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A Comparative Study of Aerobic and Anaerobic Wastewater Treatment

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Abstract--As it is widely known and accepted, water is an essential and basic human need for urban, industrial and agricultural use and has to be considered as a limited resource. Only 1% of the total water resources in the world can be considered as fresh water and by 2025 it is estimated that nearly one-third of the population of developing countries, will live in regions of severe water scarcity. As a result, the amount of water used in irrigation has to be reduced, in order for the domestic, industrial and environmental sector to survive. Around 1.2 billion people, or almost one-fifth of the world's population, live in areas of physical scarcity and 500 million people are approaching this situation. Another 1.6 billion people or almost one quarter of the world's population, are facing economic water shortage. Water use is growing at more than twice the rate of population increase in the last century, and, although there is no global water scarcity as such, an increasing number of regions are chronically short of water. In this aspect to avoid the water demand at the global level water conservation strategies should be developed. Among the water conservation strategy, wastewater treatment is one of the major pathway about the decreasing the water demand in the agricultural sector and for domestic uses except drinking. In all the major cities, wastewater treatment plants have been constructed to treat the urban wastewater in view of decreasing the water scarcity. The presence of nutrients in the wastewater is considered as beneficial to agricultural practices. The contaminants present in the wastewater pose health risks directly to agricultural workers and indirectly to the consumers as the long term application of the wastewater may result in the accumulation of toxic elements in soil and in plants. In the present study an attempt has been made to study the comparison between aerobic and anaerobic (UASB reactor) treatment of wastewater and also heavymetal concentration was studied with the analysis of wastewater/sullage water. The presence of Nitrate, Phosphate and Potassium (NPK) indicates the nutrient level in the wastewater and these nutrients will be beneficial for the use of agricultural field and it can minimize the water scarcity for agriculture purposes. The analyzed parameters showed higher amount of COD and BOD in untreated wastewater, which exceed the CPCB permissible limit for disposing the sullage water on land for irrigation.
Key words: UASB, NPK, COD, BOD, VFA, Sullage water, Heavymetals

I. INTRODUCTION

As it is widely known and accepted, water is an essential and basic human need for urban, industrial and agricultural use and has to be considered as a limited resource. Only 1% of the total water resources in the world can be considered as fresh water and by 2025 it is estimated that nearly one-third of the population of developing countries (approximately 2.7 billion people), will live in regions of severe water scarcity. As a result, the amount of water used in irrigation has to be reduced, in order for the domestic, industrial and environmental sector to survive. Additionally, human interference causes water pollution, e.g. by industrial effluents, agricultural pollution or domestic sewage, which will increase. Water reuse and recycling are the only solutions to close the loop between water supply and wastewater disposal. Within the past years, the cost of treating wastewater to a high quality has reduced to feasible. Consequently, in many parts of the world reclaimed water is used as a water resource. Hence, wastewater could be regarded as a resource that could be put to beneficial use rather than wasted. Water reuse accomplishes usually two fundamental functions: the treated effluent is used as a water resource for beneficial purpose and the effluent is kept out of streams, lakes, and beaches: thus reducing pollution of surface water and groundwater. Additionally, valuable substances and heat recovery can be achieved by water recycling obtaining a zero emission process.

II. ORIGIN AND COMPOSITION

The main constituents of wastewater are solids, soluble organics and waterborne pathogens (Figure 1), originating from domestic and industrial water uses. The composition/ratios that exist between components vary considerably, depending on local practices percentage and type of industrial waste, and amount of dilution caused by inflow/infiltration.

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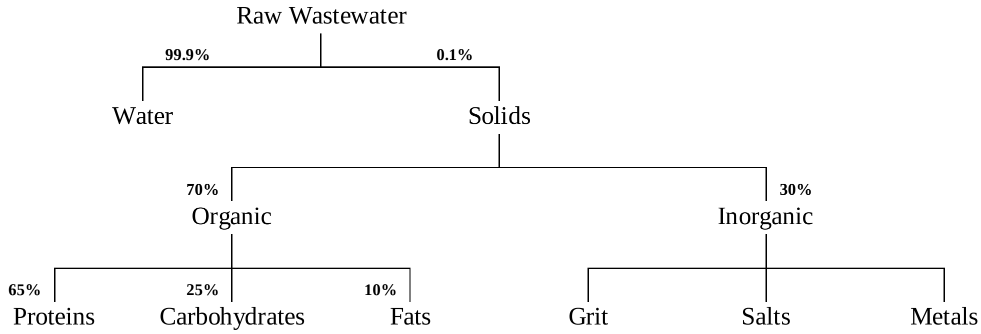

Figure 1: Typical Composition of Wastewater

Source: Butler D. and Smith S., 2003

Solids: **consist of 70:30 ratio of organic to inorganic. The organic fraction composes of body wastes, food waste, paper, rags and biological cells, whereas the inorganic, consists of surface sediments and soil. Solids have to be removed prior discharge, otherwise, they shall settle in the receiving watercourse.**

Soluble Organics**: Composed mainly of proteins (amino acids), carbohydrates (sugar, starch, cellulose) and lipids (fats, oils, grease). All these substances contain carbon that can be converted to carbon dioxide biologically. Consequently, the oxygen demand exerted on receiving water is due to soluble organics.**

Waterborne pathogens: **originate from infected people, and are primarily bacteria, viruses and protozoa. These organisms can pose a direct hazard to public health. Coliform bacteria are used as indicator of disease-causing organisms in wastewater.**

Other components of wastewater are minerals and metals. Some nitrogen is also present due to the presence of proteins, and other nutrients such as phosphorus (6-20 mg/l). The concentration of ammonia (NH_3) can range from 12-50 mg/l. The parameters that are of greater importance for wastewater treatment are Biochemical Oxygen Demand (BOD) and Suspended Solids (SS). BOD is a measure of the amount of biodegradable organic substances in the water. As naturally occurring bacteria consume these organic substances they take up oxygen from the water for respiration, while converting the substances into energy and materials for growth. In other words, BOD, the biochemical oxygen demand, measures the amount of oxygen microorganisms require to break down wastewater. On average each person produces about 60 g of BOD in faecal and other materials. The concentration of BOD in wastewater varies depending on the volume of water used to convey the faecal materials. For example if the total water usage per person is 200 L per day, then the resulting wastewater will have a BOD concentration of 300 mg/L. Untreated wastewater has a typical BOD value ranging from 100 mg/l to 300 mg/l.

A typical composition analysis is shown in the Table that follows (Table 1), for crude wastewater, settled and effluent from a wastewater treatment plant.

