % PPM the values reduced to the range of 70.84 mg/l to 80.41 mg/l corresponding to the reduction of 15.06 % to 16.5 % . With 0.050 % of PPM the value of TOC was again reduced to the range of 51.36 mg/l to 60.36 mg/l and with

0.100 % of PPM further reduction in the values observed was in the range of 26.85 mg/l to 34.52 mg/l and the reduction corresponds to 78.44 % to 80.19 % . On addition of 0.400 % of PPM the values were again reduced and the TOC reduction were in the range of 80.44 % to 82.08 % . On increasing the percentage of PPM to 0.800 , the reduction noticed were in the range of 81.20 to 82.68 percentage. With 1.00 % and 1.50 % of PPM, the increase in the reduction of TOC was also raised from 81.97 % to 83.01 % and 82.52 % to 83.25 % respectively. From the Figure - 3.5.11, it became clear that the reduction upto 0.200% of PPM was very sharp followed by a respite in reduction with higher percentage of PPM.

3.5.3.5. EFFECT ON MBAS.

The control had an MBAS in the range of 0.186 to 0.235 micrograms per litre. Applying UV irradiation without PPM, the values observed were in the range of 0.1602 to 0.210 micrograms per litre (Table - 3.5.12). On adding 0.025 % PPM, the values again reduced and the removal were in the range of 27.90 % to 40.43 % . With 0.05 % of PPM, the reduction was in the range of 40.86 % to 64.26 % and 65.05 % to 74.47% reductions were observed while adding 0.100 % of PPM. The reductions were in the range of 80.85 % to 83.87 % with 0.200 % oxidant. On addition of 0.400% of PPM, 62.36% to 67.77% reduction was noticed which were lower than the previous case. On further increasing the quantity of PPM, the reduction of MBAS observed was in reverse order. Thus the optimum removal of MBAS was found with 0.200 % of PPM (Figure - 3.5.12).

3.5.3.6. EFFECT ON NITRATE NITROGEN.

The controls had nitrate content in the range of 0.520 mg/l to 0.900 mg/l (Table - 3.5.13). On application of VU irradiation without oxidant, the values observed were in the range of 0.500 mg/l to 0.840 mg/l. With 0.025 % of PPM the values were in the range of 0.410 mg/l to 0.790 mg/l. On addition of 0.500% PPM the reductions were increased to the range of 7.69 % to 25.62 % and with 0.100 % there was further increase in the reduction and they were in the range of 38.67 % to 51.25 % . The reduction in nitrates were in the range of 54.62 % to 66.67 % with 0.200 % of PPM.

On further increase in the quantity of oxident, a negative trend in the removal of nitrate was observed (Figure - 3.5.13). Hence the optimum quantity of PPM for the reduction of nitrate can be taken as 0.200 % for the latex concentrate effluent.

On treatment with UV light in the presence of 2.0 % GAC and varying quantites of oxidant, the optimum removal of COD, MBAS, and nitrate is with 0.200 % of PPM and since pH is giving a continuous rise with increase of PPM, TOC shows an optimum removal with 0.400 % PPM.

3.5.4. UV IRRADIATION WITH DIFFERENT OXIDANTS.

3.5.4.1. TREATMENTS.

The rubber effluents collected from the latex concentrating factory were treated with 2.0 % GAC and different oxidants, then allowed to pass the UV light for 2 hours.They were then filtered through Whatman No.1 filter paper and analysed for pH, COD, TOC, MBAS, and Nitrate Nitrogen. The different oxidants used in the experiments were Potassium per manganate (PPM), Potassium dichromate (PDC), Titanium dioxide (TDO) and Hydrogen peroxide (HPO). The treatment details are the following:

A. - Effluent + 2.0 % GAC
B. - Effluent + 2.0 % GAC + 0.05 % PPM
C. - Effluent + 2.0 % GAC + 0.05 % PDC
D. - Effluent + 2.0 % GAC + 0.05 % TDO
E. - Effluent + 2.0 % GAC + 0.05 % HPO

3.5.4.2 EFFECT ON pH.

The control sample had a pH 5.98. With treatment A the pH was lowered by 5.65 and by B there was a raise to 6.86 and with C the value again reduced to 5.53 (Table - 3.5.14). With treatments D & E the rise in pH observed was in the order of 6.66 and 6.65 respectively. Thus the treatments B, D, and E were effective in bringing up the pH values for rubber effluent, which became clear from the Figure - 3.5.14.

3.5.4.3. EFFECT ON COD.

The control had a COD of 2430 mg/l. On treatment with A the value was lowered by 2210 mg/l, and the removal was 9.05 % (Table - 3.5.14). With treatment B the value could be brought down to 1050 mg/l with the removal efficiency of 56.79 % . The treatments C, D and E were giving the values 1530 mg/l, 1590 mg/l and 1560 mg/l respectively which were more or less the samebut on higher side with the reduction efficiency of 34.57 % to 37.04 % respectively. Hence in the case of COD removal the treatment B can be considered as comparitively better treatment than others (Fig. - 3.5.15).

3.5.4.4. EFFECT ON TOC.

The control had a TOC value of 88.45 %. On treatment A the value reduced to 56.75 mg/l and the reduction in TOC was 35.84 % (Table - 3.5.14). The treatments B, D, and E gave a reduction of more than 80%, of which the highest reduction was observed with D (85.98 %). Treatment C gave only 53.33 % reduction (Fig. - 3.5.16). Hence for the reduction of TOC the treatments with PPM, TDO and HPO are being efficent, TDO is the most effective.

3.5.4.5. EFFECT ON MBAS.

The value of MBAS, 0.101 microgrms per litre of control was not affected with treatment A. With treatments B, D, and E the values had reduced to 0.046, 0.007 and 0.057 micrograms/litre and the reductions was in the order of 54.56 %, 93.40 % and 43.56 % respectively. While on treatment with C, a higher value for MBAS (0.602 micrograms per litre) was obtained.Hence the treatment D is efficent in reducing the MBAS from effluent of latex concentrating factories (Figure - 3.5.17).

3.5.4.6. EFFECT ON NITRATE.

0.383 mg/l of nitrate for the control had reduced to 0.352 by treatment A . With tratments B, D and E the reduction was more and the values were 0.171 mg/l, 0.073 mg/l, and 0.135 mg/l repectively. Treatment C gave a value (0.719 mg/l) higher than that of the control. The treatment D, showed a reduction of 80.85 % (Figure - 3.5.18) which being the highest can be considered as the most effective in reducing nitrate from rubber effluent.

To sum up, the treatment B is effective in removing COD and rising pH to a considerable level than the others. In the case of TOC, MBAS and nitrate, the treatment D is found to be more effective than other treatments.

TABLE 3.5.1 : EFFECT OF UV IRRADIATION WITH TIME

TIME (hours)	pH	COD (mg/l)	TOC (mg/l)	MBAS (ug/l)	PHOSPHATE (mg/l)	NITRATE (mg/l)
CONTROL	3.60	2952	85.00	0.755	285	0.600
0.5	3.58	2465	78.00	0.680	285	0.304
1.0	3.56	1954	50.00	0.230	275	0.224
2.0	3.69	1844	32.00	0.280	255	0.120
4.0	3.68	1830	20.00	0.240	240	0.116
8.0	3.70	1825	18.00	0.210	210	0.110

TABLE 3.5.2 : PERCENTAGE REMOVAL OF POLLUTANTS BY UV IRRADIATION

TIME (hours)	COD	TOC	MBAS	PHOSPHATE	NITRATE
0.5	17.50	08.23	10.00	00.00	49.32
1.0	33.80	41.18	68.87	03.51	62.67
2.0	37.70	62.35	78.81	10.53	80.00
4.0	38.01	76.47	82.25	15.79	80.67
8.0	38.18	79.92	84.11	26.32	83.67

TABLE 3.5.3 : EFFECT OF UV IRRADIATION ON pH WITH FIXED OXIDANT AND VARYING QUANTITY OF GAC.

QTY. OF GAC (% by Volume)	pH		
	SAMPLE.1	SAMPLE.2	SAMPLE.3
CONTROL	3.71	3.88	4.10
0.00	4.20	4.60	4.72
0.50	5.22	5.25	5.33
1.00	5.67	5.45	5.38
2.00	5.50	5.55	5.68
3.00	5.15	5.50	5.66
4.00	5.01	5.33	5.65
5.00	4.95	5.33	5.62

TABLE. 3.5.4 : EFFECT OF UV IRRADIATION ON COD WITH FIXED OXIDANT AND VARYING QUANTITIES OF GAC.

QTY. OF GAC (% by volume)	COD (mg/l)			REMOVAL (%)		
	SAMPLE.1	SAMPLE.2	SAMPLE.3	SAMPLE.1	SAMPLE.2	SAMPLE.3
CONTROL	2456	1390	1438	00.00	00.00	00.00
0.0	2450	1390	1410	00.29	00.00	01.95
0.5	1044	1290	1240	57.49	07.19	13.76
1.0	1145	1220	1146	53.38	12.23	20.31
2.0	1184	1250	1167	51.79	10.07	18.85
3.0	1322	1300	1190	46.17	06.48	17.25
4.0	1545	1360	1260	37.09	02.16	12.38
5.0	2164	1390	1260	11.89	00.00	12.38

TABLE. 3.5.5 : EFFECT OF UV IRRADIATION ON TOC WITH FIXED OXIDANT AND VARYING QUANTITIES OF GAC.

QTY. OF GAC (% by volume)	TOC (mg/l)			REMOVAL (%)		
	SAMPLE.1	SAMPLE.2	SAMPLE.3	SAMPLE.1	SAMPLE.2	SAMPLE.3
CONTROL	98.30	72.68	68.60	00.00	00.00	00.00
0.0	83.40	68.50	62.75	15.16	05.75	08.53
0.5	82.54	66.80	58.24	16.03	08.09	15.10
1.0	81.85	65.24	57.10	16.73	10.24	16.76
2.0	82.35	64.86	56.56	16.22	10.26	17.55
3.0	95.95	67.85	59.95	02.39	06.65	12.61
4.0	96.72	68.90	63.40	01.61	05.20	07.58
5.0	97.20	71.85	66.80	01.12	01.14	02.62

TABLE. 3.5.6 : EFFECT OF UV IRRADIATION ON MBAS WITH FIXED OXIDANT AND VARYING QUANTITIES OF GAC.

QTY. OF GAC (% by volume)	MBAS (mg/l)			REMOVAL (%)		
	SAMPLE.1	SAMPLE.2	SAMPLE.3	SAMPLE.1	SAMPLE.2	SAMPLE.3
CONTROL	1.70	0.26	0.26	00.00	00.00	00.00
0.0	1.40	0.20	0.18	17.65	23.08	30.77
0.5	1.70	0.20	0.20	00.00	23.08	23.08
1.0	0.68	0.19	0.18	60.00	26.92	30.77
2.0	0.52	0.11	0.11	69.41	57.69	57.69
3.0	0.80	0.13	0.13	52.94	50.10	50.10
4.0	0.80	0.23	0.16	52.94	11.54	38.46
5.0	1.32	0.20	0.16	22.35	23.08	38.46

TABLE. 3.5.7: EFFECT OF UV IRRADIATION ON PHOSPHATE WITH FIXED OXIDANT AND VARYING QUANTITIES OF GAC.

QTY. OF GAC (% by volume)	PHOSPHATE (mg/l)		
	SAMPLE.1	SAMPLE.2	SAMPLE.3
CONTROL	238	275	270
0.0	260	210	240
0.5	240	300	300
1.0	244	225	220
2.0	320	210	200
3.0	342	235	240
4.0	298	255	260
5.0	260	267	270

TABLE. 3.5.8: EFFECT OF UV IRRADIATION ON NITRATE WITH FIXED OXIDANT AND VARYING QUANTITIES OF GAC.

QTY. OF GAC (% by volume)	NITRATE (mg/l)			REMOVAL (%)		
	SAMPLE.1	SAMPLE.2	SAMPLE.3	SAMPLE.1	SAMPLE.2	SAMPLE.3
CONTROL	0.62	0.44	0.48	00.00	00.00	00.00
0.0	0.60	0.37	0.42	03.23	15.91	12.50
0.5	0.32	0.22	0.24	48.39	50.00	50.00
1.0	0.36	0.19	0.20	41.39	56.82	58.33
2.0	0.46	0.15	0.16	25.81	65.91	66.67
3.0	0.52	0.21	0.28	16.16	52.27	41.67
4.0	0.56	0.22	0.20	09.68	50.00	58.33
5.0	0.42	0.17	0.21	32.23	61.36	56.25

TABLE 3.5.9: EFFECT OF UV IRRADIATION ON pH WITH FIXED GAC AND VARYING QUANTITY OF OXIDANT.

QTY. OF OXIDANT (% by Volume)	pH		
	SAMPLE.1	SAMPLE.2	SAMPLE.3
CONTROL	4.03	4.16	4.96
0.00	4.10	4.26	5.26
0.025	4.28	4.38	5.37
0.050	4.35	4.57	5.48
0.100	4.52	4.78	5.54
0.200	4.91	5.06	5.77
0.400	5.28	5.61	5.90
0.800	5.82	5.84	6.12
1.000	6.02	6.02	6.32
1.500	6.34	6.14	6.41

TABLE. 3.5.10 : EFFECT OF UV IRRADIATION ON COD WITH FIXED GAC AND VARYING QUANTITIES OF OXIDANT.

QTY. OF OXIDANT (% by volume)	COD (mg/l)			REMOVAL (%)		
	SAMPLE.1	SAMPLE.2	SAMPLE.3	SAMPLE.1	SAMPLE.2	SAMPLE.3
CONTROL	6450	4370	5410	00.00	00.00	00.00
0.0	5060	3800	4430	22.63	13.04	18.11
0.025	4220	2840	3560	35.47	35.01	34.20
0.050	4110	2760	3440	37.16	36.84	36.41
0.100	4060	2710	3385	37.92	37.99	37.43
0.200	4040	2660	3350	38.23	39.13	38.08
0.400	4100	2750	3430	37.31	37.08	36.60
0.800	4200	2830	3520	35.78	35.78	34.94
1.000	4250	2880	3565	35.02	34.11	34.10
1.500	4380	2920	3650	33.03	33.18	32.53

TABLE. 3.5.11 : EFFECT OF UV IRRADIATION ON TOC WITH FIXED GAC AND VARYING QUANTITIES OF OXIDANT.

QTY. OF OXIDANT (% by volume)	TOC (mg/l)			REMOVAL (%)		
	SAMPLE.1	SAMPLE.2	SAMPLE.3	SAMPLE.1	SAMPLE.2	SAMPLE.
CONTROL	93.75	95.60	83.42	00.00	00.00	00.00
0.0	90.43	93.12	80.90	3.540	2.590	2.990
0.025	78.26	80.41	70.84	16.52	15.89	15.06
0.050	59.13	60.36	51.36	36.93	36.86	28.42
0.100	30.72	34.52	26.85	67.61	63.89	67.81
0.200	18.57	21.37	17.98	80.19	75.65	78.44
0.400	16.80	18.70	16.25	82.08	80.44	80.52
0.800	16.24	17.80	15.68	82.68	81.38	81.20
1.000	15.93	16.95	15.04	83.01	82.27	81.97
1.500	15.70	16.66	14.58	83.25	82.57	82.52

TABLE. 3.5.12 : EFFECT OF UV IRRADIATION ON MBAS WITH FIXED GAC AND VARYING QUANTITIES OF OXIDANT.

QTY. OF OXIDANT (% by volume)	MBAS (mg/l)			REMOVAL (%)		
	SAMPLE.1	SAMPLE.2	SAMPLE.3	SAMPLE.1	SAMPLE.2	SAMPLE.3
CONTROL	0.235	0.186	0.215	00.00	00.00	00.00
0.0	0.210	0.160	0.195	10.64	13.98	16.00
0.025	0.140	0.125	0.155	40.43	32.80	27.90
0.050	0.084	0.110	0.105	64.26	40.86	51.16
0.100	0.060	0.065	0.070	74.47	65.05	67.44
0.200	0.045	0.030	0.040	80.85	83.87	81.41
0.400	0.080	0.070	0.065	65.96	62.36	67.77
0.800	0.095	0.085	0.075	59.57	54.30	65.12
1.000	0.130	0.098	0.090	44.68	47.31	58.14
1.500	0.175	0.130	0.115	25.53	30.11	46.51

TABLE. 3.5.13 : EFFECT OF UV IRRADIATION ON NITRATE WITH FIXED GAC AND VARYING QUANTITIES OF OXIDANT.

QTY. OF OXIDANT (% by volume)	NITRATE (mg/l)			REMOVAL (%)		
	SAMPLE.1	SAMPLE.2	SAMPLE.3	SAMPLE.1	SAMPLE.2	SAMPLE.3
CONTROL	0.520	0.640	0.900	00.00	00.00	00.00
0.0	0.500	0.620	0.840	03.85	06.36	06.67
0.025	0.496	0.410	0.790	04.62	20.31	12.22
0.050	*0.480*	*0.476*	*0.712*	*07.69*	*25.62*	*20.89*
0.100	0.272	0.312	0.582	47.69	51.25	38.67
0.200	0.236	0.240	0.300	54.62	62.50	66.67
0.400	0.304	0.340	0.380	41.54	46.88	57.78
0.800	0.472	0.384	0.445	09.23	40.00	50.56
1.000	0.500	0.482	0.482	03.85	24.69	46.44
1.500	0.510	0.520	0.680	01.02	18.75	24.44

ABLE. 3.5.14 : EFFECT OF UV IRRADIATION ON POLLUTANTS WITH DIFFERENT OXIDANTS.

OXIDANT 0.05% by volume)	VALUES					REMOVAL (%)			
	pH	COD	TOC	MBAS	NITRATE	COD	TOC	MBAS	NITRATE
ONTROL	5.98	2430	88.45	0.101	0.383	00.00	00.00	00.00	00.00
ithout	5.65	2210	56.75	0.101	0.352	09.05	35.84	00.00	08.09
PPM	6.86	1050	16.81	0.046	0.171	56.79	80.99	54.46	55.27
PDC	5.53	1530	41.25	0.602	0.719	37.04	53.33	--	--
TDO	6.66	1590	12.40	0.007	0.073	34.57	85.98	93.40	80.85
HPO	6.65	1560	14.35	0.057	0.135	35.80	83.74	43.56	64.75

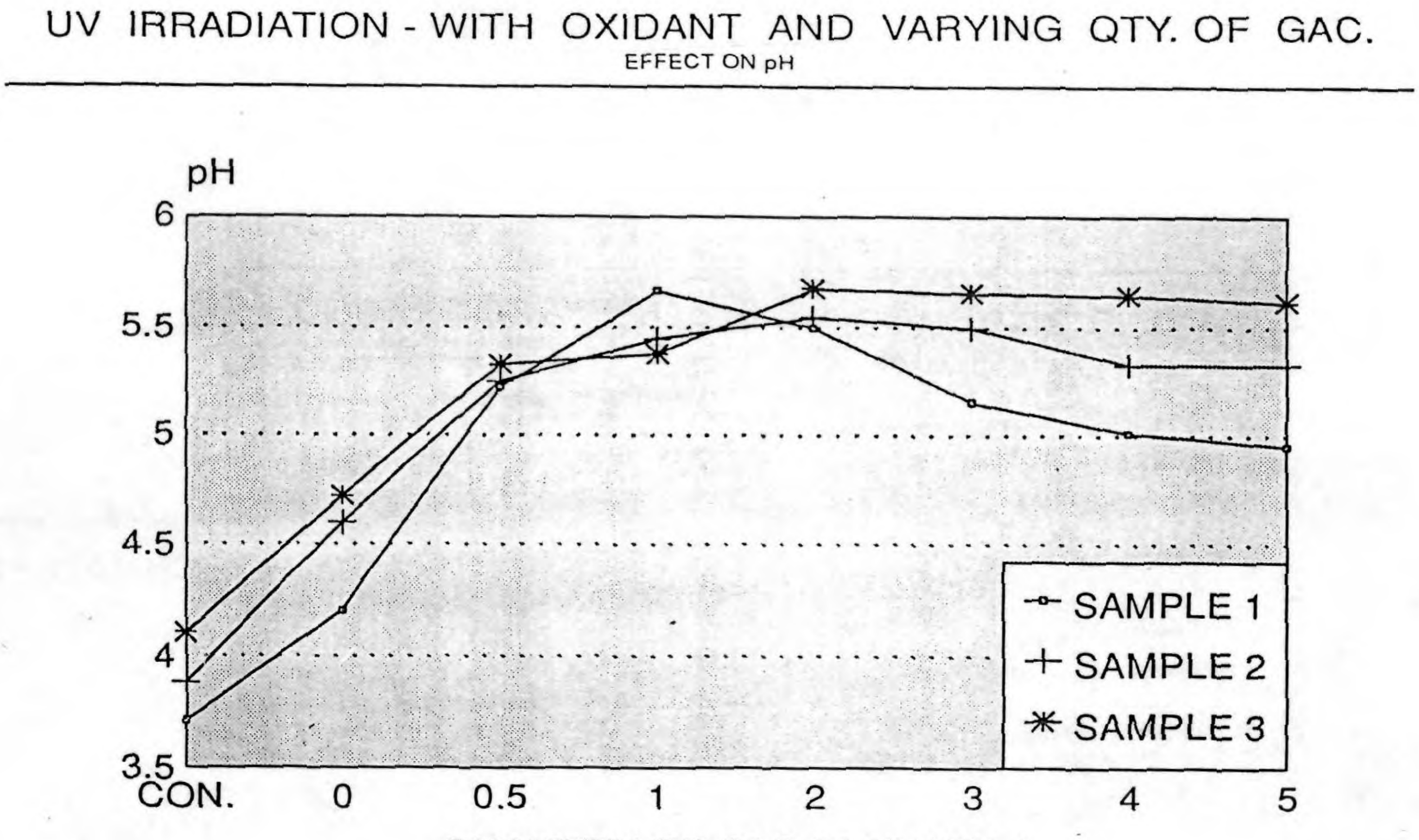

UV IRRADIATION - WITH OXIDANT AND VARYING QTY. OF GAC.
EFFECT ON pH
pH
6
5.5
5
4.5
4
3.5
CON.
0
0.5
1
2
3
4
5
QUANTITY OF GAC (% BY VOL.)
SAMPLE 1
SAMPLE 2
SAMPLE 3

FIGURE -3.5. 1

EFFECT OF UV IRRADIATION - PERCENTAGE REDUCTION OF POLLUTANTS
AT DIFFERENT PERIODS

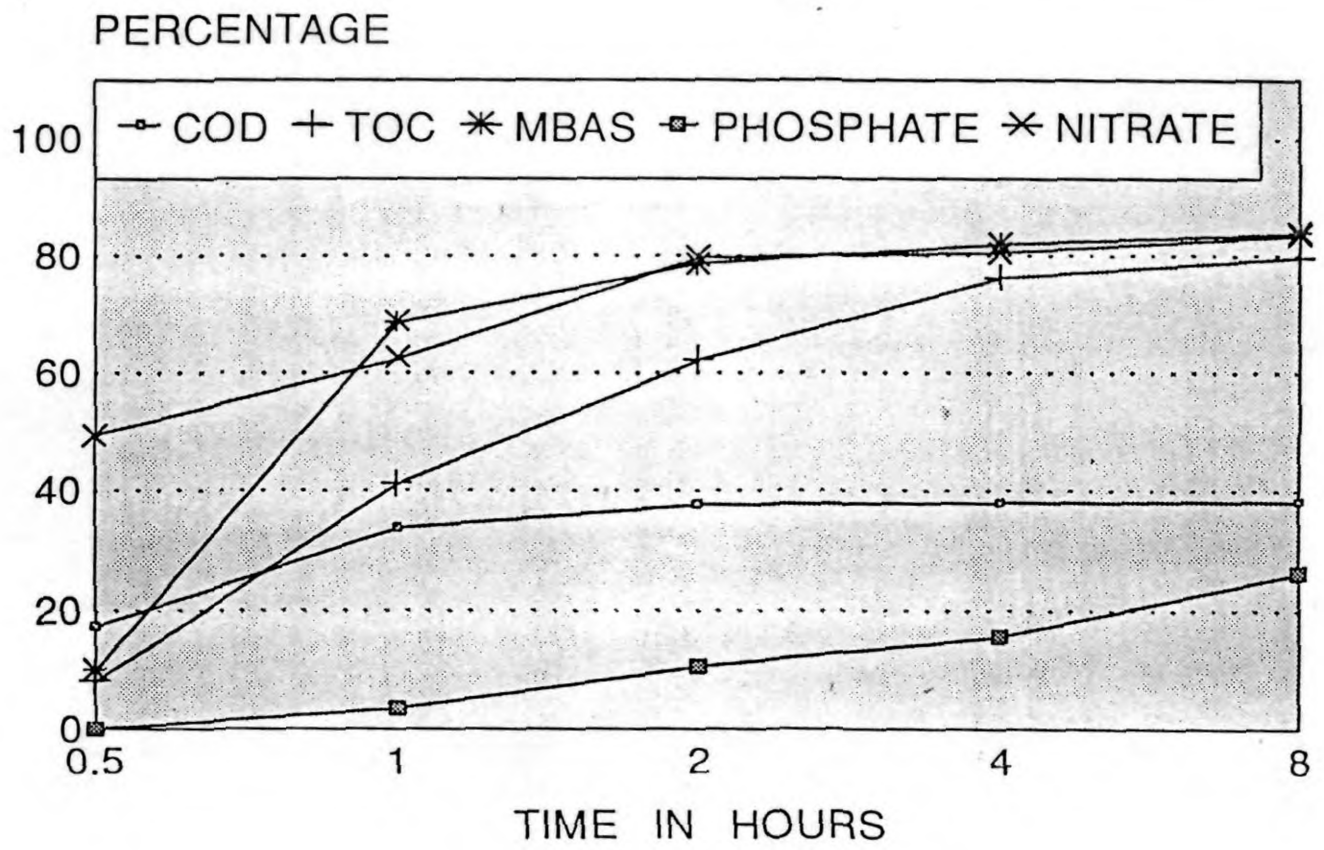


FIGURE - 3.5.2

UV IRRADIATION - WITH OXIDANT AND VARYING QTY. OF GAC.

EFFECT ON pH

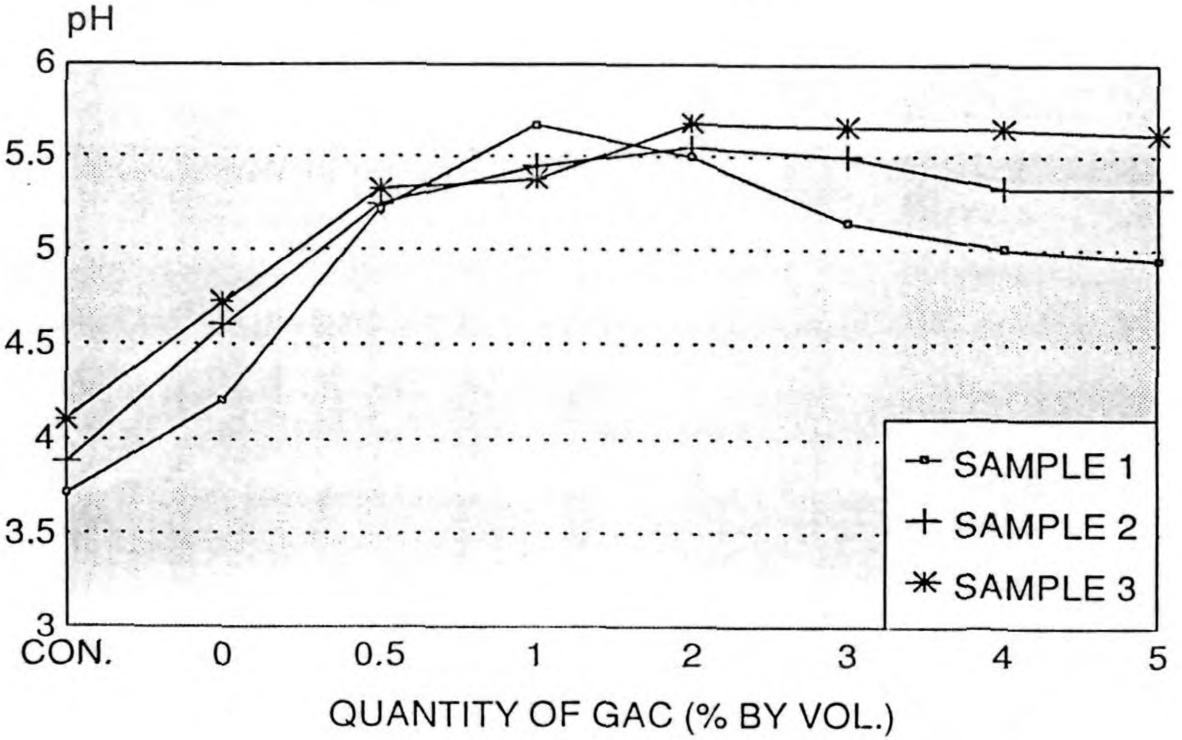


FIGURE - 3.5.3

UV IRRADIATION - WITH OXIDANT AND VARYING QTY. OF GAC.

EFFECT ON COD

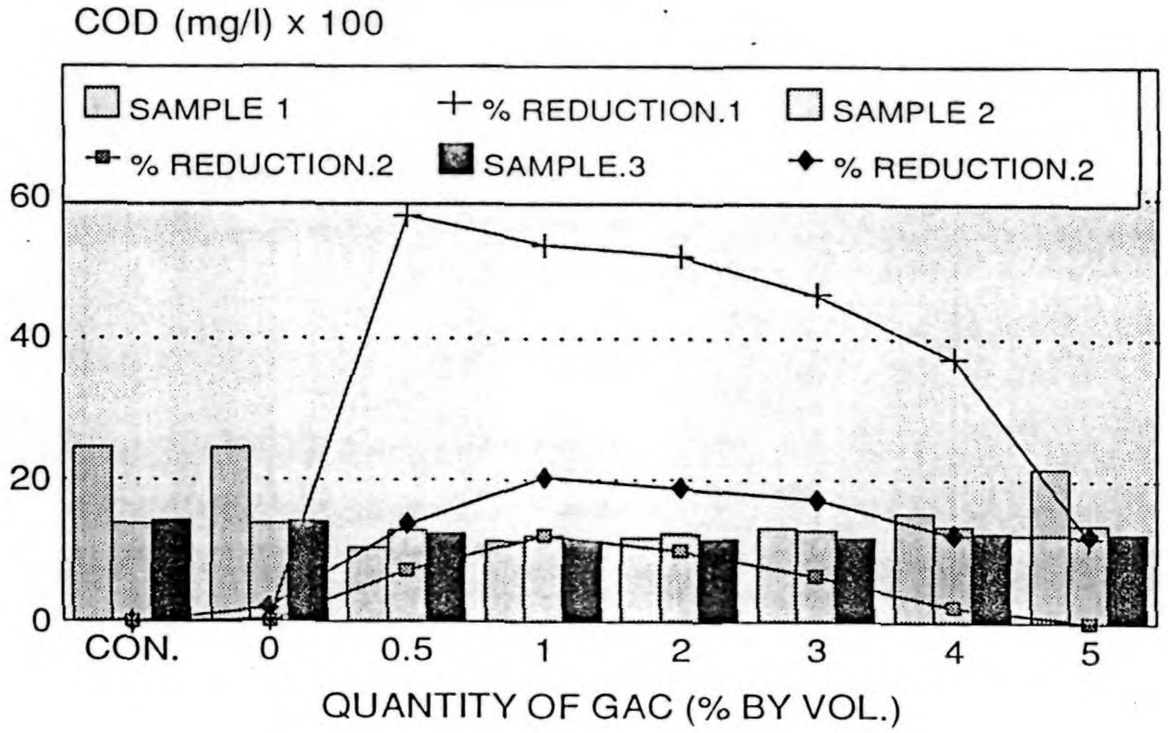


FIGURE - 3.5.4

UV IRRRADIATION - WITH OXIDANT AND VARYING QTY. OF GAC

EFFECT ON TOC

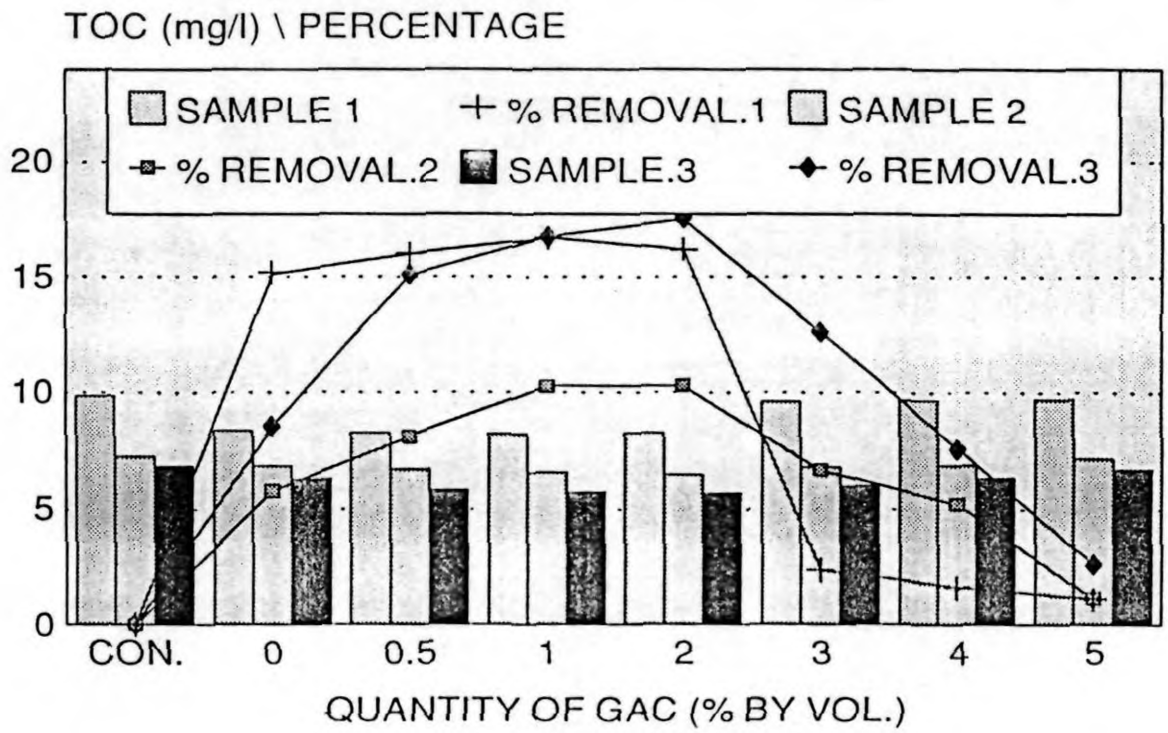


FIGURE - 3.5.5

UV IRRADIATION - WITH OXIDANT AND VARYING QTY. OF GAC.

EFFECT ON MBAS

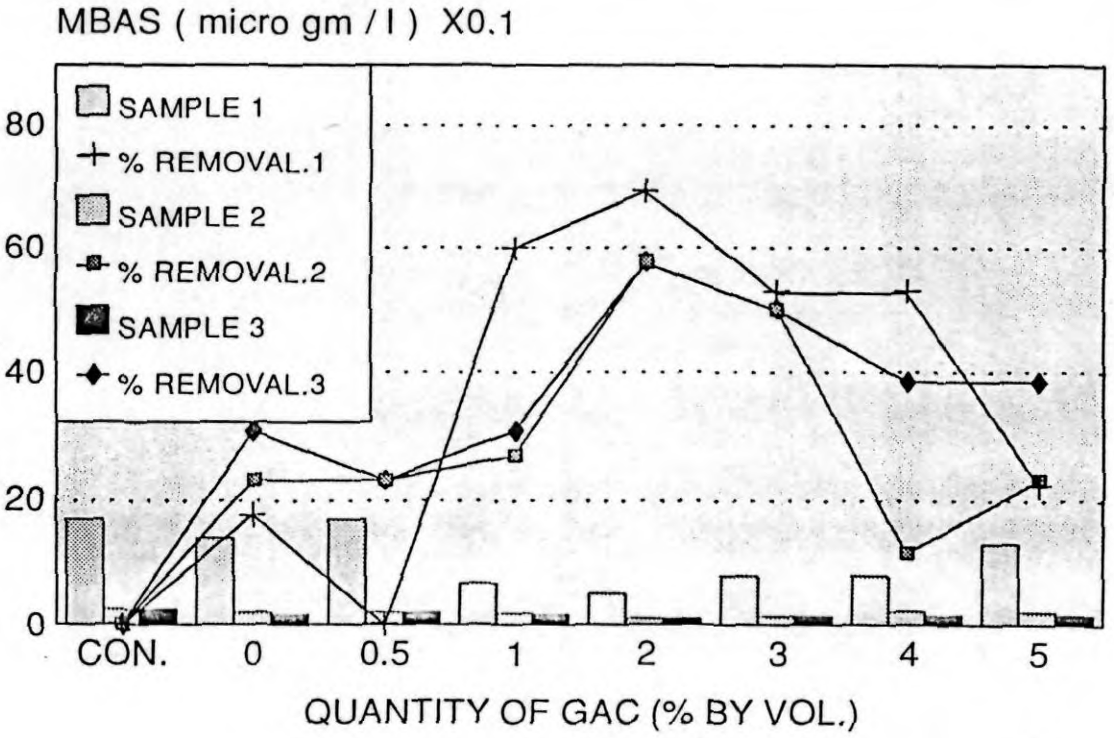


FIGURE - 3.5.6

UV IRRADIATION - WITH OXIDANT AND VARYING QTY. OF GAC.