Table 1: Typical Wastewater Analysis at Various Points in Its Course

Characteristic (mg/l)	**Source**		
	Crude	***Settled***	***Final Effluent***
BOD	300	175	20
COD	700	400	90
TOC	200	90	30
SS	400	200	30
NH_4 - N	40	40	5
NO_3 - N	<1	<1	20

Domestic Wastewater/ Sullage water

Household (domestic) wastewater derives from a number of sources. Wastewater from the toilet is termed 'blackwater'. It has a high content of solids and contributes a significant amount of nutrients. Blackwater can be further separated into faecal materials and urine. Each person on average excretes about 4 kg N and 0.4 kg P in urine, and 0.55 kg N and 0.18 kg P in faeces per year. In Sweden it has been estimated that the nutrient value of urine from the total population is equivalent to 15 - 20 % of chemical fertiliser use in 1993. Greywater consists of water from washing of clothes, from bathing/showering and from the kitchen. The latter may have a high content of solids and grease, and depending on its intended reuse/treatment or disposal can be combined with toilet wastes and form the blackwater. Both greywater and blackwater may contain human pathogens, though concentrations are generally higher in blackwater. The volume of wastewater and concentration of pollutants produced depend on the method of volume of water used and water conservation measures. The use of flushing toilets results in higher wastewater volumes and lower concentrations. The characteristics of wastewater differ regionally, according to factors such as lifestyle, water availability etc.

Impact of Wastewater (Untreated)

Several heavymetals are known to accumulate in water, soil, sediments and tissues of organisms (Chaphekar, 1991; Lambou & Williams, 1980; Ramadan, 2003). The most important wastewater contaminants are suspended solids, biodegradable organics, pathogens, nutrients, refractory organics, heavymetals and dissolved inorganic solids (Table 2).

Table 2: Important wastewater contaminants

Contaminant	Source	Environmental Significance
Suspended Solids (SS)	Domestic use, industrial wastes, erosion by infiltration/ inflow	Cause sludge deposits and anaerobic conditions in aquatic environment.
Biodegradable Organics	Domestic and industrial waste	Cause biological degradation, which may use up oxygen in receiving water and result in undesirable conditions
Pathogens	Domestic waste	Transmit communicable diseases
Nutrients	Domestic and industrial waste	May cause eutrophication
Refractory Organics	Industrial waste	May cause taste and odour problems, may be toxic or carcinogen
Heavymetals	Industrial waste, mining etc.	Are toxic
Dissolved Inorganic Solids	Increases above level in water supply by domestic and/or industrial use	May interfere with effluent reuse

Solids in urban wastewater form sediments and can eventually clog drains, streams and rivers. Grease particles form scum and are aesthetically undesirable. The nutrients N and P cause eutrophication of water bodies. Lakes and slow moving waters are affected more than faster flowing waters. In the former, the algae are fertilised by the nutrients and settle as sediment when they decay. The nutrients are released regularly to the water column by the sediment which acts as a store of nutrients. As a result the cycle of bloom and decay of the algae is intensified. In the early stages of eutrophication aquatic life is made more abundant, because fish, for example, graze on the algae. As the concentration of algae increases, the decaying algae contribute to BOD and the water is deoxygenated. Thus wastewater treated for BOD reduction but still high in nutrients, can still have a significant impact on the receiving water. Additionally, some algae produce toxins which can be harmful to bird life and irritate skins coming into contact with the water. Eutrophic water adds to the cost of water treatment, when the water is used for drinking purposes. Heavymetals and possible toxic and household hazardous substances are other sources of pollution. Heavymetals include copper, zinc, cadmium, nickel, chromium and lead, originating from materials used in the making of pipes for the supply of drinking water, household cleaning agents used, and for storm water the type of materials used for roofing and guttering. In high enough concentrations these heavymetals are toxic to bacteria, plants and animals, and to people. Other sources of toxic materials are substances disposed with household wastewater, such as medicines, pesticides and herbicides which are no longer used, excess solvents, paints and other household chemicals. These substances can corrode sewer pipes and seriously affect operation of treatment plants. They will also limit the potential of water reuse, and therefore should not be disposed with household wastewater. To prevent degradation of the receiving environment wastewater needs to be treated. Treatment basically consists of removing solids from the wastewater and reducing its BOD. From there on, the degree of treatment that is required dependents on the final use of the effluent: in cases where is to be disposed in water bodies, the treatment depends on the capacity of the receiving environment to assimilate the remaining organic wastes. The Table 3 describes briefly the treatment levels used in wastewater treatment. The objective of preliminary treatment is to prevent damage from occurring at later treatment steps. In primary treatment, by the use of physical operations (primarily sedimentation) floating and settleable materials are removed from wastewater, and could be enhanced by the addition of chemicals. The majority of organic matter is removed in secondary treatment, by the use of biological and chemical processes. In advanced treatment, residual suspended solids and other constituents of wastewater that cannot be reduced by previous treatment are removed by the application of combinations of unit operation and processes.

Table 3: Levels of Wastewater Treatment

Treatment Level	Description
Preliminary	Removal of wastewater constituents such as rags, sticks, floaTables, grit, and grease that may cause maintenance or operational problems with the treatment operations, processes, and ancillary systems
Primary	Removal or portion of the suspended solids and organic matter from wastewater
Secondary	Removal of biodegradable organic matter (in solution or suspension) and suspended solids. Disinfection is also typically included in the definition of conventional secondary treatment
Tertiary	Removal or residual suspended solids (after secondary treatment), usually by granular medium filtration or microscreens. Disinfection is also typically a part of tertiary treatment. Nutrient removal is often included in this definition

Adapted In Part from Tchobanoglous G. & Crites R., 1998

Table 4, classifies the most common wastewater treatment processes as proposed by WHO and UNEP in the publication of 1997, "*Water Pollution Control – A Guide to the Use of Water Quality Management Principles*".