EFFECT ON PHOSPHATES

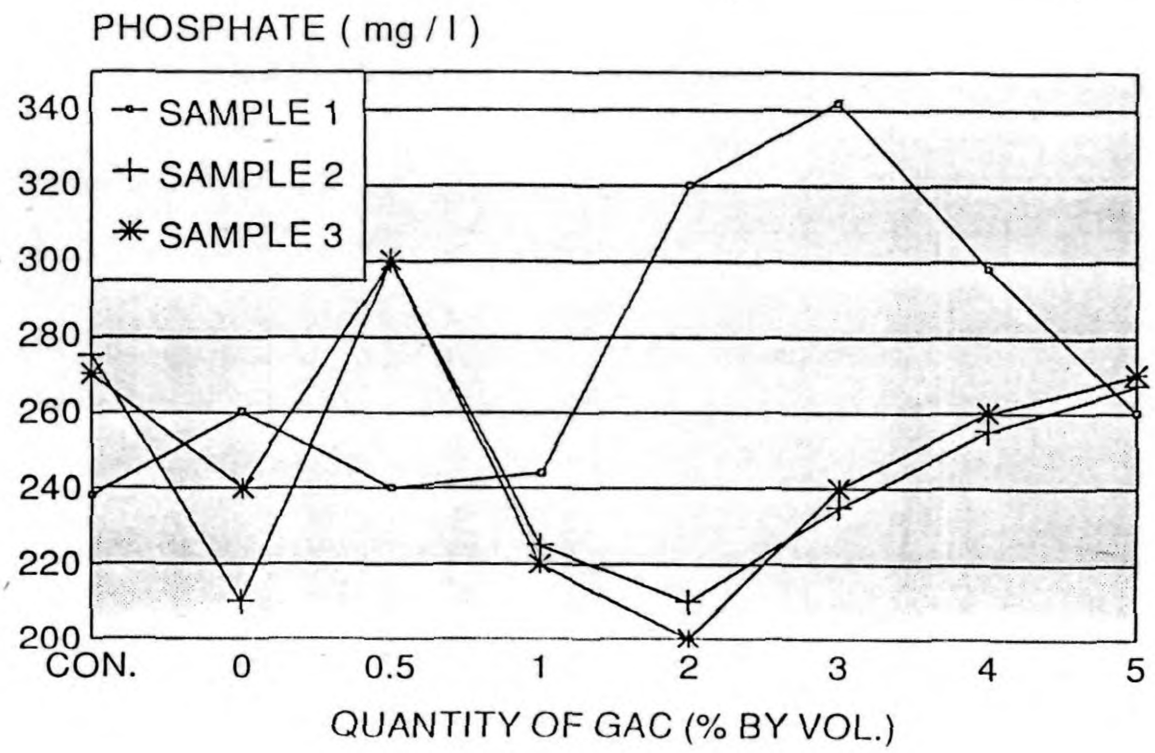


FIGURE - 3.5.7

UV IRRADIATION - WITH OXIDANT AND VARYING QTY. OF GAC.