Table 4: Classification of Common Wastewater Treatment Processes According To Level of Advancement

Primary	Secondary	Tertiary	Advanced
Bar or bow screen	Activated sludge	Nitrification	Chemical treatment
Grit removal	Extended aeration	De-nitrification	Reverse osmosis
Primary sedimentation	Aerated lagoon	Chemical precipitation	Electrodialysis
Comminution	Trickling filter	Disinfection	Carbon adsorption
Oil/fat removal	Rotating bio-discs	(Direct) filtration	Selective ion exchange
Flow equalisation	Anaerobic treatment/UASB	Chemical oxidation	Hyperfiltration
pH neutralisation	Anaerobic filter	Biological P removal	Oxidation
Imhoff tank	Stabilisation ponds	Constructed wetlands	Detoxification
	Constructed wetlands	Aquaculture	
	Aquaculture		

Source: WHO/ UNEP, 1997

Anaerobic Process

Anaerobic process refers to a diverse array of biological wastewater treatment systems from which dissolved oxygen and nitrate-N are excluded. They are most commonly applied for the conversion of biodegradable organic matter (soluble and particulate) to methane and carbon dioxide. Through the process the methane can be recovered and inactivation of pathogens can be achieved. In some cases, anaerobic processes are used for the conversion of biodegradable particulate organic matter to volatile fatty acid; separated and fed to systems of biological nutrient removal, they enhance their performance. A wide range of configurations for anaerobic processes are available, depending on the objective of the treatment. Anaerobic digesters, low-rate anaerobic processes and high-rate anaerobic processes, are used for the stabilisation of organic matter by conversion to methane and carbon dioxide. Solids fermentation processes are used for the production of volatile fatty acids.

Anaerobic Biological Treatment: when anaerobic microorganisms come in contact with wastewater, dissolved and suspended organic matter is converted to biomass and methane. Similarly to the aerobic treatment, in some processes the microorganisms are supported on solid support media, whereas in others are kept in suspension. Often, anaerobic digesters are used after aerobic treatment and primary clarifiers for the treatment of the solids produced, since the volume of the solids is reduced considerably.

Anaerobic Digestion: The aim of the process is stabilisation of particulate organic matter. Well mixed, with no liquid solids separation, the reactor can be treated as continues stirred tank reactor. HRT and SRT are identical, with typical SRTs being 15-20 days. Lower SRTs of up to 10 days have been used successfully, and longer SRTs are used where greater waste stabilisation is necessary.

The shape of the reactor is typically cylindrical of diameter 10 – 40 m, with cone shaped bottom, made up of concrete, and steel or concrete covers. The typical depth of sidewall is 5 – 10 m. The required mixing is achieved with internal mechanical mixers, external mechanical mixers re-circulating the contents and various types of gas or pump recirculation systems. As previously being mentioned, methane is generated by an anaerobic process; combusted, it can be used to heat the contents of the feed system and the digester. Typically, bioreactor temperatures are typically maintained mesophilic (~35°C). Gas production variations are compensated with gas storage, also allowing the operation of boilers and other equipment that can use the gas as fuel. Gas is most commonly stored in the digester under a cover floating on the contents. The configuration of anaerobic bioreactors has developed for improved mixing characteristics and reduced accumulation of grit on the bottom and floating scum on the surface. A new development is an egg shaped digester developed in Germany. A large height-to-diameter ration, steep sloped lower and upper sections of the vessel, allow better mixing, reduction in grit and scum accumulation and easier removal in cases of accumulation. Another digester allowing grit and heavy solids removal is the baffled bottom digester. The performance of a digester is assessed by the percent VS destruction, since its aim is the stabilisation of biodegradable matter. 80 – 90% of influent biodegradable particulate organic matter is converted to methane at SRT of 15- 20 days; corresponding to ~60% destruction of VS in primary solids, and 30 – 50% in waste activated sludges. There are cases where two digesters are operated in series, known as two-stage anaerobic digestion. In the first stage heating and mixing is provided, promoting active digestion, and the second, quiescent conditions promote the solid-liquid separation. Settled solids having been thickened from the second stage are directed for further processing or disposal, whereas supernatant is recycled to the liquid process train. The use though of the two-stage anaerobic digestion has declined due to various reasons concerning the efficiency of the process and technology progress. Subsequently, the most commonly used practice, is the thickening of feed solids prior to single-stage, high-rate anaerobic digestion.

Hybrid Upflow Anaerobic Sludge Blanket (UASB) and Anaerobic Filters

High rate anaerobic digestion in recent years has been developed with a sound scientific and engineering foundation and is regarded as a mature technology (Iza *et al.*, 1991). Combining characteristics of both systems (Upflow Anaerobic Sludge Blanket And Anaerobic Filters), this system uses suspended biomass, with process loadings similar to upflow anaerobic sludge blanket, and so is the solids removal system. Influent wastewater and re-circulated effluent flow upward through the sludge blankets (flocculent and granular) after being uniformly distributed across the cross section of the bioreactor (Figure 2). Then it passes through a media bed as anaerobic filter. Gas is collected under the cover of the bioreactor.

Among the various high rate anaerobic reactor design, UASB (Lettinga *et al*., 1980; Fang *et al*., 1990) and AF (Suidan *et al*., 1983; Young and Young, 1991) have been successfully commercialized and hundreds of full scale systems have been installed worldwide.

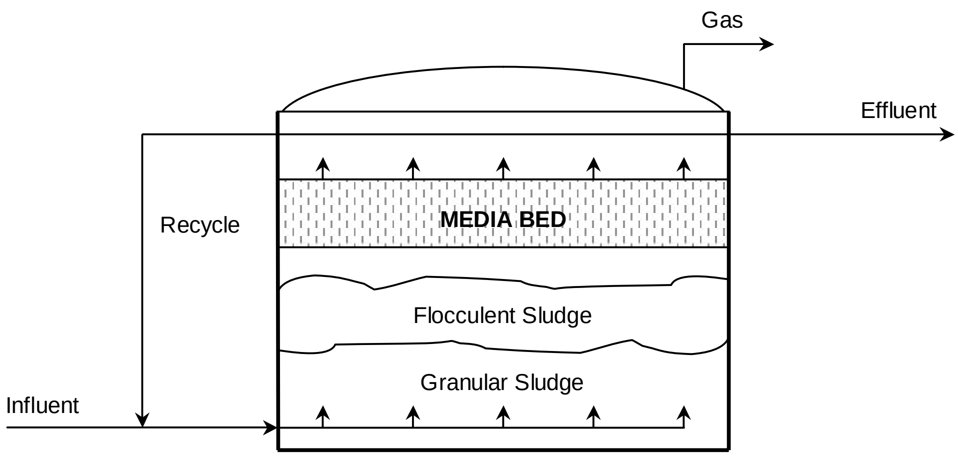

Figure 2: Hybrid Upflow Anaerobic Sludge Blanket and Anaerobic Filters Process

Source: Grandy et al., 1999

Comparison of Anaerobic Processes

The main advantages and disadvantages of the anaerobic treatment systems used for the stabilisation of organic matter are summarised in Table 5.