EFFECT ON NITRATES

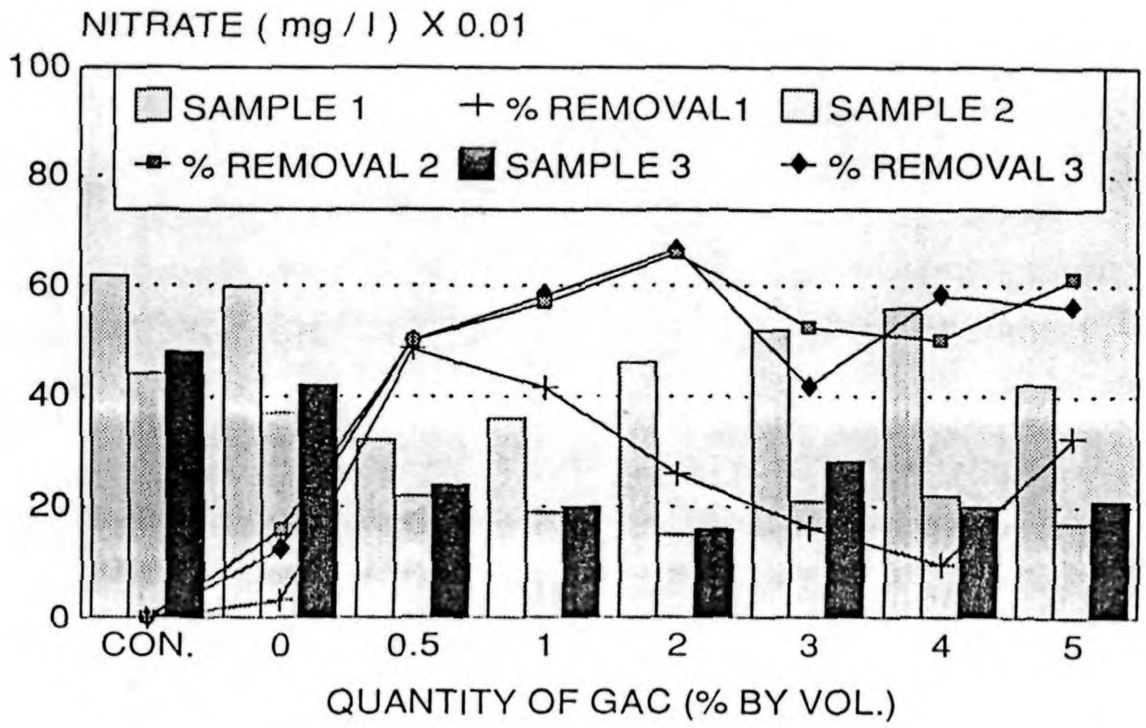


FIGURE - 3.5.8

UV IRRADIATION - WITH FIXED GAC AND VARYING QTY. OF OXIDANT
EFFECT ON pH

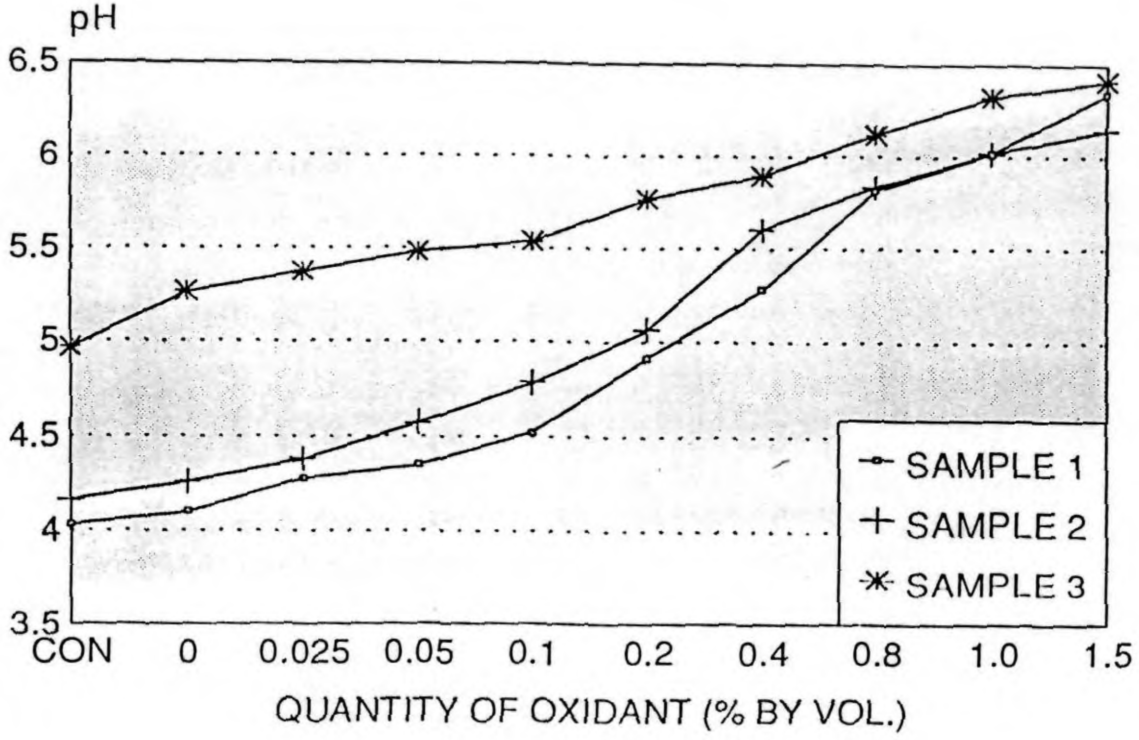


FIGURE - 3.5.9

UV IRRADIATION - WITH FIXED GAC AND VARYING QTY. OF OXIDANT
EFFECT ON COD

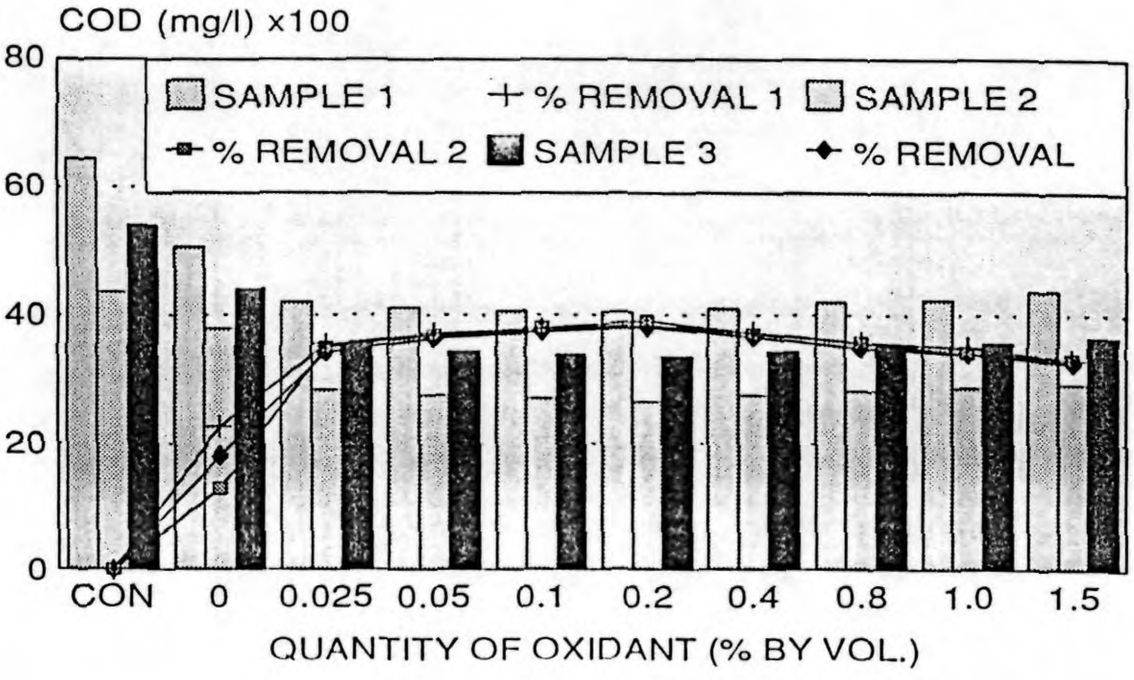


FIGURE - 3.5.10

UV IRRADIATION - WITH FIXED GAC AND VARYING QTY. OF OXIDANT

EFFECT ON TOC

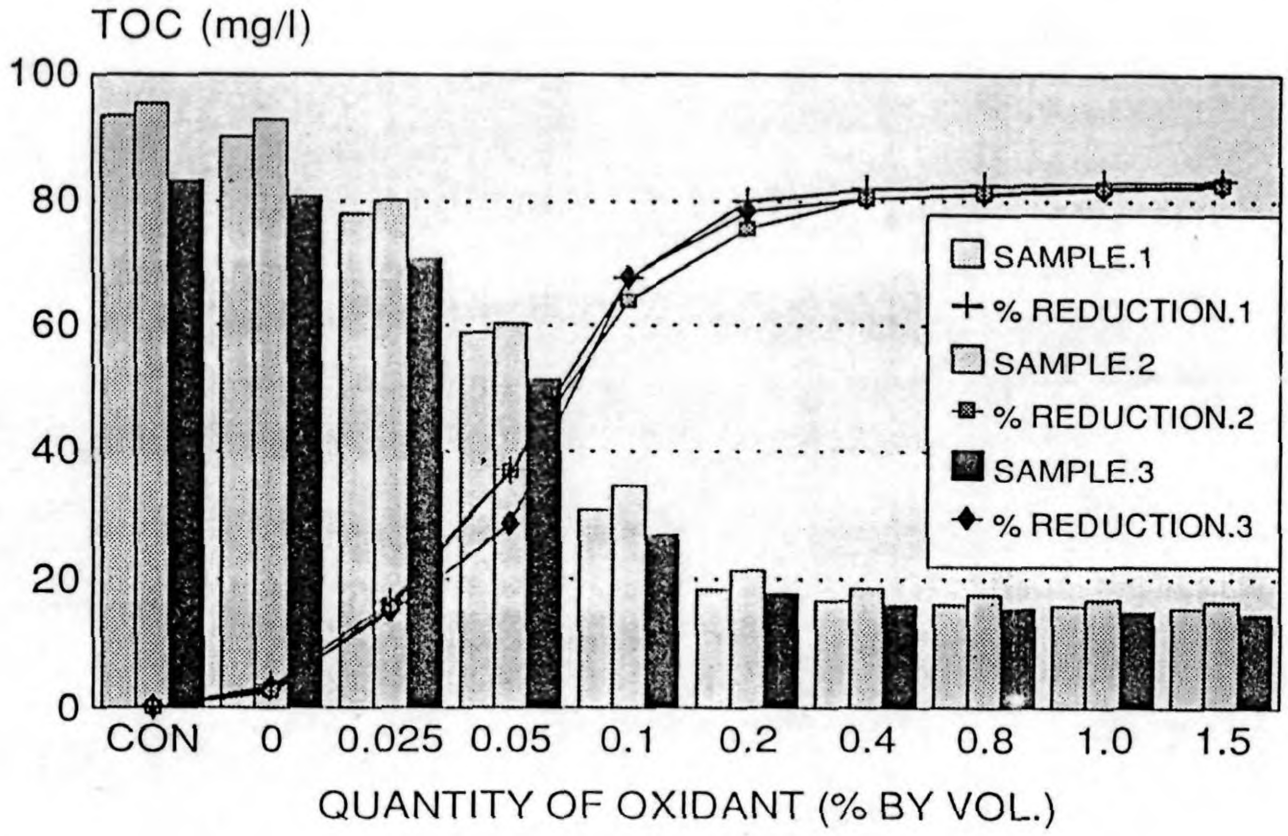


FIGURE - 3.5.11

UV IRRADIATION - WITH FIXED GAC AND VARYING QTY. OF OXIDANT

EFFECT ON MBAS

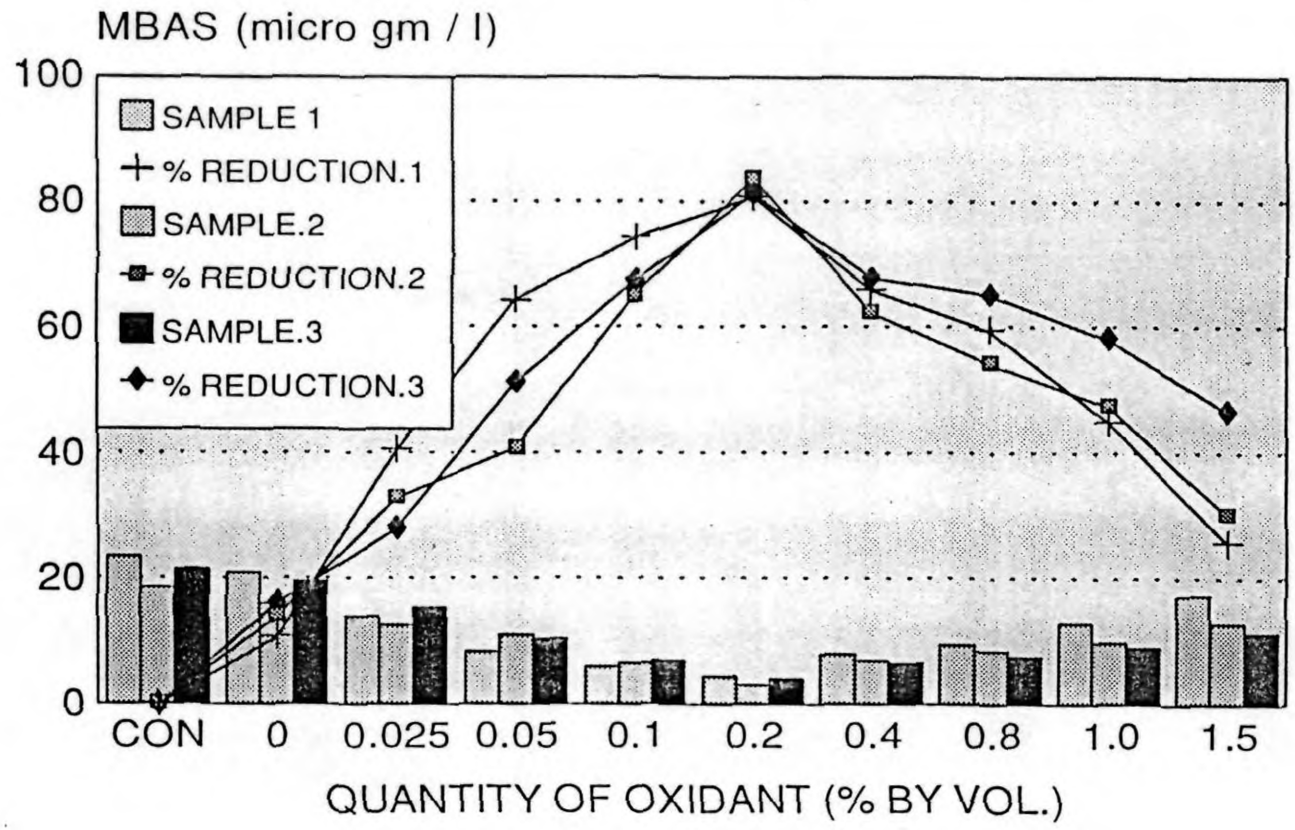


FIGURE - 3.5.12

UV IRRADIATION - WITH FIXED GAC AND VARYING QTY. OF OXIDANT
EFFECT ON NITRATE

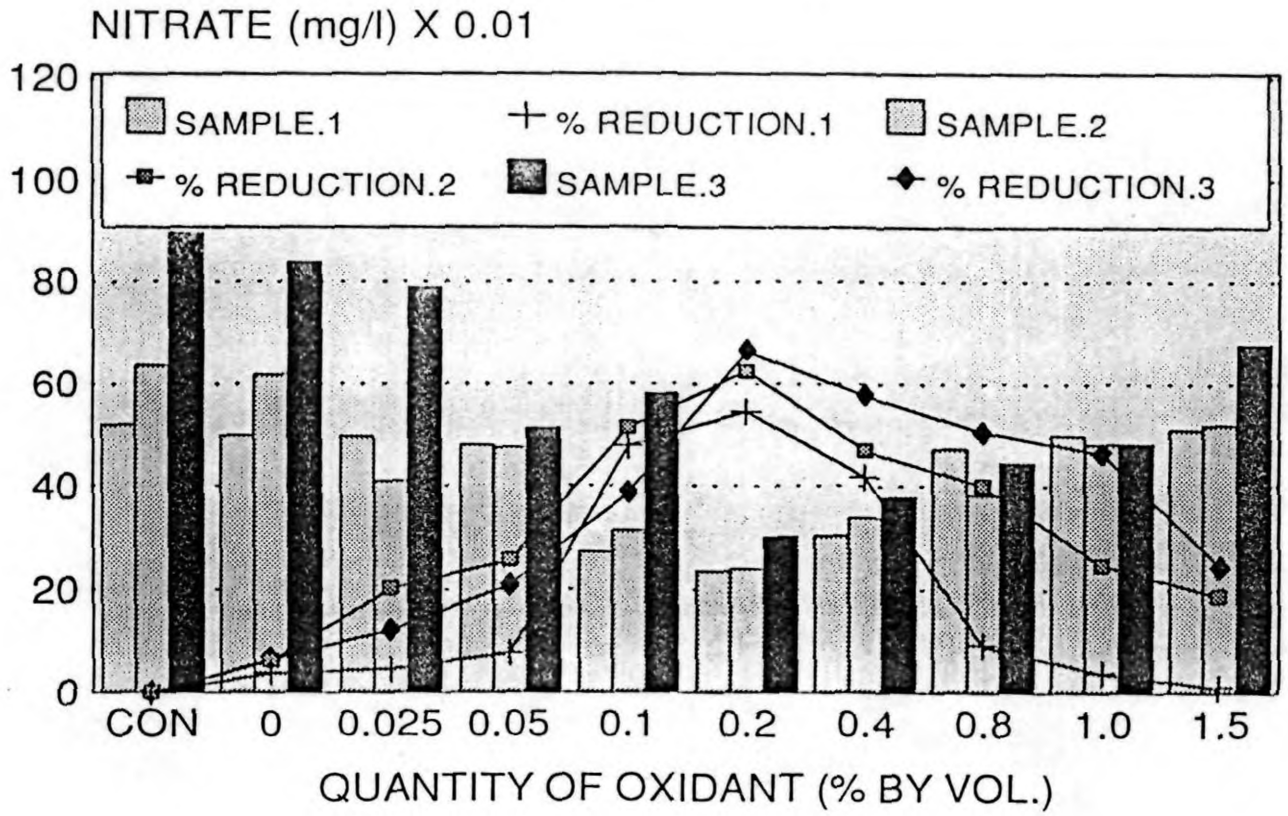


FIGURE - 3.5.13

UV IRRADIATION - WITH DIFFERENT OXIDANTS : EFFECT ON POLLUTANTS

pH

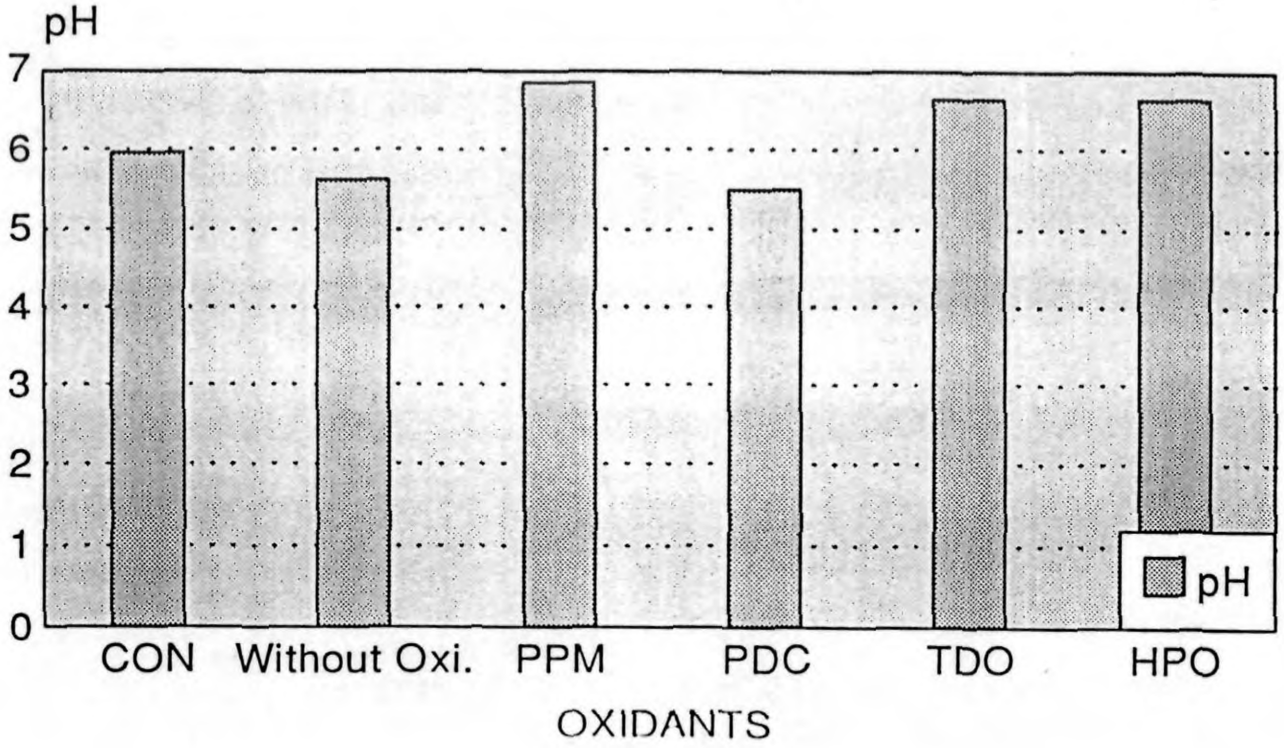


FIGURE - 3.5.14
PPM = Potassium Permanganate, PDC = Potassium Dichromate
TDO = Titanium Dioxide and HPO = Hydrogen Peroxide

UV IRRADIATION - WITH DIFFERENT OXIDANT : EFFECT ON POLLUTANTS
COD

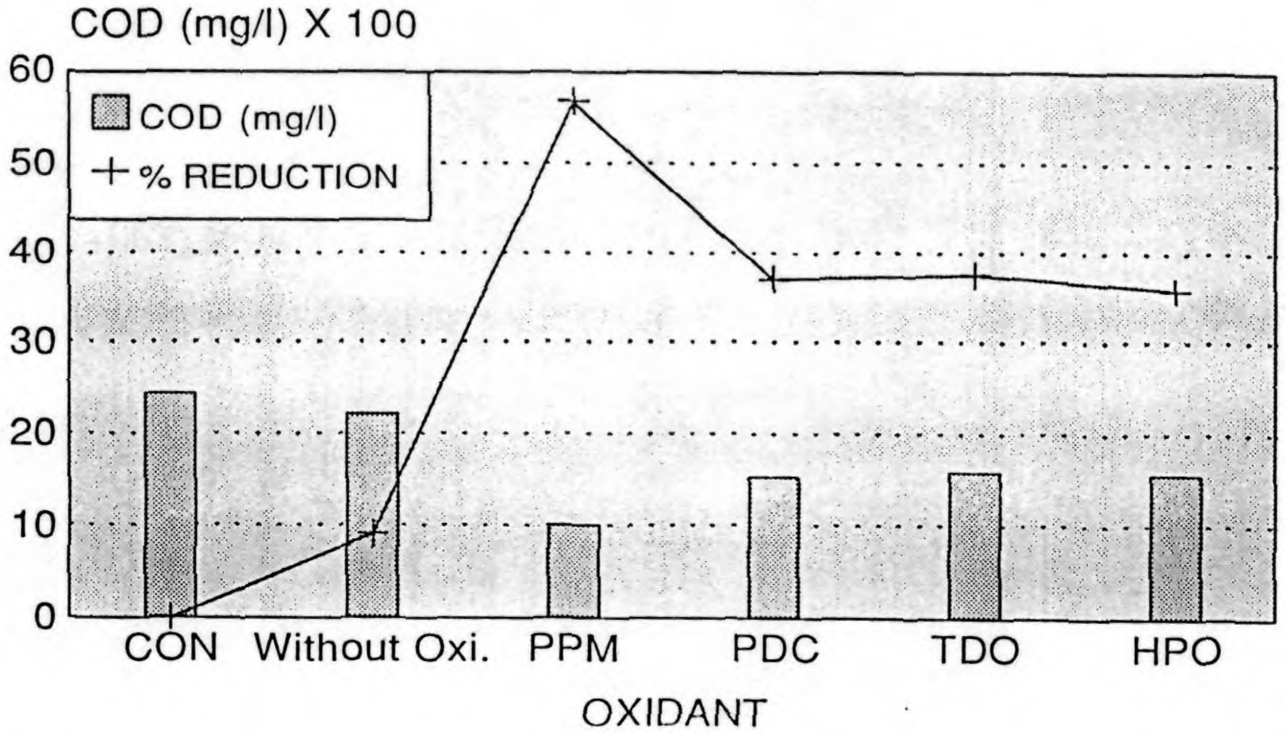


FIGURE - 3.5.15
PPM = Potassium Permanganate , PDC = Potassium Dichromate
TDO = *Titanium Dioxide* , HPO = *Hydrogen Peroxide*

UV RADIATION - WITH DIFFERENT OXIDANT : EFFECT ON POLLUTANTS
TOC

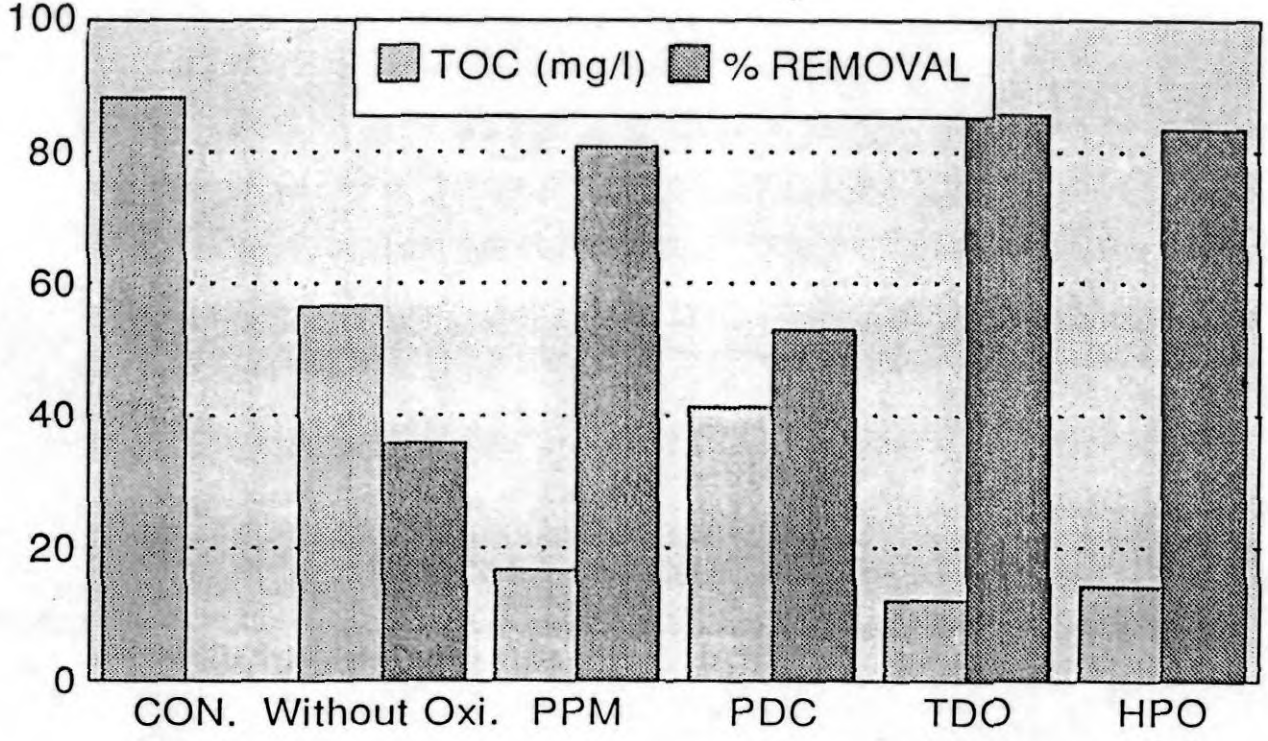


FIGURE - 3.5.16
PPM = Potassium Permanganate , PDC = Potassium Dichromate
TDO = Titanium Dioxide , HPO = Hydrogen Peroxide

UV IRRADIATION - WITH DIFFERENT OXIDANT : EFFECT ON POLLUTANTS

MBAS

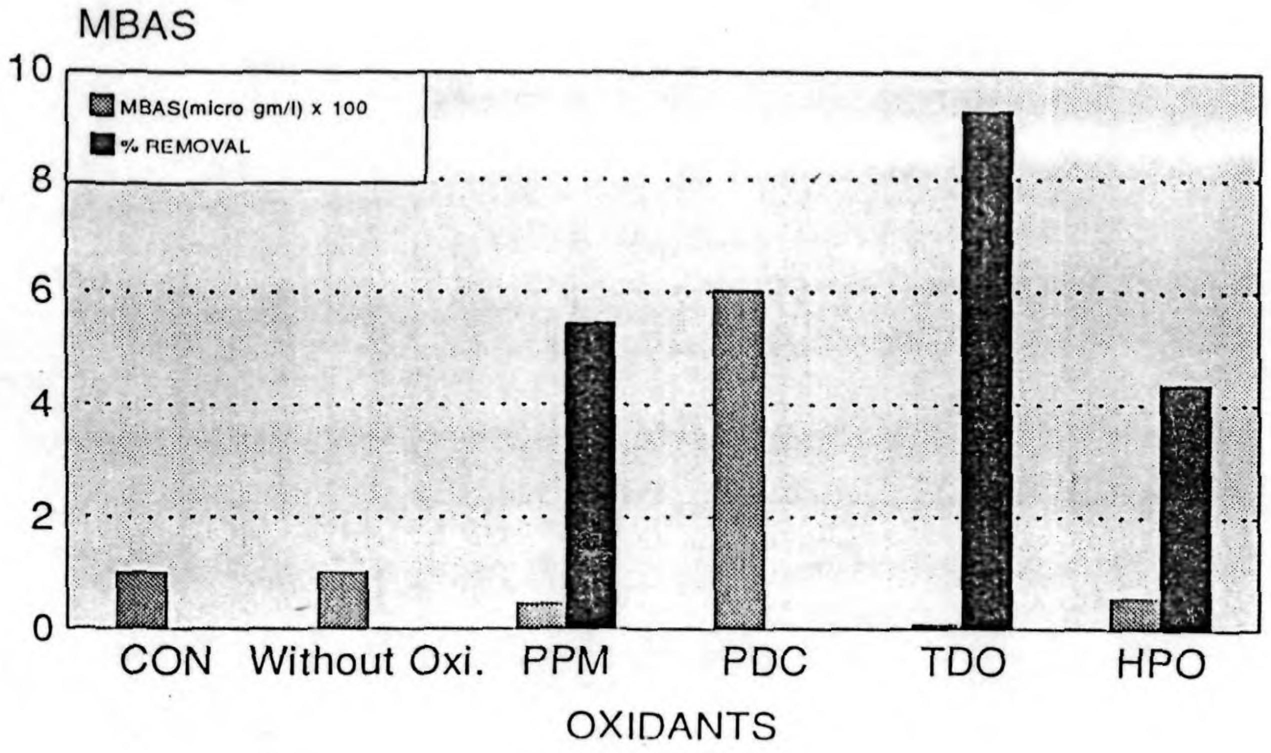


FIGURE - 3.5.17
PPM = Potassium Permanganate , PDC = Potassium Dichromate
TDO = Titanium Dioxide , HPO = Hydrogen Peroxide

UV IRRADIATION - WITH DIFFERENT OXIDANT : EFFECTON POLLUTANTS

NITRATE

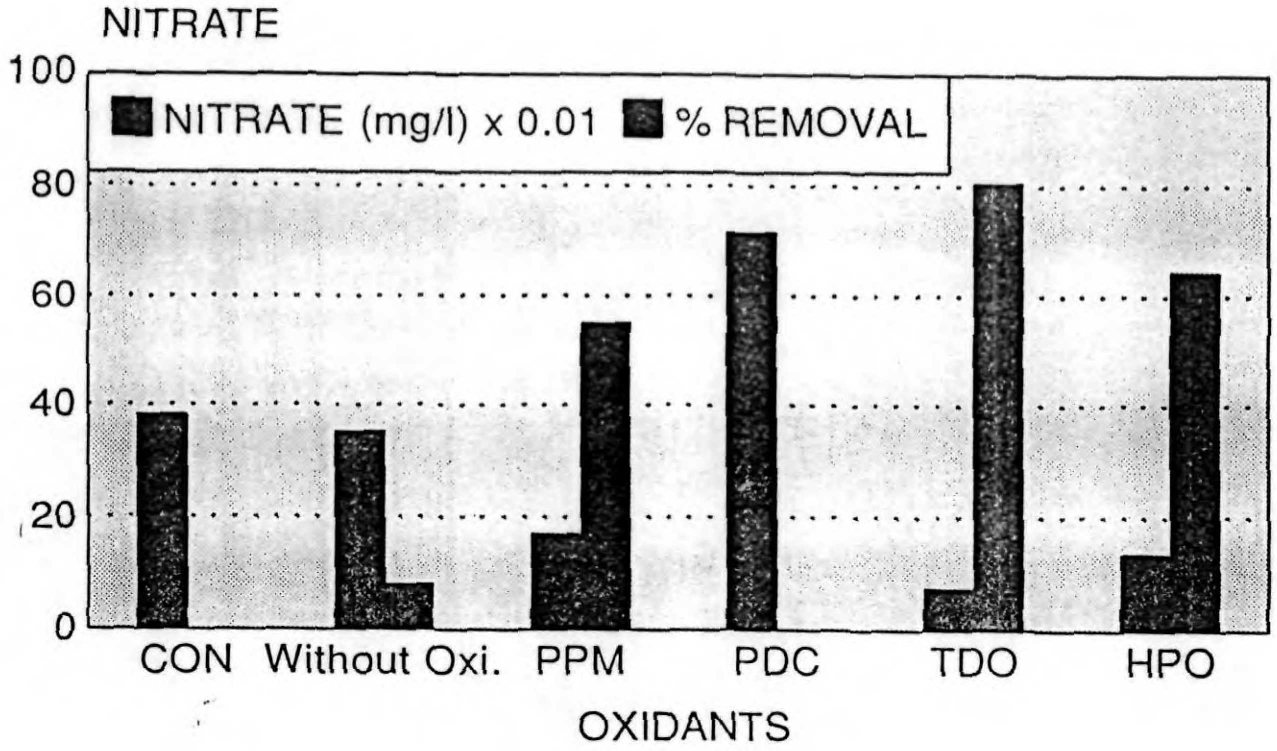


FIGURE - 3.5.18
PPM = Potassium Permanganate , PDC = Potassium Dichromate
TDO = Titanium Dioxide , HPO = Hydrogen Peroxide

CHAPTER - III

PART - VI: SOLAR TREATMENTS

PART VI.

3.6. EFFECT OF SOLAR RADIATION IN THE REMOVAL OF HEAVY METALS FROM LATEX CONCENTRATE EFFLUENTS.

It has been recognised for many years that sunlight is moderately effective as a bactericide (134). Photocatalytic degradation in water and wastewater treatment was studied and reported in several published works (164 - 171). The application of photocatalytic oxidation with oxidant to water treatment has been extensively developed (165 & 172). Photocatalytic degradation with semiconductor suspension has been viewed with interest recently (173 - 175) and has been found a promising method for the removal of trace levels of organic and inorganic contaminants from water and wastewater. Photocatalytic technique though being a destructive technique, is better than transfer of phase technologies used in the removal of micro pollutants (176).

The studies on the effect of Solar radiation with oxidants were concentrated mainly for the reduction of micro pollutents such as TOC and surfactants (177 - 181).

In the present study, the effect of Solar radiation with different oxidants on reduction of toxic elements such as Iron, Chromium, Lead, Manganese, Copper and Magnesium was studied. The role of different types of vessels viz. Aluminium, Glass, Brass, Steel and Copper coupled with various oxidants on the removal of these toxic elements were also studied.

3.6.1. EFFECT OF SOLAR RADIATION COUPLED WITH DIFFERENT OXIDANTS.

3.6.1.1. TREATMENTS.

The wastewater collected from latex concentrating factory was treated with various oxidants and Solar Radiation was allowed to pass for different time periods . Then the irradiated samples were filtered through Whatman No.1 filter paper and the different elements present in the wastewater were determined by Atomic Absorption Spectrometer (AAS). Hydrogen peroxide (HPO), Titanium dioxide (TDO), Potassium permanganate (PPM) and Potassium dichromate (PDC) were the various oxidants used in the experiment. 100 ml of the effluent sample with 1.0 % of different oxidants were taken in a glass vessels having a diamension of 7 cm. diameter and 5 cm. height. The vessels were subjected to incoming solar radiation for 50 hours by placing the samples in sunlight for 10 hrs per day for 5 days.

The elements studied are Iron (Fe), Chromium (Cr), Lead (Pb), Manganese (Mn), Copper (Cu) and Magnesium (Mg).

3.6.1.2. EFFECT ON IRON (Fe).

The control had an Iron content of 11.4841 mg/l. Subjecting solar radiation without any oxidant, this value was reduced to 2.6998 mg/l (Table - 3.6.1) and with HPO the value was 1.9184 mg/l. On treatment with TDO, PPM and PDC the values was reduced considerabily to 0.5501 mg/l for both TDO and PPM , and 0.3134 mg/l for PDC. The maximum reduction was observed with PDC on solar treatment.

3.6.1.3. EFFECT ON CHROMIUM (Cr).

0.5089 mg/l of chromium in the control got reduced by the treatment without oxidant to 0.3348 mg/l. For the treatments using HPO, TDO and PPM the values were found to be higher than that of the control viz. 1.2054 mg/l, 0.6250 mg/l and 2.7724 mg/l respectively. Since PDC itself contains chromium, treatment using PDC was not employed.

The optimum reduction was obtained for the treatment without any oxidant.

3.6.1.4. EFFECT ON LEAD (Pb).

In the case of lead no noticeable reduction had been found while applying the treatment with all type of the oxidants. The tereatment without oxidant gave the same value as that of control, ie. 0.1415 mg/l. With all the oxidants values for lead were found to be higher than that for control.

For the removal of lead none of the treatment was effective.

3.6.1.5. EFFECT ON MANGANESE (Mn).

The control had a manganese content of 0.5605 mg/l. Without oxidant, sample gave higher value (0.6007 mg/l). With HPO and PDC also values were higher than that of control. But with TDO there was a negligible reduction of 0.4856 mg/l. PPM is being a Manganese compound, PPM treatment was not employed.

The solar radiation treatment with TDO only was giving a slight decrease of Mn from the sample.

3.6.1.6. EFFECT ON COPPER (Cu).

0.5378 mg/l copper in the control was increased to 0.9646 mg/l by applying solar radiation without oxidant. But on addition of oxidants, the copper content showed a reduction from the effluent. HPO, PPM and PDC showed more or less the same values of reduction (Table-3.6.1). TDO gave a value 0.3877 mg/l which was lesser than other values.

The highest reduction was observed with TDO on solar radiation for copper.

3.6.1.7. EFFECT ON MAGNESIUM (Mg).

The control had a Mg content of 195.6630 mg/l. Without adding oxidants the value was reduced to 167.9750 mg/l. The solar radiation on latex concentrate effluent along with oxidants showed an increase in the magnesium content to a range of 261.1860 mg/l to 404.9910 mg/l which were very much higher than the control.

None of the treatment is effective in reducing the Mg from the effluent, however the treatment without oxidants showed a slight reduction in the value of Mg.

3.6.2. EFFECT OF SOLAR RADIATION WITH OXIDANTS IN VESSELS OF DIFFERENT MATERIALS.

3.6.2.1. TREATMENTS.

The wastewater collected from the latex concentrating factory was treated with 1.0% of each oxidants (HPO, TDO, PPM, PDC and Blank) and kept for oxidation in different types of vessels. The vessels used in the experiment were Glass, Aluminium, Steel, Brass and Copper. After 50 hrs of solar radiation, the samples were filtered through Whatman No.1 filter paper and determined Fe, Cr, Pb, Mn, Cu and Mg contents by AAS.

3.6.2.2. GLASS VESSEL.

Table - 3.6.1 explains the effect of glass with various oxidants on different elements. The control had an iron content of 11.4841 mg/l, which was reduced to 2.6998 mg/l by solar radiation alone. On treatments with the HPO the value was again reduced to 2.6998 mg/l, with TDO and PPM the values were the same 0.5501 mg/l and with PDC the value was 0.3143 mg/l which found to be the lowest among all the values.

The solar radiation with oxidant in the glass vessel gave an optimum reduction of iron with PDC. The treatments with TDO and PPM were also effective.

Chromium content in the control was 0.5089 mg/l.On aplication of solar radiation alone gave a negligible reduction in the value of Cr to 0.3324 mg/l . All the oxidants shows a higher value than that of control.

None of the treatment was effective for reducing Cr in glass vessel. However the solar irradiation in glass vessel alone without oxidants gave a slight reduction.

In the case of lead the reduction was not at all possible with any of the oxidant (Table - 3.6.1) . On the contrary some additions of lead with oxidants was noticed. Hence the treatment with SR without oxidant only could show a value near to that of control.

None of the treatment in case of lead was effective.

For. Manganese there was a reduction observed with TDO only. All other treatments gave the values higher than that of control (Table - 3.6.1).

The control had a copper content of 0.5378 mg/l. On treatment with SR in glass vessel the value was rised to 0.9646 mg/l. While on treatment with oxidants in glass vessels the values was negligilby reduced to a range of 0.3877 mg/l to 0.4565 mg/l. The TDO showed the maximum reduction and the value was 0.3877 mg/l.

The optimum reduction was observed with TDO for Cu.

In the case of Magnesium, all the treatments in glass vessels except the SR without any oxidant gave some reduction in the Mg, the value (167.975 mg/l), which was lesser than that of control (195.6630 mg/l).

None of the treatment in glass vessel was efficient in reducing the Mg from latex concentrate effluent.

3.6.2.3. ALUMINIUM VESSEL.

In Aluminium vessels, iron removal was obtained with all the treatments . The SR without oxidant gave a value 5.3879 mg/l (Table - 3.6.2), which was less than that of the control of 11.4841 mg/l. With HPO the value was 7.0076 mg/l. But with TDO, PPM and PDC it gave considerably lesser values (0.3141 mg/l, 0.3348 mg/l and 0.2354 mg/l respectively). The PDC gave the highest removal.

For chromium, the SR in aluminium vessels gave some removal with HPO, TDO and without oxidant and the values are 0.4509 mg/l, 0.2767 mg/l and 0.4509 respectively. The lower value was with TDO . PPM gave a value higher than that of control. Since PDC itself contains Cr, tratment employing the oxidant was not conducted. The optimum reduction was observed with TDO in Aluminium vessel for Cr.

As in the case of glass vessel, aluminium also did not gave any removal for Pb. Where as there was a rise in values of Pb with all treatments (Table - 3.6.2).

In the case of Mn, all treatments except TDO showed a higher value than that of control (Table - 3.6.2). With TDO treatment the value was 0.4856 mg/l.

For copper, there was considerable reduction with all the oxidants in Aluminium vessel. The control had a copper content of 0.5378 mg/l, which was negligibly reduced to 0.3262 mg/l, 0.1782mg/l, 0.2085 mg/l and 0.1912 mg/l with HPO, TDO, PPM and PDC respectively. The treatment without oxidant showed a value 0.8234 mg/l which was higher than the control (Table - 3.6.2). Hence the optimum reduction was found with TDO in Aluminium vessel. The treatments with PPM and PDC were also good.

In the case of Mg, very high values were observed for all treatments except with PPM (Table - 3.6.2). The value of control 195.6630 mg/l was reduced to 100.1360 mg/l by treatments.

3.6.2.4. <u>STEEL VESSEL.</u>

Solar radiation on effluent in steel vessel showed a reduction in Iron content. Table - 3.6.3 shows that the maximum removal was with TDO in Steel vessel.

In the case of Cr, the treatments without oxidant and with PPM showed a negligible decrease in the value (0.3348 mg/l), from 0.5089 mg/l of control. With HPO and TDO, higher values of 0.7410 mg/l and 0.9152 mg/l respectively were observed. The optimum reduction was obtained with TDO on SR in steel vessel.

For lead, treatment values in steel vessel were observed very high than the control (Table - 3.6.3), hence none of the treatment in steel can be cosidered effective.

The 0.5605 mg/l of Mn for control was slightly decreased to 0.1198 mg/l, 0.1230 mg/l and 0.1524 mg/l by HPO, TDO and PDC respectively. Without oxidant a comparable value of 0.6054 mg/l was obtained. PPM teatment in steel vessel was not employed. The optimum reduction was with HPO in steel vessel for Manganese.

As in the case of Mn, the values of copper also showed a decrease with oxidants and showed a rise without the oxidant. The 0.5378 mg/l of the control was negligibly reduced to 0.2158 mg/l, 0.2049 mg/l, 0.2210 mg/l and 0.2173 mg/l by HPO, TDO, PPM and PDC respectively; and negligibly rised to 0.6162 by SR alone. For the removal of manganese the optimum condition was the SR treatment with HPO in steel vessel.

The 195.6630 mg/l of control was decreased to 105.0910 mg/l and 119.0610 mg/l by PPM and PDC in steel vessel. Where as in the other treatments the values were higher than the control (Table - 3.6.3). For magnesium none of the treatment was efficient, however PPM in steel vessel showed a slight reduction in the value.

3.6.2.5. BRASS VESSEL.

Table - 3.6.4 explains the effect on SR with various oxidants on different metals.

Reduction of iron content from the effluent in the brass vessel when sunlight was passed without oxidant and in presence of TDO and PDC gave the same value of 0.0784 mg/l. The treatments with PPM and HPO resulted in a negligible rise in the values of 0.1961 mg/l and 0.5501 mg/l respectively.

In the case of Cr, only with TDO a slight reduction was observed. None of the treatment with other oxidant was found efficient.

For Lead none of the treatment was found effective.

The control value of 0.5605 mg/l of magnesium reduced to 0.1831 mg/l and 0.2045 mg/l by oxidants HPO and TDO respectively on SR in Brass vessel. For others the values were more than the control.

The values for copper in the brass vessel were found very much high. Hence Brass vessel can not be used for the removal of copper in SR treatments.

None of the treatment was found effective for reducing magnesium from the effluent in Brass vessel while on treating with SR and oxidants.

3.6.2.6. COPPER VESSEL.

Treatment with Solar radiation on rubber effluent in copper vessel, showed a decrease in the values of iron (Table - 3.6.5). The control had an iron content of 11.4841 mg/l, which was reduced to 0.1961 mg/l by SR without oxidant and 0.5501 mg/l by HPO. The vaues were 0.0784 mg/l, 0.1568 mg/l and 0.0784 mg/l for TDO, PPM and PDC repectively. Hence the optimum reduction was observed for iron with TDO and PDC in copper vessel.

In the case of chromium, the treatment in copper vessels showed an increase in values over control except for without oxidant (Table - 3.6.5). The 0.5089 mg/l of chromium for control was reduced to 0.3348 mg/l by SR without oxidant in copper vessel.

For lead, treatment in copper vessel was not giving a satisfactory reduction. Only with HPO there was a low value than the control (Table - 3.6.5), however the reduction was very poor.

Manganese content had reduced in the copper vessel by treatment with HPO and TDO to 0.1831 mg/l and 0.2045 mg/l repectively from 0.5605 mg/l of the control. But with PDC and SR without oxidant showed a rise in values (Table - 3.6.5).

For copper, all the vaues after treatment were very much higher than the control.

In the case of Magnesium also higher values than the control was observed for all treatments. Hence none of the treatment found effective.

3.6.3. EFFECT OF DIFFERENT OXIDANTS.

3.6.3.1. TREATMENTS.

The latex concentrate effluent collected was treated with 1.0 % of each oxidants (HPO, TDO, PPM and PDC) in vessels of glass, aluminium, steel, brass and copper and passed solar radiation for 50 hours (10 hours per day for 5 days). Then the samples were filtered and analysed for the elements; Iron, Chromium, Lead, Manganese, Copper and Magnesium by AAS.

3.6.3.2. EFFECT OF VESSEL (WITHOUT OXIDANT).

The control have an iron content of 11.4841 mg/l, which was reduced to 0.3879 mg/l, 1.7389 mg/l, 0.0784 mg/l, 0.5501 mg/l and 2.6998 mg/l by using Aluminium, Steel, Brass, Copper and Glass vessels respectively (Table - 3.6.6). The optimum reduction was obtained with brass vessel on treating without any oxidant.

The vessels Aluminium,Steel and glass gave values lower than the control for chromium (Table - 3.6.6). The values of chromium observed for Brass and copper vessels were higher than that of control. It could be concluded that the optimum reduction for Cr was with steel vessel without the oxidant on SR treatment.

In the case of lead the values found with copper vessel was slightly low and the reduction rate was not satisfactory. For all other vessels it was observed either same or higher values for lead. None of the vessel was effective in reducing the lead without oxidant on SR treatment.

In the case of manganese, only the copper vessel was showing a value of 0.1831 mg/l lower than the control value of 0.5605 mg/l. With all other vessels the values were very high (Table - 3.6.6). Hence the maximum reduction was observed with copper vessel.

For copper, the values were high in all the cases except for steel which was 0.2158 mg/l. With brass vessel very high value of 24.9522 mg/l was observed, where as the control had 0.5378 mg/l only (Table - 3.6.6). The Steel vessel was giving an optimum reduction for Cu without oxidant on SR treatment.

In the case of magnesium only glass vessel was showing slightly lower value (Table - 3.6.6). With all other vessels the observed values were high. Hence none of the vessel was effective for the removal of magnesium from the effluent sample.

3.6.3.3. EFFECT OF HYDROGEN PEROXIDE (HPO).

The Table - 3.6.7 explains the effect of HPO as oxidant with Solar Radiation on Rubber Effluent in different vessels.

With HPO the control value of 11.4841 mg/l of iron was decreased to 0.3141 mg/l, 0.1961 mg/l, 0.5501 mg/l, 0.1961 mg/l and 1.9184 mg/l by using Aluminium, Steel, Brass, Copper and Glass vessels respectively. Among these the decrease with Steel and Copper vessels were the lowest.

With Aluminium and Copper vessel there was practically no decrease in the value of chromium .With other vessels the values were quite higher than the control.

For lead there was no desrease with any of the vessel (Table - 3.6.7) but an increase in values were observed. Hence none of the vessel was effective with HPO on SR treatment for reducing lead.

The 0.5605 mg/l (Table - 3.6.7) of manganese present in control was practically constant (0.4856 mg/l) by treating the effluent in Aluminium vessel. The SR given for the effluents in the Steel and Brass vessels showed a considerable decrease in the Mn content, and the values were 0.1230 mg/l and 0.1821 mg/l respectively. Where as the other treatments in the Copper and Glass vessels gave the values higher than that of control.

With Brass and Copper vessels HPO showed a very high values for copper, where as aluminium and steel gave a considerable decrease to 0.1782 mg/l and 0.2049 mg/l respectively from 0.5378 mg/l of control. With glass, the removal was less (Table - 3.6.7).

With HPO, higher values than the contol was observed for magnesium with all types of vessels (Table - 3.6.7). Hence none of the vessel was effective with HPO for reducing magnesium.