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Table 5: Anaerobic Treatment Process Comparison for Organic Stabilisation

Process	Advantages	Disadvantages
Anaerobic digestion	▪ suitable for a wide range of wastewaters ▪ efficiently handles high concentrations of SS ▪ easy to mix, thereby creating uniform reaction environment ▪ large bioreactor volume to dilute inhibitors ▪ performance not dependent on sludge settleability ▪ capable of accepting waste aerobic biomass	▪ large bioreactor volumes required ▪ effluent quality can be poor if non-degradable matter is present or if a large concentration of anaerobic organisms are generated ▪ process stability and performance poor at short SRTs ▪ required separate mechanical mixing
Low-rate anaerobic processes	▪ simple and relatively economical construction ▪ suitable for a wide range of wastewater ▪ efficiently handles high concentrations of SS ▪ large bioreactor volume to dilute inhibitors ▪ performance not dependent on sludge settleability ▪ capable of accepting waste aerobic biomass ▪ good performance possible	▪ relatively large bioreactor volumes required ▪ large land area required ▪ poorly controlled conditions within bioreactor reduce efficiency ▪ limited process control capability
Anaerobic contact	▪ suitable for concentrated wastewater ▪ easy to mix, thereby creating uniform reaction environment ▪ relatively high quality effluent achievable ▪ reduced bioreactor volume compared to aerobic digestion ▪ capable of accepting waste aerobic biomass	▪ biomass settleability critical to successful performance ▪ most suitable for wastes with low to moderate levels of suspended solids ▪ system is relatively complex mechanically ▪ shorter bioreactor HRTs mean less equalisation and dilution of inhibitors
Upflow anaerobic sludge blanket	▪ high biomass concentrations and long SRTs achievable ▪ small bioreactor volumes due to high volumetric organic loading rates ▪ high quality effluent achievable ▪ mechanically simple ▪ compact system, relatively small area ▪ well mixed conditions produced	▪ performance dependent on development of dense, settleable solids ▪ much lower process loading required if wastewater contains suspended solids ▪ special bioreactor configuration required which is based on experience ▪ little process control possible ▪ shorter bioreactor HRTs mean less equalisation and dilution inhibitors

Anaerobic filter	▪ high biomass concentrations and long SRTs achievable ▪ small bioreactor volumes due to high volumetric organic loading rates ▪ high quality effluent achievable ▪ mechanically simple ▪ compact system, relatively small land area ▪ performance not dependent on development of dense settleable solids ▪ well mixed conditions produced in bioreactor	▪ suspended solids accumulation may negatively affect performance ▪ not suitable for high SS wastewater ▪ little process control possible ▪ high cost for media and support ▪ shorter bioreactor HRTs mean less equalisation and dilution inhibitors
Hybrid Upflow anaerobic sludge blanket / Anaerobic filter	▪ high biomass concentrations and long SRTs achievable ▪ small bioreactor volumes due to high volumetric organic loading rates ▪ high quality effluent achievable ▪ mechanically simple ▪ compact system, relatively small land area ▪ performance partially dependent on development of dense settleable solids ▪ well mixed conditions produced in bioreactor ▪ reduced media cost	▪ lower process loadings required if wastewater contains SS ▪ little process control possible ▪ shorter bioreactor HRTs means less equalisation and dilution inhibitors
Downflow stationary fixed film	▪ high biomass concentrations and long SRTs achievable ▪ small bioreactor volumes due to high volumetric organic loading rates ▪ high quality effluent achievable ▪ mechanically simple ▪ compact system, relatively small land area ▪ performance not significantly affected by high suspended solids wastewater ▪ performance not dependent on development of dense settleable solids ▪ well mixed conditions produced in bioreactor	▪ biodegradable SS not generally degraded ▪ high cost of media and support ▪ organic removal rate generally lower than other high-rate processes ▪ little process control possible ▪ shorter bioreactor HRTs means less equalisation and dilution inhibitors

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Fluidised bed/ expanded bed	▪ high biomass concentrations and long SRTs achievable ▪ small bioreactor volumes due to high volumetric organic loading rates ▪ excellent mass transfer characteristics ▪ high quality effluent achievable, often better than other high rate processes ▪ performance not dependent on development of settleable solids ▪ very well mixed conditions generally produced in bioreactor ▪ increased process control capability relative to other high-rate processes	▪ lengthy start-up period required ▪ high power requirements for bed fluidisation and expansion ▪ not suitable for high SS wastewater ▪ mechanically more complex than other high-rate processes ▪ cost of carrier media is high ▪ shorter bioreactor HRTs mean less equalisation and dilution of inhibitors

Source: Grandy et al., 1999

Wastes with pH Neutralisation

Several unit operations or processes, especially biological, are sensitive to pH. Consequently, influent wastewater (especially wastewater originating from industry) has to be pH adjusted for the processes or operations to perform efficiently. Treated wastewater also needs to have its pH adjusted, before it can be discharged in to the environment, or being reused. Neutralisation of pH is typically performed by the addition of chemicals.

Table 6: Chemicals typically used for pH Control/ Neutralisation

Chemicals		Availability	
		Form	Percent
CHEMICALS USED TO RAISE pH			
Calcium Carbonate Calcium Hydroxide (Lime) Calcium Oxide	$CaCO_3$ $Ca(OH)_2$ CaO	Powder granules Powder granules Lump, pebble, ground	96 – 99 82 – 95 90 – 98
Dolomitic Hydrated Lime Dolomitic Quicklime	$[Ca(OH)_2]_{0.6}$ $[Mg(OH)_2]_{0.4}$ $(CaO)_{0.6}(MgO)_{0.4}$	Powder Lump, pebble, ground	58 – 65 55 – 58 CaO
Magnesium Hydroxide Magnesium Oxide	$Mg(OH)_2$ MgO	Powder Powder granules	 99
Sodium Bicarbonate Sodium Carbonate (Soda Ash) Sodium Hydroxide (Caustic Soda)	$NaHCO_3$ Na_2CO_3 NaOH	Powder granules Powder Solid flake, ground flake, liquid	99 99.2 98
CHEMICALS USED TO LOWER pH			
Carbonic Acid	H_2CO_3	Gas (CO_2)	
Hydrochloric Acid	HCl	Liquid	27.9, 31.45, 35.2
Sulphuric Acid	H_2SO_4	Liquid	77.7 (60˚Be) 93.2 (60˚Be)

Adapted in part from Eckenfelder W.W., 2000

high lipids concentration: longer SRT for acidogenesis increasing required SRT for an anaerobic process

anaerobic digestion typically used for treatment of high strength wastewaters; in particular high suspended solids concentration:

high-rate anaerobic treatment: <20,000 mg/l COD

low-rate anaerobic treatment: 20,000-30,000 mg/l COD

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factors affecting performance: (i) solids retention time; (ii) volumetric organic loading rate; (iii) total hydraulic loading; (iv) temperature; (v) pH; (vi) inhibitory and toxic materials; (vii) nutrients; (viii) mixing; (ix) waste type

Materials and Methods

Study area

Mysuru has adequate water supply resources due to the proximity of Rivers Cauvery and Kapila. The topography of the city is such that the entire UWW drains into three valleys viz., northern out-fall into Kesare Valley, and other outfalls to the south one into Dalvai tank feeder valley and another to Malalavadi tank valley. Based on the topography of the city, Mysuru city comprises of five drainage districts, namely, A, B, C, D and E districts respectively, covering different areas. The city has been provided with three wastewater treatment plants. Drainage districts of A & D have the wastewater treatment plant of capacity 60.0MLD, which is located at Rayankere, H.D.Kote Road, Mysuru. The treatment plant for drainage district B is of capacity 67.65MLD, which is located at sewage Farm, Vidyaranyapuram, Mysuru. The treatment plant for drainage district C is of capacity 30.0MLD, which is located at Kesare Village, Mysuru.

Sample Collection

The anaerobic treated wastewater in the laboratory condition and Sullage water from the treatment plant were collected in two litres capacity polyethylene cans. The samples were brought to laboratory and stored at 4°C. The separate samples of untreated and treated Sullage water samples of one litre capacity in polyethylene cans were collected for heavymetal analysis and preserved by adding 2 ml of concentrated nitric acid to prevent precipitation of metals and growth of algae.

Experimental setup

A laboratory scale UASB reactor was fabricated from acrylic pipe of 90 mm internal diameter. The overall height of the reactor was 1300 mm, one inlet at 50 mm from the bottom of the reactor was provided for the influent. The effluent outlet was provided at 50 mm below the top level of the reactor. One opening at the top of the reactor was provided for collection of gas. The three phase separator was designed to meet these requirements, as per the guidelines given by Lettinga and Hulshoff Pol (1991). The three phase separator was provided at a distance of 865 mm from the bottom. Baffles are provided to guide gas bubbles into the separator to collect the gas generated and to allow the settling of suspended solids. Five sampling ports are provided at a height of 145 mm from the bottom of the reactor at 180 mm c/c. the effective volume of the reactor was 7.95 litres. The effluent tube was connected to the water seal to avoid the escape of gas through the effluent. The gas out let was connected to a wet gas meter through rubber tubing. The lid of the reactor and other fittings were sealed to maintain anaerobic conditions inside the reactor. The reactor was supported by mild steel framed structure; the schematic representation of this experimental setup is shown in Figure 3.

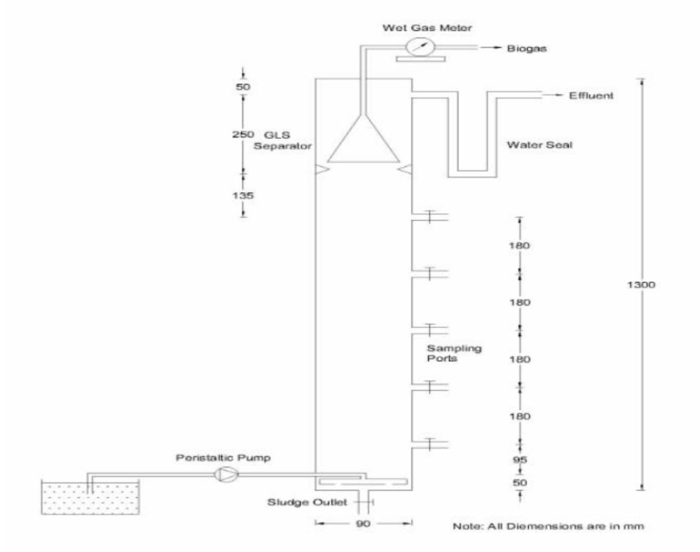

Figure 3: Experimental setup

III. RESULT AND DISCUSSION

The pH of natural water can provide important information about chemical and biological processes and provides correlations to a number of different impairments. In unpolluted or pure waters, the pH is governed by the exchange of carbon dioxide with the atmosphere. A high organic content will tend to decrease the pH because of the carbonate chemistry. The pH was varied between 6.8 to 7.4 in UASB reactor and 7.0 to 7.4 in aerobic process. EC is also the measure of the water quality parameter. EC is also correlation with the Total Dissolved Solids (TDS) or salinity. At about 0.3 S/m is the point as which the health of some crops and fresh water aquatic organisms will to be affected by the salinity. Many aquatic organisms are sensitive to changes in water temperature. Temperature is an important water quality parameter and is relatively easy to measure. Some of the micro organisms can't tolerate the higher temperature during the wastewater treatment process in anaerobic technology. In the UASB reactor the temperature was little higher than the aerobic process since the discharge of the CO_2 release by the microorganism's respiration. Nitrogen (N_2) is essential to life on Earth and is the most abundant element in Earth's atmosphere. Biological compounds such as proteins, amino acids, and nucleic acids contain nitrogen. In the environment, plants and micro organisms convert N_2 into a different oxidation states where it becomes part of the nitrogen cycle. The major inorganic oxidation states include nitrate ion (NO^{3-}), nitrite ion (NO^{2-}), ammonia (NH3), and ammonium ion (NH^{4-}). Nitrate ion (NO^{3-}) is the common form of nitrogen in natural waters. Nitrite (NO^{2-}) will oxidize into nitrate after entering an aerobic regime. Phosphorous is an essential nutrient to living organisms. In pure water, phosphorous can enter a water system from the weathering of phosphorous baring rocks and minerals. These mineral is also one of the important material for the growth of plants. In the experimental results the concentration of phosphorus varied from 2.53mg/lt to 1.574 mg/lt in reactor and 2.8mg/lt to 1.86 mg/lt in aerobic process. The volume of MLSS is also counts for the proper treatment of the wastewater during aerobic and anaerobic process. MLSS refers to the total volume of liquor suspended solods which is present in the 1000ml, whenever the MLSS is more than enough; the purification rate of the wastewater becomes very effective. During the treatment process the recycling of sludge will be made called Activated Sludge Process (ASP). In the anaerobic process the ASP will be continue in the reactor itself. Most of the metals will soluble in water as the pH decreases. The acid rain will dissolve metals such as Copper, Lead, Zinc and Cadmium as the rain runs off of man made structures and into bodies of water. The excesses of dissolved metals in solution will negatively affect the health of the aquatic organisms. Lead concentration showed as below detection limit (BDL), whereas remaining analyzed metals were tabulated in the Table 8.