3.6.3.4. EFFECT OF TITANIUM DIOXIDE (TDO).

The Table - 3.6.8 give a description of the effect of TDO with different types of vessels on SR treatment.

With TDO, the Aluminium vessel gave a value of iron (7.0076 mg/l) which was not satisfactory considering the control value of 11.4841 mg/l. Steel and Glass vessels with TDO gave better reduction of 0.9053 mg/l and 0.5501 mg/l respectively. Brass and Copper vessels showed the lowest value for iron of 0.0784 mg/l for both cases. Hence the optimum reduction with TDO on SR was with Brass and Copper vessels.

In the case of chromium, there was no significant reduction with any of these vessels noticed but an increase in the values with Steel, Copper and Glass than the control was observed (Table - 3.6.8). With Aluminium and Brass slight decrease was observed (0.4509 mg/l) from 0.5089 mg/l of the control. Hence none of the treatment seems to be effective.

In the case of lead also there was no significant reduction with these vessels noticed on SR teatment with TDO .

For manganese all vessels except Aluminium showed more or less a decrease on SR treatment with TDO. The lowest value observed was with Steel (0.1198 mg/l) . Copper and Brass gave a comparable value of 0.2045 mg/l for both; where as with Glass the value observed was 0.4856 mg/l which was comparable with that of the control (0.5605 mg/l).

For copper the treatments with Aluminium , steel and Glass vessels showed practically no decrease (Table - 3.6.8), where as Brass and Copper vessels reported very high values.

As in the previous cases magnesium could not be reduced by SR treatment but increased to some extent (Table - 3.6.8). Hence none of the vessel was effective in reducing the Mg with TDO.

3.6.3.5. EFFECT OF POTASSIUM PERMANGANATE (PPM).

The Table - 3.6.9 shows the effect of PPM with different types of vessels on SR in latex concentrate effluents.

Iron gave a reduction with all the vessels ranging from 0.1568 mg/l to 1.0239 mg/l. The order of decrease was: Steel < Glass< Aluminium< Brass < Copper. With Copper vessel the optimum reduction of iron was observed with PPM as oxidant.

Only with Steel vessel PPM showed practically no decrease in the value of chromium to 0.3348 mg/l from 0.5089 mg/l of control. With all other vessels the vlaues were higher than that of the control (Table - 3.6.9). The optimum reduction was with Steel.

As in the case of other oxidants discussed earlier, the PPM had no effect on any of the vessel in removing the lead hence none of the vessel with PPM was effective in reducing lead.

Manganese was not determined in the treatment with PPM.

With PPM, copper values showed a marginal reduction on treatment in Aluminium and Steel vessels. With Glass the reduction of Cu was insignificant (Table - 3.6.9) and with the

Brass and Copper vessels very high values were observed. The aluminium vessel gave an optimum reduction in Cu with PPM oxidant on SR treatment.

In the case of Mg, PPM gave negligible reduction with Aluminium and Steel vessels, where as with others higher values of Mg were observed. The optimum removal was with Aluminium vessel.

3.6.3.6. EFFECT OF POTASSIUM DICHROMATE (PDC).

Table - 3.6.10 explains the effect of PDC and SR on rubber effluent in different types of vessels.

The 11.4841 mg/l iron content for the control was decreased by all the types of vessels. The values observed after treatment were 0.2354 mg/l, 0.3140 mg/l and 0.3134 mg/l for Aluminium, Steel, and Glass vessels respectively. With Brass and Copper vessels PDC showed the lowest value of iron (0.0784 mg/l) which can be considered as the optimum reduction for Fe with PPM.

Chromium was not measured in the treatment with PDC.

Like other oxidants higher values were observed for lead with PDC also (Table - 3.6.10) . Hence none of the vessel with PDC was efficient in removing lead from effluent.

In the case of manganese all types of vessels except Steel gave higher values than the control (0.5387 mg/l). Treatment in the Steel vessel gave a value (0.1524 mg/l) which was comparable to that of control. With Steel vessel the optimum reduction can be observed.

Similar to the other oxidants studied earlier, PDC also showed the same trend of reduction of Cu. With Aluminium vessel the lowest value of 0.1912 mg/l was observed. With Steel the value (0.2173 mg/l) was comparable to that of with Aluminium. With glass the value (0.4386 mg/l) was comparable with that for control (0.5378 mg/l). Brass and Copper vessels showed very high values.

As in the case of PPM , Mg showed some decrease with Steel vessel only. With all other types of vessel it gave higher values than that of control (Table - 3.6.10). The maximum reduction of Mg was with Steel vessel.

3.6.4. EFFECT OF DIFFERENT OXIDANTS AND VESSELS ON VARIOUS ELEMENTS.

3.6.4.1. TREATMENTS

Solar radiation was allowed to pass through the latex concentrate effluent collected for 50 hours in different types of vessels such as Aluminium, Steel, Brass, Copper and Glass with 1.0 % each oxidant. The oxidants used were HPO, TDO, PPM and PDC. A blank without oxidant was also conducted. After solar radiation the solutions were filtered and the quantity of Iron, Chormium, Lead, Manganese, Copper and Magnesium was estimated using AAS.

3.6.4.2. EFFECT ON IRON (Fe)

Table - 3.6.11 explains the effect of solar radiation with various oxidants in different types of vessels on iron in the rubber effluent.

The raw effluent had an Fe content of 11.4841 mg/l. The treatments in all types of vessels showed more or less descrease in the value with or without oxidant(Fig.3.6.1).

Without the oxidant the brass vessel gave the lowest value of 0.0784 mg/l. The same value was reported for TDO and PDC with Brass and Copper vessels. The next higher value, 0.1568 mg/l was observed with PPM in Copper vessel. Copper vessel without oxidant, Steel with TDO and Brass with PPM gave 0.1961 mg/l for Fe. The values 5.3879 mg/l and 7.0076 mg/l observed with Aluminium vessels were higher.

The optimum reduction of iron was observed with Brass and Copper vessels, on SR in the presence of both TDO and PDC.

3.6.4.3. EFFECT ON CHROMIUM (Cr)

Table - 3.6.12 describes the effect of solar radiation (SR) on rubber effluent with different oxidants in various types of vessels.

Wide discrepancy was obesrved with Cr on SR treatment . The control has a Cr content of 0.5089 mg/l. On treatment without oxidant gave comparable values with all vessels.

With HPO the Aluminium vessel gave a lesser value than control, with TDO, Steel gave the value 0.4509 mg/l and with PPM 0.3348 mg/l. In none of the cases, significant reduction in the value of Cr was observed .

3.6.4.4. EFFECT ON LEAD (Pb).

Table - 3.6.13 explains the effect of SR on lead with oxidants and different vessels.

None of the combination of the oxidant and vessel showed any reduction in the values of lead after employing Solar Radiation on latex concentrate effluent (Fig.3.6.3).

3.6.4.5. FFECT ON MANGANESE (Mn)

The Table - 3.6.14 describes the effect of SR with different oxidants and vessels on Manganese.

Most of the treatments showed no decrease in values. Using HPO with Steel gave a value (0.1198 mg/l) showing some reduction from 0.5605 mg/l of the control. Copper with HPO, Steel and Copper with TDO and Steel with PDC gave considerable decrease in the Mn content. Aluminium and Glass gave insignificant decrease for both with TDO.

Hence the optimum reduction for Mn was with HPO in steel vessel (Fig.3.6.4).

3.6.4.6. FFECT OF COPPER (Cu).

The Table - 3.6.15 explains the effect of Solar Radiation with various oxidants on latex concentrate effluent in different types of vessels. High values are obtained for Brass and Copper .

In most cases, the reduction was insignificant (Fig.3.6.5).

3.6.4.7. FFECT ON MAGNESIUM (Mg).

The amount of Magnesium was higher than the other elements. Table - 3.6.16 shows the effect of Solar Radiation with various oxidants in different vessels.

Neither any oxidant nor any vessel gave a considerable reduction for Mg (Fig.3.6.6). PPM in aluminium and steel vessels and PDC in steel vessel showed a marginal reduction in Mg value.

TABLE-3.6.1: EFFECT OF SOLAR RADIATION ON HEAVY METALS WITH OXIDANTS IN GLASS VESSELS.

OXIDANTS	PARAMETERS (mg/l)					
	IRON	CHROMIUM	LEAD	MANGANESE	COPPER	MAGNESIUM
CONTROL	11.4841	0.5089	0.1415	0.5605	0.5378	195.6630
WITHOUT OXI.	2.6998	0.3348	0.1415	0.6007	0.9646	167.9750
HPO	1.9184	1.2054	0.3211	0.5862	0.4565	338.7600
TDO	0.5501	0.6250	0.3233	0.4856	0.3877	261.1860
PPM	0.5501	2.7724	0.2184	xxx	0.4560	381.1260
PDC	0.3134	xxx	0.2415	0.6042	0.4386	404.9110

HPO = Hydrogen peroxide, TDO = Titanium dioxide,

PPM = Potassium permanganate, PDC = Potassium dichromate.

TABLE-3.6.2: EFFECT OF SOLAR RADIATION ON HEAVY METALS WITH OXIDANTS IN ALUMINIUM VESSELS.

OXIDANTS	PARAMETERS (mg/l)					
	IRON	CHROMIUM	LEAD	MANGANESE	COPPER	MAGNESIUM
CONTROL	11.4841	0.5089	0.1415	0.5605	0.5378	195.6630
WITHOUT OXI.	5.3879	0.3928	0.6963	0.6253	0.8234	323.0100
HPO	7.0076	0.4509	0.3069	0.6826	0.3262	327.3670
TDO	0.3141	0.2767	0.4069	0.4856	0.1782	364.1570
PPM	0.3348	0.7791	0.2248	xxx	0.2085	100.1360
PDC	0.2354	xxx	0.2154	0.8406	0.1912	435.1320

HPO = Hydrogen peroxide, TDO = Titanium dioxide,

PPM = Potassium permanganate, PDC = Potassium dichromate.

TABLE-3.6.3: EFFECT OF SOLAR RADIATION ON HEAVY METALS WITH OXIDANTS IN STEEL VESSELS.

OXIDANTS	PARAMETERS (mg/l)					
	IRON	CHROMIUM	LEAD	MANGANESE	COPPER	MAGNESIUM
CONTROL	11.4841	0.5089	0.1415	0.5605	0.5378	195.6630
WITHOUT OXI.	1.7389	0.3348	0.3400	0.6054	0.6162	306.2260
HPO	0.9053	0.7410	0.8817	0.1198	0.2158	330.3170
TDO	0.1961	0.9152	0.8724	0.1230	0.2049	464.1570
PPM	1.0239	0.3348	0.5842	xxx	0.2210	105.0910
PDC	0.3130	xxx	0.5482	0.1524	0.2173	119.0610

HPO = Hydrogen peroxide, TDO = Titanium dioxide,

PPM = Potassium permanganate, PDC = Potassium dichromate.

TABLE-3.6.4: EFFECT OF SOLAR RADIATION ON HEAVY METALS WITH OXIDANTS IN BRASS VESSELS.

OXIDANTS	PARAMETERS (mg/l)					
	IRON	CHROMIUM	LEAD	MANGANESE	COPPER	MAGNESIUM
CONTROL	11.4841	0.5089	0.1415	0.5605	0.5378	195.6630
WITHOUT OXI.	0.0784	0.7217	0.6806	0.8217	24.9522	316.9990
HPO	0.5501	1.5429	0.1418	0.1831	35.2567	232.4220
TDO	0.0784	0.4509	0.1402	0.2045	33.5271	432.4490
PPM	0.1961	0.5690	0.4189	xxx	45.2150	464.3540
PDC	0.0784	xxx	0.3958	0.7377	43.8144	416.5720

HPO = Hydrogen peroxide, TDO = Titanium dioxide,

PPM = Potassium permanganate, PDC = Potassium dichromate.

TABLE-3.6.5: **EFFECT OF SOLAR RADIATION ON HEAVY METALS WITH OXIDANTS IN COPPER VESSELS.**

OXIDANTS	PARAMETERS (mg/l)					
	IRON	CHROMIUM	LEAD	MANGANESE	COPPER	MAGNESIUM
CONTROL	11.4841	0.5089	0.1415	0.5605	0.5378	195.6630
WITHOUT OXI.	0.1961	0.3348	0.7126	0.7788	HIGH	243.1980
HPO	0.5501	0.5530	0.1383	0.1445	HIGH	265.2350
TDO	0.0784	0.5428	0.1445	0.2045	HIGH	395.2410
PPM	0.1568	0.6971	0.4325	xxx	HIGH	449.1910
PDC	0.0784	xxx	0.3958	0.7377	HIGH	459.2150

HPO = Hydrogen peroxide, TDO = Titanium dioxide,

PPM = Potassium permanganate, PDC = Potassium dichromate.

TABLE-3.6.6: EFFECT OF SOLAR RADIATION ON HEAVY METALS WITHOUT OXIDANTS IN DIFFERENT VESSELS.

VESSELS	PARAMETERS (mg/l)					
	IRON	CHROMIUM	LEAD	MANGANESE	COPPER	MAGNESIUM
CONTROL	11.4841	0.5089	0.1415	0.5605	0.5378	195.6630
ALUMINIUM	0.3879	0.3928	0.6963	0.6253	0.8234	323.0100
STEEL	1.7389	0.3348	0.3400	0.6054	0.2158	330.3170
BRASS	0.0784	0.7217	0.6806	0.8217	24.9522	316.9990
COPPER	0.5501	0.5530	0.1383	0.1831	HIGH	265.2350
GLASS	2.6998	0.3348	0.1415	0.6007	0.9646	167.9750

TABLE-3.6.7: EFFECT OF SOLAR RADIATION ON HEAVY METALS WITH HYDROGEN PEROXIDE IN DIFFERENT VESSELS.

VESSELS	PARAMETERS (mg/l)					
	IRON	CHROMIUM	LEAD	MANGANESE	COPPER	MAGNESIU
CONTROL	11.4841	0.5089	0.1415	0.5605	0.5378	195.6630
ALUMINIUM	0.3141	0.2767	0.4069	0.4856	0.1782	364.1570
STEEL	0.1916	0.9152	0.8724	0.1230	0.2049	464.1570
BRASS	0.5501	1.5429	0.1418	0.1831	35.2567	232.4220
COPPER	0.1961	0.3348	0.7126	0.7788	HIGH	243.1980
GLASS	1.9184	1.2054	0.3211	0.5862	0.4565	338.7600

TABLE-3.6.8: EFFECT OF SOLAR RADIATION ON HEAVY METALS WITH TITANIUM DIOXIDE IN DIFFERENT VESSELS.

VESSELS	PARAMETERS (mg/l)					
	IRON	CHROMIUM	LEAD	MANGANESE	COPPER	MAGNESIUM
CONTROL	11.4841	0.5089	0.1415	0.5605	0.5378	195.6630
ALUMINIUM	7.0076	0.4509	0.3069	0.6826	0.3262	327.3670
STEEL	0.9053	0.7410	0.8817	0.1198	0.2158	330.3170
BRASS	0.0784	0.4509	0.1402	0.2045	33.5271	423.4490
COPPER	0.0784	0.5428	0.1445	0.2045	HIGH	395.2140
GLASS	0.5501	0.6250	0.3233	0.4856	0.3877	261.1860

TABLE-3.6.9: EFFECT OF SOLAR RADIATION ON HEAVY METALS WITH POTASSIUM PERMANGANATE IN DIFFERENT VESSELS.

VESSELS	PARAMETERS (mg/l)					
	IRON	CHROMIUM	LEAD	MANGANESE	COPPER	MAGNESIUM
CONTROL	11.4841	0.5089	0.1415	0.5605	0.5378	195.6630
ALUMINIUM	0.3348	0.7791	0.2248	xxxx	0.2085	100.1360
STEEL	1.0239	0.3348	0.5842	xxxx	0.2210	105.0910
BRASS	0.1961	0.5690	0.4189	xxxx	45.2150	464.3540
COPPER	0.1568	0.6971	0.4325	xxxx	HIGH	449.1910
GLASS	0.5501	2.7724	0.2184	xxxx	0.4560	381.1260

TABLE-3.6.10: EFFECT OF SOLAR RADIATION ON HEAVY METALS WITH POTASSIUM DICHROMATE IN DIFFERENT VESSELS.

VESSELS	PARAMETERS (mg/l)					
	IRON	CHROMIUM	LEAD	MANGANESE	COPPER	MAGNESIUM
CONTROL	11.4841	0.5089	0.1415	0.5605	0.5378	195.6630
ALUMINIUM	0:2354	xxxx	0.2154	0.8406	0.1912	435.1320
STEEL	0.3140	xxxx	0.5482	0.1524	0.2173	119.0610
BRASS	0.0784	xxxx	0.3958	0.7377	43.8144	416.5720
COPPER	0.0784	xxxx	0.3958	0.7377	HIGH	459.2150
GLASS	0.3134	xxxx	0.2415	0.6042	0.4386	404.9110

TABLE-3.6.11: EFFECT OF SOLAR RADIATION COUPLED WITH OXIDANTS AND VESSELS IN REDUCTION OF IRON.

VESSELS	WITHOUT OXIDANT	HYDROGEN PEROXIDE	TITANIUM DIOXIDE	POTASSIUM PERMANGANATE	POTASSIUM DICHROMATE
ALUMINIUM	5.3879	7.0076	0.3141	0.3348	0.2354
STEEL	1.7389	0.9053	0.1961	1.0239	0.3140
BRASS	0.0784	0.5501	0.0784	0.1961	0.0784
COPPER	0.1961	0.5501	0.0784	0.1568	0.0784
GLASS	2.6998	1.9184	0.5501	0.5501	0.3134

All values are in mg/l

Control value of Iron = 11.4841 mg/l

TABLE-3.6.12: EFFECT OF SOLAR RADIATION COUPLED WITH OXIDANTS AND VESSELS IN REDUCTION OF CHROMIUM.

VESSELS	WITHOUT OXIDANT	HYDROGEN PEROXIDE	TITANIUM DIOXIDE	POTASSIUM PERMANGANATE
ALUMINIUM	0.3928	0.4509	0.2767	0.7791
STEEL	0.3348	0.7410	0.9152	0.3348
BRASS	0.7217	1.5429	0.4509	0.5690
COPPER	0.3348	0.5530	0.5428	0.6971
GLASS	0.3348	1.2054	0.6250	2.7724

All values are in mg/l

Control value of Chromium = 0. 5089 mg/l

TABLE-3.6.13: EFFECT OF SOLAR RADIATION COUPLED WITH OXIDANTS AND VESSELS IN REDUCTION OF LEAD.