IV. CONCLUSION

The present research was aimed to examine the treatment efficiency between aerobic and anaerobic treatment methods. The anaerobic method of treatment of wastewater was carried out in a laboratory condition with the help of UASB reactor. In the meanwhile the impacts over disposal of the wastewater to the onland were exceeding the CPCB's guidelines. From the results of present investigation it is concluded that, the treatment of wastewater in the laboratory condition by adopting UASB reactor showed a significant effect than the aerobic condition. The release of the gas by the anaerobic condition would be collected by trapping in a collector. The treatment efficiency in the laboratory condition made a significant removal of the pollutant. The concentrations of the organic pollutants those can undergo for degradation also were removed. But the anaerobic technology was failed to execute in larger volume in the urban/rural areas. The characters of the treated wastewater for the onland disposal from the UASB reactor were well within the prescribed CPCB limit. But the temperature of the UASB reactor was comparatively higher than the aerobic process due to the respiration of the microorganisms, where the released CO_2 and Methane will be present in the same reactor till the treated wastewater comes out. Other than the temperature, all the analyzed parameters are well within the limit. The COD and BOD were removed very well in UASB reactor. Heavymetals also significantly removed during the anaerobic treatment process than the aerobic treatment technology due to the adoptation of ASP.

REFERENCES

[1] Arun Kansal, K V Rajeshwari, Malini Balakrishnan, Kusum Lata, V V N Kishore, (1998). Anaerobic Digestion technologies for energy recovery from industrial wastewater- a study in Indian context. TERI information Monitor on Environmental Science3(2): 67-75

[2] Borja, R., C.J. Banks and Z. Wang (1995) Performance of Hybrid anaerobic reactor, combining a sludge blanket and a filter, treating slaughter house waste water, Applied micro biology and biotechnology, No.43,

[3] Campos, C.M.M. and Anderson, S.A (1992)Effect of liquid upflow velocity and substrate concentration on the start-up of UASB reactor . Water Science and technology , vol-25(7), pg-41-50.

[4] Chaphekar, S. B. (1991). An overview on bioindicators. Journal of Environmental Biology, Vol.12, pp. 163-168.

[5] Chaudhry, S., Manthan.M., Saroo N., Rohella R.S (1999)Anaerobic Treatment of Pulp and Paper mill effluent -a case study. Indian journal of Environmental health 41(1): 74-5.

[6] Chawla, O.P (1989)Advances in Biogas technology‖, Indian Council of Agricultural Research, New Delhi, page-144.

[7] Fang, H.H.P. and Chui, H.K. (1995) Performance and sludge characteristics of UASB process treating propionate –rich waste water– wat. Res. 29 (3) : 895- 898.

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
[8] Guiot, S.R. and L. Van den Berg (1984)Performance of an Upflow Anerobic Reactor Combining a Sludge Blanket and a Filter Treating Sugar Waste, Biotechnology and Bioengineering, No-27, pg: 800-806.

[9] Hall ER, Cornacchio L-A (1988) Anaerobic Treatability of Canadian pulp and paper mill waste water‖. Pulp pap can; 89(6): 100-4. International Journal of Modern Engineering Research ,Vol.2, Issue.3, May-June 2012 pp-602-606 ISSN: 2249-6645

[10] J.R. Banu, S. Kalliappan; I.T.Yeom (2007) Treatment of domestic wastewater using upflow anaerobic sludge blanket reactor —- centre for environmental studies(CES) Anna university, Chennai. Institute of journal Environmental Science & Technology, 4(3): 363-370.

[11] K. Kavitha and A.G. Murugesan (2007) Efficiency of Upflow Anaerobic Granulated sludge blanket reactor in treating fish processing effluent. Journal of Industrial Pollution Control 23(1), pg 77-92.

[12] K.R. Chakravarthi, M.Singanan and K.Somasekhara Rao (1995) A correlation study on physico-chemical characteristics of paper mill effluent, Nuzvid. Indian journal of Environmental protection vol: 16 (1), pg: 46-49.

[13] Kavitha, K. and A.G. Murugesan, (2004)Performance evaluation of paper mill effluent in a granular bed UASBR. Jr. of Indian. Environ & Ecoplanning. 8(3) :551-556.

[14] Lambou, V. W., & Williams, L. R. (1980). Biological monitoring of hazardous wastes in aquatic systems. Second Interagency Workshop on in-situ Water Sensing: Biological Sensors, Pensacola Beach, Florida, pp. 11-18.

[15] Lettinga, G. and Hulshoff Pol, L.W. (1986) Advanced reactor design, operation and economy. Wat.Sci. Technology. 18(12): 99-108.

[16] Lettinga, G., A.F.M. Van Velsen, S.W. Homb, and A.Klapwisk, (1980) Use of Upflow Sludge Blanket Reactor Concept for Biological Waste water Treatment, Biotechnology and Bioengineering, No. 22, pg. 699-734.

[17] M.M. Ghangrekar, U.J. Kahalekar, S.V.Takalkar (2003) Design of Upflow Anaerobic Sludge Blanket Reactor for treatment of organic waste waters. Indian journal of environmental health Vol-45, No:2, Pg no:121-132.

[18] Metcalf and Eddy (2003) .Waste water Engineering treatment and Reuse. Tata McGraw - Hill Edition.

[19] Ozturk, L, V. Eroglue, G. Ubay and I. Permir, (1993)Hybrid upflow Anerobic Sludge Blanket Reactor (HUASBR) – Treatment of Dairy Effluents - water science and Technology, No. 23, pg.77-85.

[20] R.F. Hickey, W.M. Wu, M.C. Veiga and R. Jones (1991). Start-up, operation, Monitoring and control of high rate anaerobic treatment systems‖ – Michigan Biotechnology Institute, Lansing, USA, & Environment Canada, Waste water technology center, Canada.Wat. Sci. Technology, Vol. 24, No. 08, pg. 207-255.

[21] Raghu Rama Sharma, S. and Bandyopandhy Y.M. (1991) Treatment of pulp and paper mill effluent by upflow anaerobic filter. Indian J. Environ. Hlth. Vol. 33, No.4, pg. 456-463.

[22] Ramadan, A. A. (2003). Heavy metal pollution and biomonitoring plants in lake Manzala, Egypt. Pakistan Journal of Biological Sciences, Vol. 6, pp. 1108-1117.

[23] Trlche, A. and Vieira, S M.M., (1991) Discussion reports on reactor design of anaerobic filters and sludge bed reactors. Wat Sci Technol., 24, 193-206.

Table 8: Characteristics of Aerobic and Anaerobic Wastewater

	Anaerobic condition		Aerobic condition	
	Inlet	Outlet	Inlet	Outlet
pH	6.8	7.4	7.0	7.4
EC(ds/m)	1.317	1.012	1.41	1.12
Temperature (^oC)	28	36	28	29
MLSS (ml/ltr)	200	270	245	260
TDS (mg/ltr)	780	600	860	720
TSS (mg/ltr)	100	42	125	50
COD (mg/ltr)	204.8	57.6	348	192
BOD(mg/ltr)	125	28	176	48
Nitrate (mg/ltr)	3.046	1.976	3.146	2.08
Phosphate(mg/ltr)	2.533	1.574	2.876	1.860
Potassium (mg/ltr)	46	28	53	36
VFA (mg/ltr)	0.46	0.28	0.46	0.18
Fe (ppm)	1.21	0.46	1.6	0.92
Cr(ppm)	0.42	0.22	0.50	0.39
Zn(ppm)	0.39	0.2	0.43	0.31
Pb(ppm)	BDL	BDL	BDL	BDL
Cu(ppm)	0.18	0.08	0.22	0.16
Ni(ppm)	0.56	0.23	0.50	0.39
Cd(ppm)	0.16	0.12	0.18	0.15

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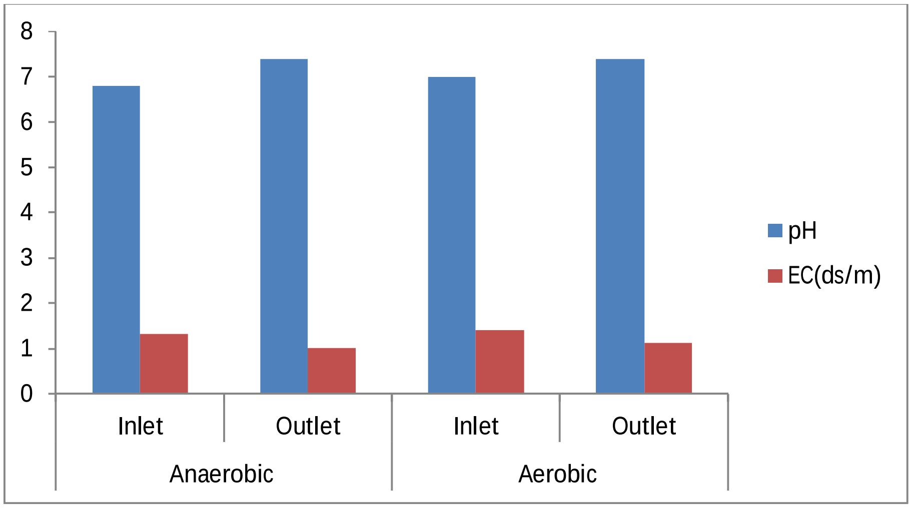
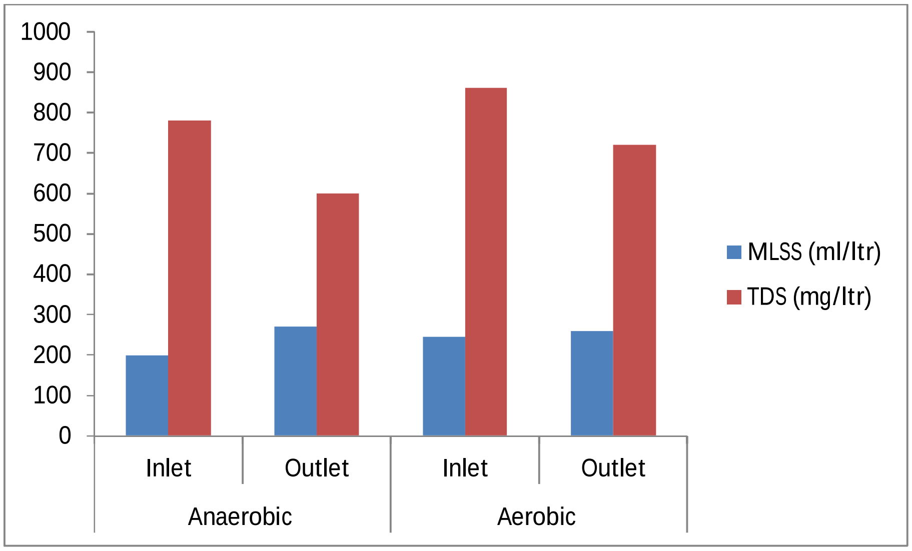
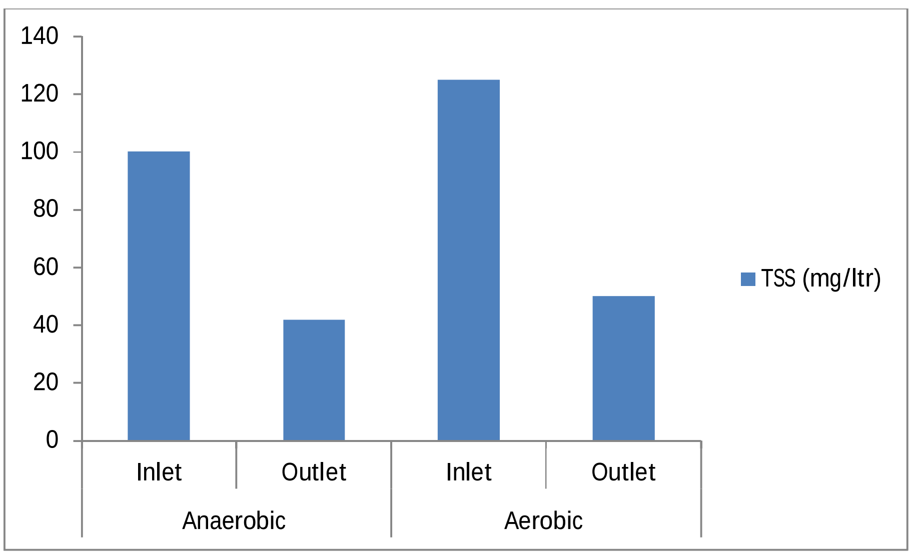
Graphical presentation of analyzed parameters