VESSELS	WITHOUT OXIDANT	HYDROGEN PEROXIDE	TITANIUM DIOXIDE	POTASSIUM PERMANGANATE	POTASSIUM DICHROMATE
ALUMINIUM	0.6963	0.3069	0.4069	0.2248	0.2154
STEEL	0.3400	0.8817	0.8724	0.5842	0.5482
BRASS	0.6806	0.1418	0.1402	0.4189	0.3958
COPPER	0.7126	0.1383	0.1445	0.4325	0.3958
GLASS	0.1415	0.3211	0.3233	0.2184	0.2415

All values are in mg/l

Control value of Lead = 0.1415 mg/l

TABLE-3.6.14: EFFECT OF SOLAR RADIATION COUPLED WITH OXIDANTS AND VESSELS IN REDUCTION OF MANGANESE

VESSELS	WITHOUT OXIDANT	HYDROGEN PEROXIDE	TITANIUM DIOXIDE	POTASSIUM DICHROMATE
ALUMINIUM	0.6253	0.6826	0.4856	0.8406
STEEL	0.6054	0.1198	0.1230	0.1524
BRASS	0.8217	0.1831	0.2045	0.7377
COPPER	0.7788	0.1831	0.2045	0.7377
GLASS	0.6007	0.5862	0.4856	0.6042

All values are in mg/l

Control value of Manganese = 0.5605 mg/l

TABLE-3.6.15: EFFECT OF SOLAR RADIATION COUPLED WITH OXIDANTS AND VESSELS IN REDUCTION OF COPPER.

VESSELS	WITHOUT OXIDANT	HYDROGEN PEROXIDE	TITANIUM DIOXIDE	POTASSIUM PERMANGANATE	POTASSIUM DICHROMATE
ALUMINIUM	0.8234	0.3262	0.1782	0.2085	0.1912
STEEL	0.6162	0.2158	0.2049	0.2210	0.2173
BRASS	24.9522	35.2567	33.5271	45.2150	43.8144
COPPER	HIGH	HIGH	HIGH	HIGH	HIGH
GLASS	0.9646	0.4565	0.3877	0.4560	0.4386

All values are in mg/l

Control value of Copper = 0.5378 mg/l

TABLE-3.6.16: EFFECT OF SOLAR RADIATION COUPLED WITH OXIDANTS AND VESSELS IN REDUCTION OF MAGNESIUM.

VESSELS	WITHOUT OXIDANT	HYDROGEN PEROXIDE	TITANIUM DIOXIDE	POTASSIUM PERMANGANATE	POTASSIUM DICHROMATE
ALUMINIUM	323.0100	327.3670	364.1570	100.1360	435.1320
STEEL	306.2260	330.3170	464.1570	105.0910	119.0610
BRASS	316.9990	232.4220	423.4490	464.3540	416.5720
COPPER	243.1980	265.2350	395.2410	449.1910	459.2150
GLASS	167.9750	338.7600	261.1860	381.1260	404.9110

All values are in mg/l

Control value of Magnesium = 195.6630 mg/l

EFFECT OF SOLAR RADIATION COUPLED WITH OXIDANTS AND VESSELS
REDUCTION OF IRON

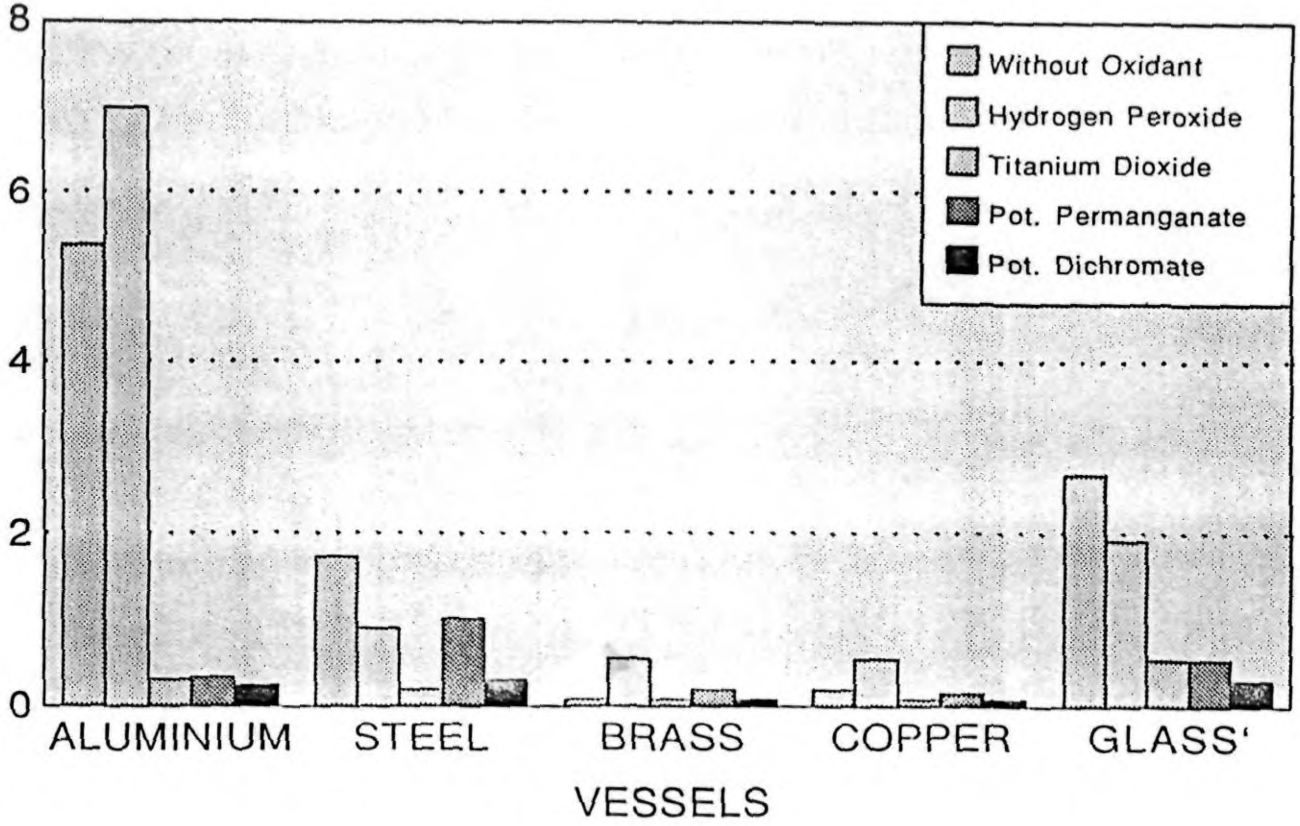


FIGURE - 3.6.1

EFFECT OF SOLAR RADIATION COUPLED WITH OXIDANTS AND VESSELS
REDUCTION OF CHROMIUM

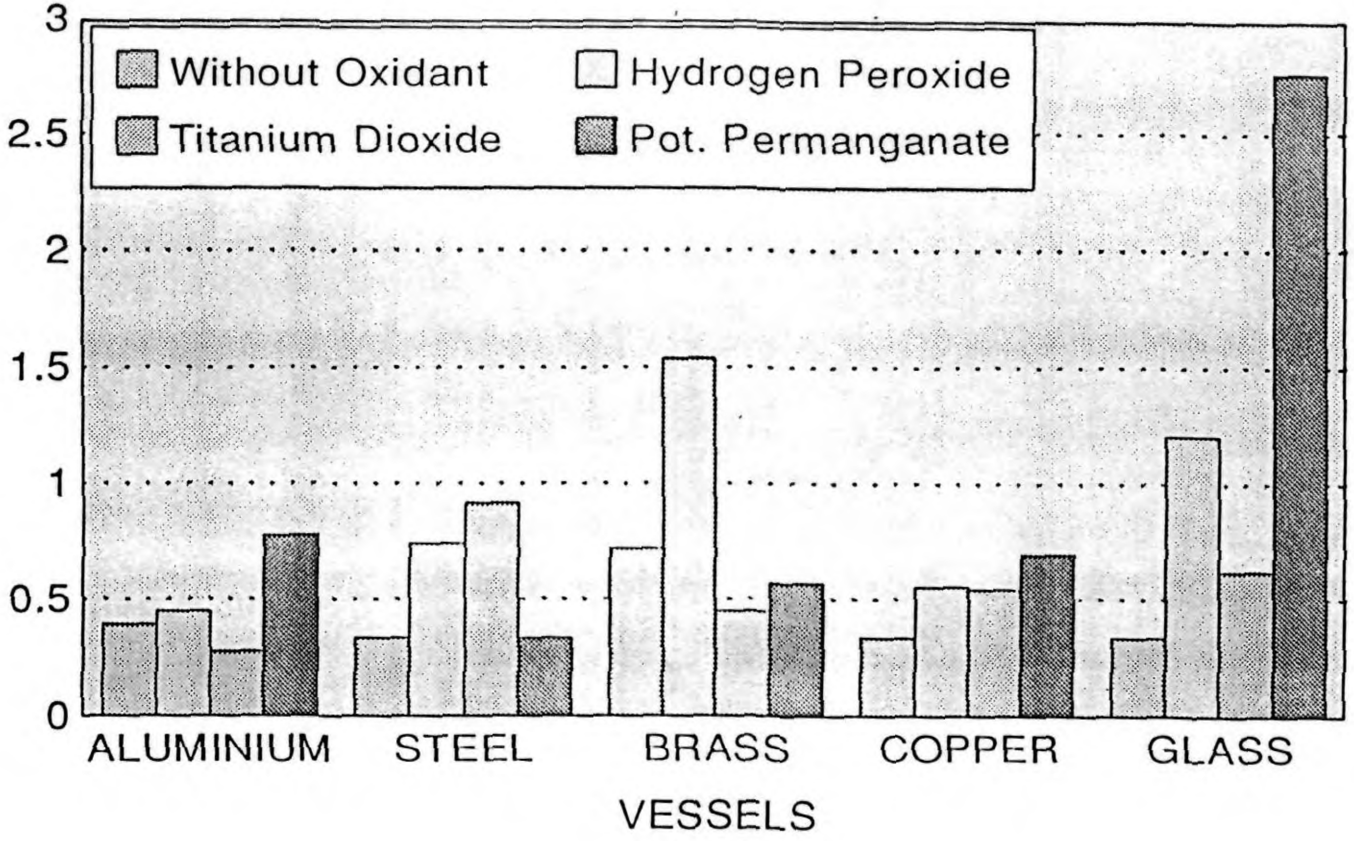


FIGURE - 3.6.2

EFFECT OF SOLAR RADIATION COUPLED WITH OXIDANTS AND VESSELS

REDUCTION OF LEAD

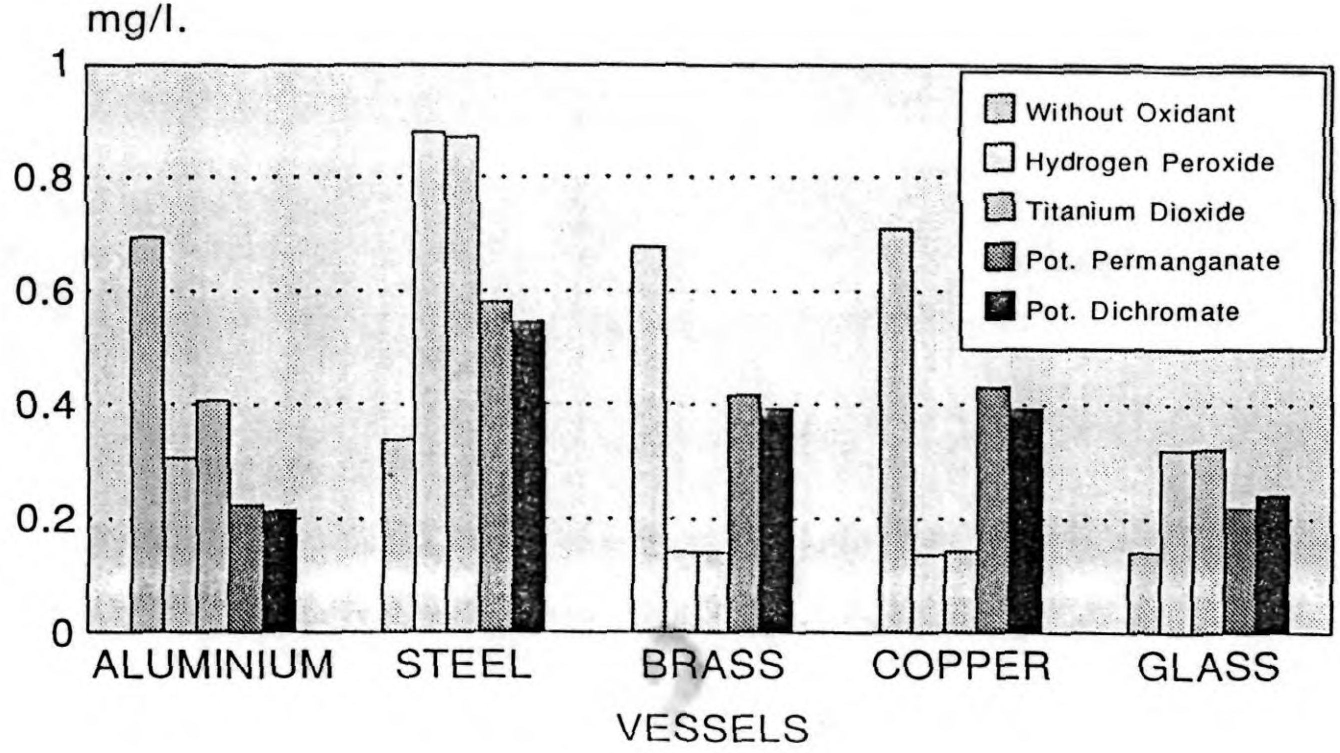


FIGURE - 3.6.3

All values are in mg/l

EFFECT OF SOLAR RADIATION COUPLED WITH OXIDANTS AND VESSELS
REDUCTION OF MANGANESE

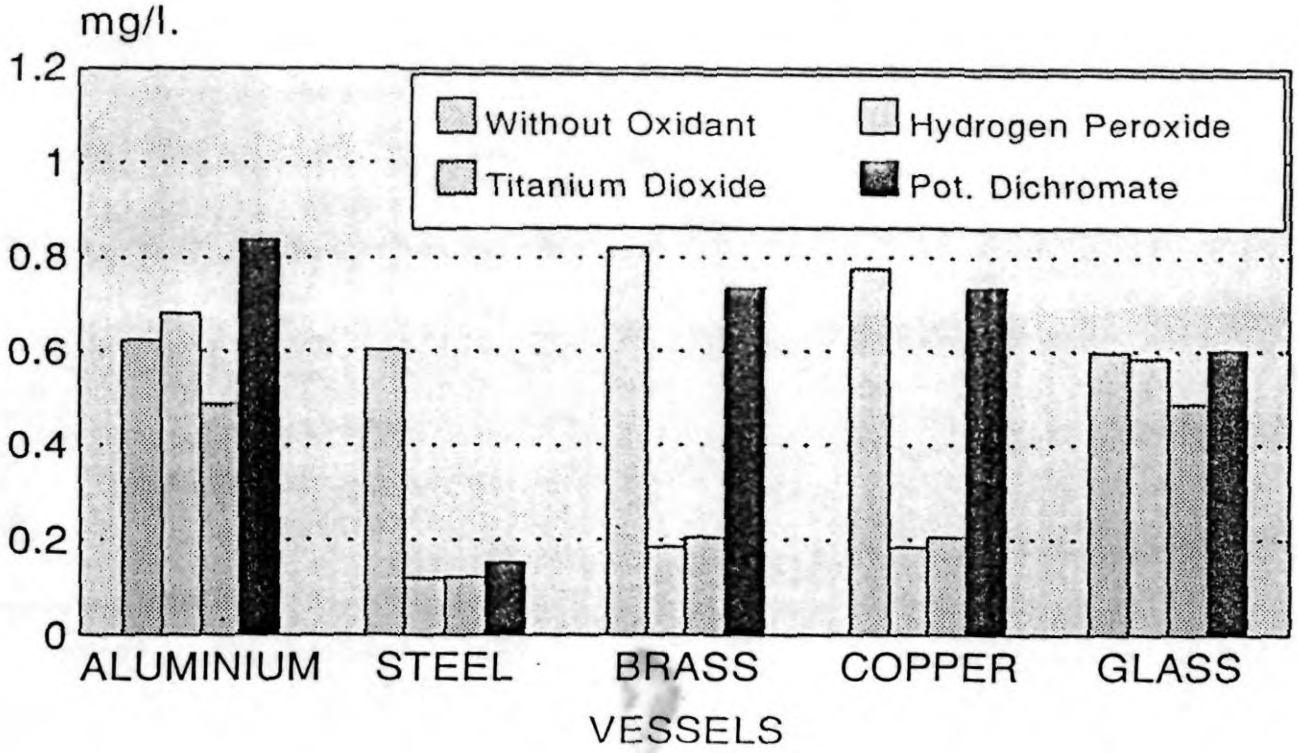


FIGURE - 3.6.4

All values are in mg/l

EFFECT OF SOLAR RADIATION COUPLED WITH OXIDANTS AND VESSELS

REDUCTION OF COPPER

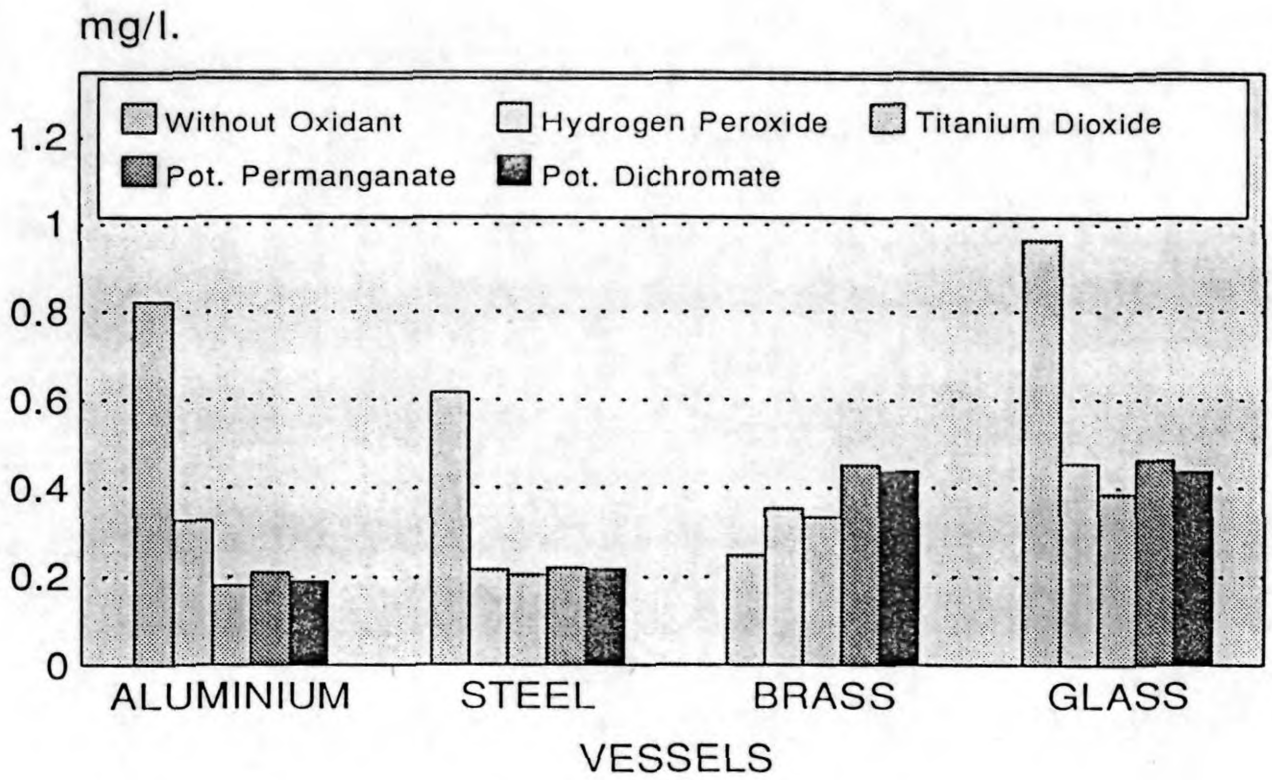


FIGURE - 3.6.5

Values for Brass Vessel are in mg/l X 100

EFFECT OF SOLAR RADIATION COUPLED WITH OXIDANTS AND VESSELS

REDUCTION OF MAGNESIUM

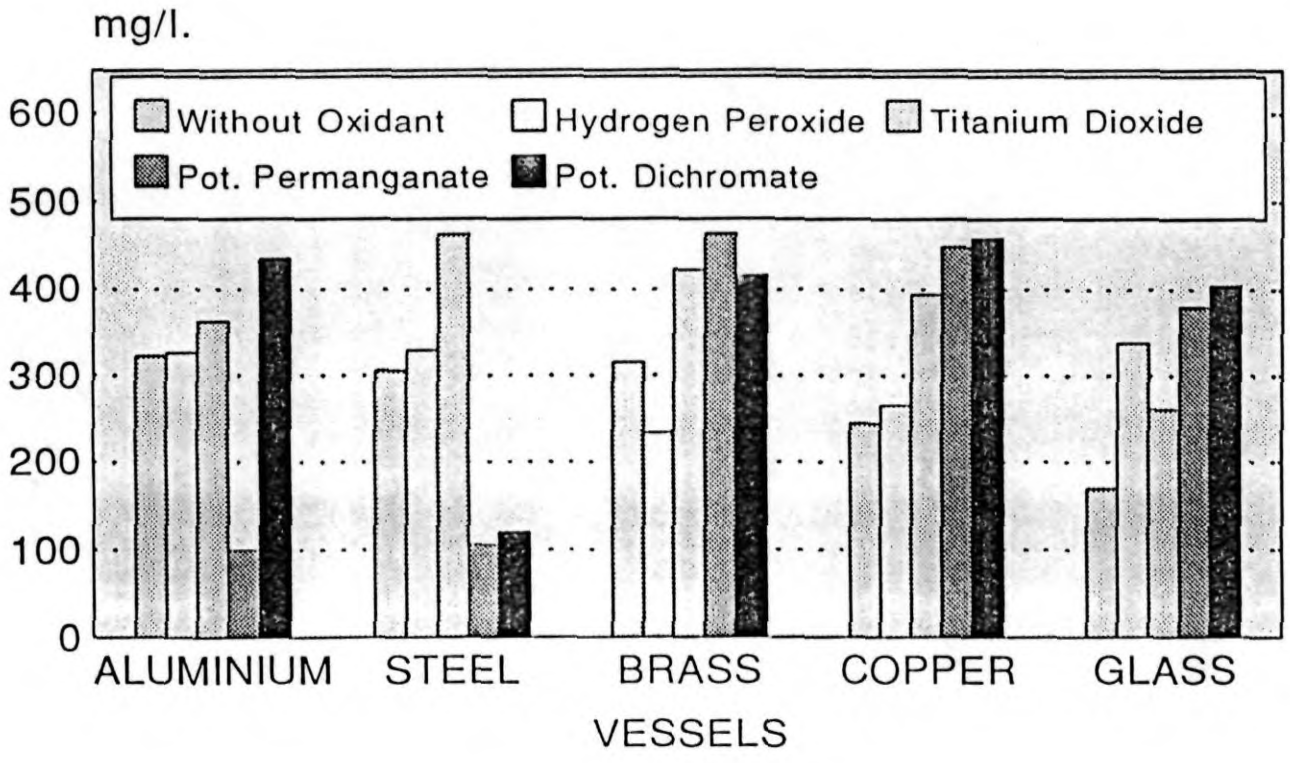


FIGURE - 3.6.6

All values are in mg/l

CHAPTER - IV

SUMMARY AND CONCLUSION

4.1 INTRODUCTION

Rubber latex from the field normally contains about 30 percent of dry rubber and significant amounts of non latex including proteins, sugurs, lipids, carotenoids, inorganic and organic salts . Most of the non-rubber constituents will go into the effluent discharged from the latex concentrating factories while processing. Altogether 46 centrifuging and 15 creaming factories are currently engaged in natural rubber latex processing and many more are expected to set up in future. The effluent discharged from each factory vary from 20,000 to 70,000 litres/day. The usual disposal practice of discharge them into surface water creates significant environmental problems.

Under the water pollution and prevention control act, each factory is legally bound to set up facilities to treat the effluent before discharge into water course or on land for irrigation.

In the present study the waste water collected from latex centrifuging factories were treated with various flocculants . The effect of various type of flocculating agents under different conditions with particular attention to the reduction of Phosphate and Nitrogen were studied. Reduction of pollutants by UV radiation and solar irradiation with different oxidants were also investigated.

The Thesis is divided into four chapters.

4.2 CHAPTER - 1

The first chapter opens up with a general introduction to water pollution, Rubber and its processing and the impact of associated pollutants on environment.

4.3 CHAPTER - 2

Second chapter includes the general discussion and experimental proceedures followed for sample collection and determination of various parameters such as pH, Chemical Oxygen Demand (COD), Biochemical Oxygen Demand (BOD), Total Dissolved Solids (TDS)., Suspended Solids (SS), Phosphates, Nitrogen, Heavy Metals, Total Organic Carbon (TOC), Cationic Surfactant etc..

4.4 CHAPTER - 3

Third chapter incorporates the results obtained and discussion of the results. This chapter is divided into six parts. The first part explains the routine analysis of raw effluent from latex concentrating factories. Amoung the twenty five parameters studied (Table 3.1.1), it was found that the values of most of them were very much higher than the limits specified by BIS (Table 1.3), especially in the case of pH, oxygen demands, nitrogens, solid contents etc. . Hence the effluents discharged from the latex concentrating factories are highly polluted.

The second part comprises of the comparative study of the flocculating agents in the reduction of various pollutants. The flocculants used in the study were lime, Aluminium alum, Ferric alum, Pickle liquor and Ferric Chloride. The lime was used alone and together with Aluminium alum, Ferric alum and Pickle liquor. The effect of Ferric Chloride and Aluminium alum without lime were also studied . It was found that the treatment of Ferric Chloride and Pickle liquor along with lime was more effective in reducing pollutants from the waste water. With these flocculants the Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) were reduced to 95% and complete removal of sulphide was observed. The total solids contents were reduced to about 84 % where as the reduction in Nitrogen and Phosphate were only about 50 % .

The third part contains the study of the reduction of phosphates with different flocculating agents and their efficiency at different pH. The different flocculants studied are lime, Ferric alum, Ferric Chloide, Ferric sulphate, Poly Aluminium Chloride and Alumina. It was found that all the flocculants were effective in reducing Phosphate to more than 99 percent. The effect of pH with all these flocculants was studied and it was observed that the reduction of phosphates increases with increase of pH. At pH value of 10 and above all the flocculating agents gave more than 99 percent reduction of phosphate. For ferric chloride and ferric sulphate the 99 percent reduction was obtained from pH 8 onwards. PAC gave complete removal of phosphate at pH 12.

Fourth part consists of the study on Nitrogen reduction efficiency of different flocculating agents at different concentrations and at different pH. The flocculants used are poly aluminium chloride (PAC), alumina and NIPE. The effect of granulated activated carbon (GAC) was also studied at different concentrations and different treatment time periods. 10 mg/l of PAC at pH 12 gave the maximum reduction of nitrogen. With alumina, the optimum condition obtained was with 10 gm/l at pH 10 and for NIPE it was with 100 mg/l at pH 10. Amoung the three flocculants studied, the alumina showed a better nitrogen removal efficiency of 89.88 percent where as for PAC and NIPE it was only 42.91 % and 86.26 % respectively.

The optimum concentration of GAC was 10 % and the reduction of nitrogen increases with increase of time . In the study the maximum treatment time given was 10 days. It was also observed that the effluent samples having higher nitrogen content required more time for reduction of nitrogen.

In the fifth part the effect of UV irradiation along with oxidants were studied. The effect of irradiation time, different concentration of GAC, different concentrations of oxidants and comparative effect of different oxidizing agents were studied on parameters such as pH, COD, TOC, MBAS, phosphates and nitrates.

It was observed that on increasing the irradiation time, a corresponding increase was noticed in pH although COD was reduced. But for all other parameters an effective reduction was obtained after 2 hours treatment.

With different concentration of GAC and fixed quantity of oxidant, it was observed that 2% GAC was giving an optimum reduction values for pH, TOC, MBAS and nitrates. For COD the optimum reduction obtained was with 1% GAC. But for phosphates instead of reduction an increase in values was noticed.

With 2% GAC and different quantity of oxidant, optimum reduction of COD, MBAS and nitrates was obtained at 0.200% of oxidant though pH increases with increasing quantities of oxidant. For TOC the reduction increases with increase of oxidant. However the rate of reduction is less at higher concentrations and the optimum can be considered as with 0.400% oxidant.

Different oxidizing agents used were Potassium permanganate (PPM), Potassium dichromate (PDC), Titanium dioxide (TDO) and Hydrogen peroxide. It was observed that the PPM gave the highest pH and maximum reduction of COD. The optimum reduction of TOC, MBAS and nitrate was found with the treatment of TDO.

The effect of solar radiation with different oxidants and vessels on the reduction of various heavy metals were studied in the sixth and last part. The oxidants used were Hydrogen peroxide, Titanium chloride, Potassium permangante and Potassium dichromate and the vessels used were glass, Aluminium, steel, Brass and copper. The elements studied were iron, chromium, lead, manganese, copper and magnesium.

During the study, it was observed that the optimum reduction of iron can be achieved by treating the effluent in brass and copper vessels in the presence of TDO and PDC. The brass vessel without any oxidant also gave the optimum reduction of iron.

Copper and Brass vessels in the presence of HPO and TDO and glass vessel without oxidants gave better removal of lead from waste waters of latex concentrating factories. Amoung these the copper vessel in presence of HPO gave the optimum reduction of lead.

Hydrogen peroxide and Titanium dioxide with steel, brass and copper vessels and PDC in steel vessels showed better removal of manganese. However the optimum reduction was with HPO in steel vessel.

The optimum reduction of copper could be achieved when the effluent was treated with TDO oxidant in aluminium vessel.

Chromium and Magnesium could not be reduced effectively by treating with above oxidants and vessels.

Thus from the present study, it can be concluded that the flocculation treatment of natural latex concentrating effluent with Pickle liquor and Ferric alum is capable of reducing the values of parameters like pH, COD, BOD, TDS and sulphide and at pH 10 or above , the phosphate content can be reduced using ferric sulphate, ferric alum, PAC, alumina etc.

Nitrogen can be reduced with NIPE and alumina on treating the effluent at pH 10 and also with 10% GAC.

UV irradiation is capable of reducing the micropollutants from the rubber effluents.

Solar radiation is causing reduction in the metallic content such as iron, lead, copper and manganese on treating the effluent in suitable vessels and oxidants. However, the mechanism of this reduction is not studied.

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USE OF FLOCCULANTS IN NATURAL RUBBER EFFLUENT TREATMENTS

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Abstract:. The effluents from Natural Rubber Processing Industry have complex composition. In order to remove the effluent pollutants in an effective manner, a modification in the effluent composition is usually necessary. Recent developments in the field of the treatment of the effluent water involve the use of flocculants which act as settling agents and coagulants. They aggregate the suspended particles into large flocs which may be easily removed from waste water. This study highlights the use of common chemicals as cheap and efficient flocculants for the treatment of effluents from the rubber industry.

INTRODUCTION

Latex is a weak lyophillic colloidal system of spherical or pear-shaped rubber globules suspended in an aqueous serum. The rubber particle is surrounded by a protective layer of protein and phospolipids which imparts the colloidal nature to the latex. Along with rubber particles the latex contains a variety of non- rubber constituents of inorganic and organic nature. The normal composition of latex is as follows[1]:-

Constituents	Concentration Ranges (% by weight)
Rubber	30.0 to 40.0
Protein	2.0 to 2.5
Ash	0.7 to 0.9
Resin	1.0 to 2.0
Sugar	1.0 to 1.5
Water	55 0 to 60 0

Types of Rubber Factory effluents

Various types of crops harvested are highly susceptible to bacterial action due to contamination on keeping. Hence it is very essential to process them differently for safe storage and marketing. While processing of the crop about 20-30 liters of water is consumed per kg of dry rubber. Common methods of concentrating the latex are centrifugation and creaming. During the process of concentration about 20 litres of water is consumed per kg of natural rubber. Effluents from rubber processing factories are acidic in nature because of the use of acids in processing stage. Another important characteristic of rubber effluent is the high ammoniacal and total nitrogen of latex concentrate due to substantial quantity of ammonia used in the preservation of latex. The main feature of the effluents is the oxygen demand. The latex concentrate and sheet factory effluents have total dissolved solids mainly of organic origin with high Chemical and Biochemical Oxygen Demand for their oxidation. Also the survey[2] on the chemical and physical properties of various types of effluents discharged from the rubber/latex factories showed that the effluents from the latex processing factories are the most polluting[3].

The effluents are highly turbid. For the effectiv treatment of this effluent it is necessary to remove th solid contents present. *The solids of very small size ca* be-removed by settling after flocculation[4,5]. In this study the effluent from latex concentrating factory was treate with different inorganic flocculants which are easil *available and cheap.*

Flocculants and their Functions

Flocculating agents of inorganic origin are hydrolyzabl *salts of aluminium and iron. In general the process o* flocculation is aggregation or binding of small particles o a suspension into a larger mass known as flocs. It is als defined as the process of particle destabilization an *collection into large aggregates*[6,7]. *The main function* is to create rapid separation of liquid phase from suspende phase, minimize the solid concentrate in the liquid phase and maximize the solid content in the solid phase *Flocculants are also helpful in the reduction of* BOD COD, colour, turbidity, inorganic and organi components[5,9].

MATERIALS AND METHODS

Samples were collected from latex centrifuging factor near Kottayam, Kerala. These samples had huge quantit of total solid content and were treated with variou inorganic flocculants viz. alum, lime, ferric chloride an their mixtures. Trials were made on raw effluent by addin various quantities of lime to get a clear solution. It wa found that 0.25% lime gives a visually clear solution o settling the flocculants in minimum period of time. Henc 0.25% of lime was selected as optimum dosag throughout the study. Trials were also made with variou quantities of alum and it was found that with 0.05% o alum along with lime gives a visually clear solution at minimum settling time. Hence this composition of the tw flocculants was used throughout the experiment Following are the compositions of the different flocculant used:-

A : Lime 0.25%
B : Lime 0.25% + Alum 0.05%
C : Lime 0.25% + Ferric chloride 0.05%
D : Lime 0.25% + Pickle liquor * 0.05%
E : Alum 0.05%
F : Ferric chloride 0.05%

(*Pickle liquor is a by-product from electrochemical factories which contains ferric salts.)

After the addition of chemicals, the effluent was mixed well and allowed to settle. It was then filtered and analysed for various parameters according to the standard procedures[10,11,12]

RESULTS AND DISCUSSIONS

Table 1 shows the values of different parameters of the raw effluent from the latex concentrating factory and treated effluents with various flocculating agents. Each reading is the average of five observations. The raw effluent has a pH 4.8. It is due to the addition of acid while coagulating the rubber from the skim. By adding lime (A) the pH has risen to 9.1 which is beyond the limit specified by BIS (Table 2). By the treatment B and C, pH was raised to 8.6 and 8.4 respectively which are also slightly above the limit. But with E and F there is not much rise in pH. With D the pH was raised to 7.7 which is within the limit. The COD of the raw sample was 5250 mg/litre. By the treatment C and D the values were reduced to 240 and 230 mg/l respectively which are well within the permissible limits.

The BOD of the raw effluent (2870 mg/litre) was reduced to 990, 180, 80, 74, 1290 and 1270 mg/litre by treatments. A, B, C, D, E and F respectively. Among these the values for C and D are well within the limit.

The treatment C and D could remove the Total Dissolved Solids (TDS) to the extent of 83.80 % and 84.18%. The values obtained are (2050 and 2000 mg/l) which are within the limit.

The Total Kjeldhal Nitrogen (TKN) of the raw sample was 840 mg/litre. The Maximum reduction of TKN was obtained by treatment C and D, but the values obtained were still much above the limit. Also in the case of Ammoniacal Nitrogen (AN) the maximum reduction of 56.14% was obtained by both the treatments C and D and the values of AN (110 mg/litre) which is very high and above the limit.

The treatments C and D could remove Sulphides (S) completely. The Phosphate (P) content of the raw sample was 60 mg/litre. Although treatments C and D gave a maximum reduction in P, the reduced values of P (28 and 27 mg/litre respectively) are still much above the limit.

CONCLUSIONS

The most important parameters describing the degree of pollution are pH, Oxygen Demands, Total Solids and Nitrogen. All these factors are high in the case of effluents discharged from the latex centrifuging factories. The flocculation treatments C and D are almost successful in bringing all the parameters except nitrogen within permissible limits. Hence these flocculation methods can be used for the treatment of highly polluted effluents from latex centrifuging factories.

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