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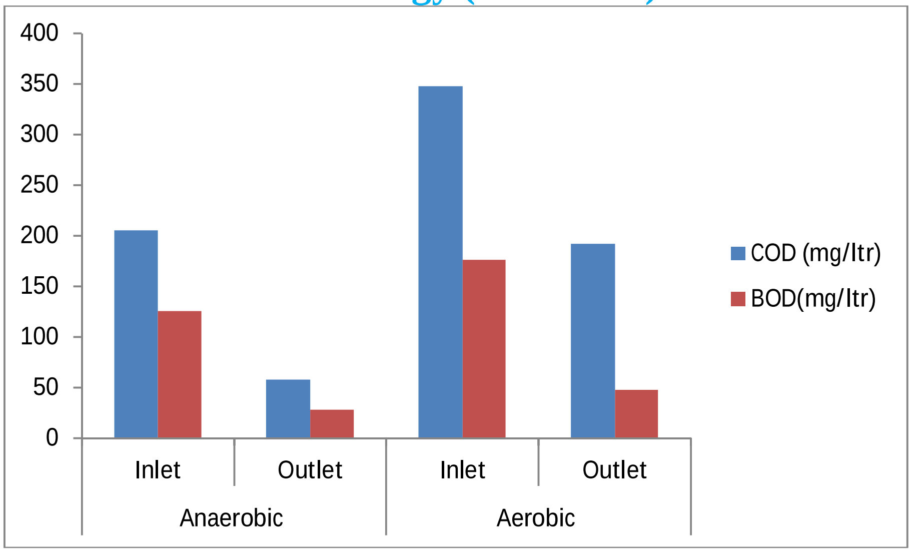

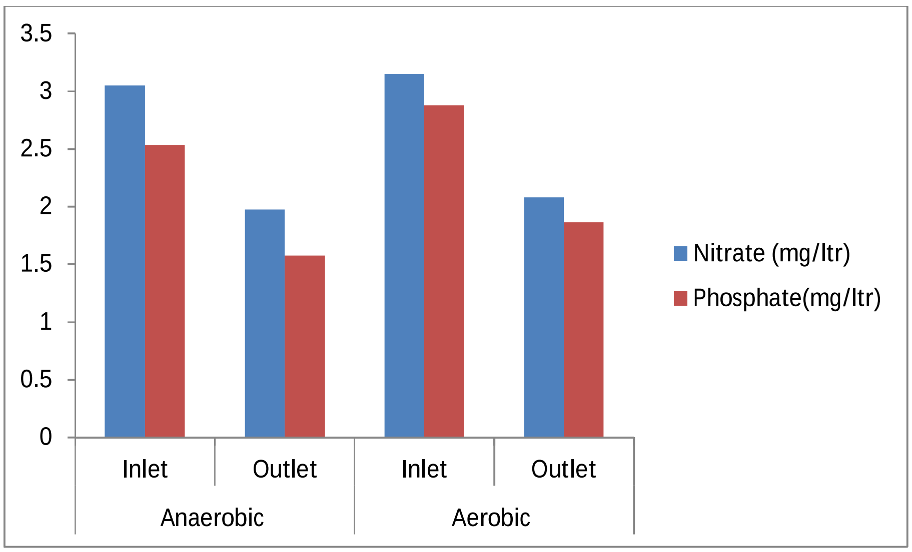

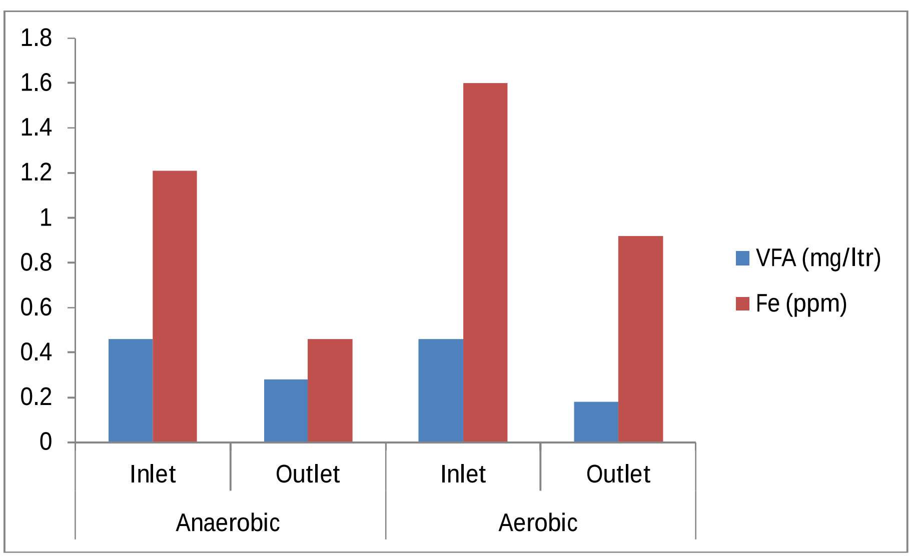

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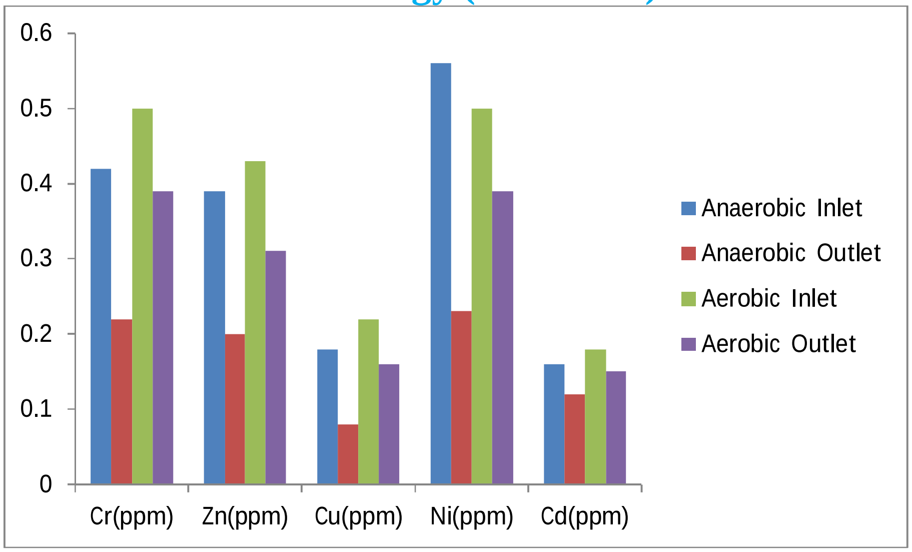

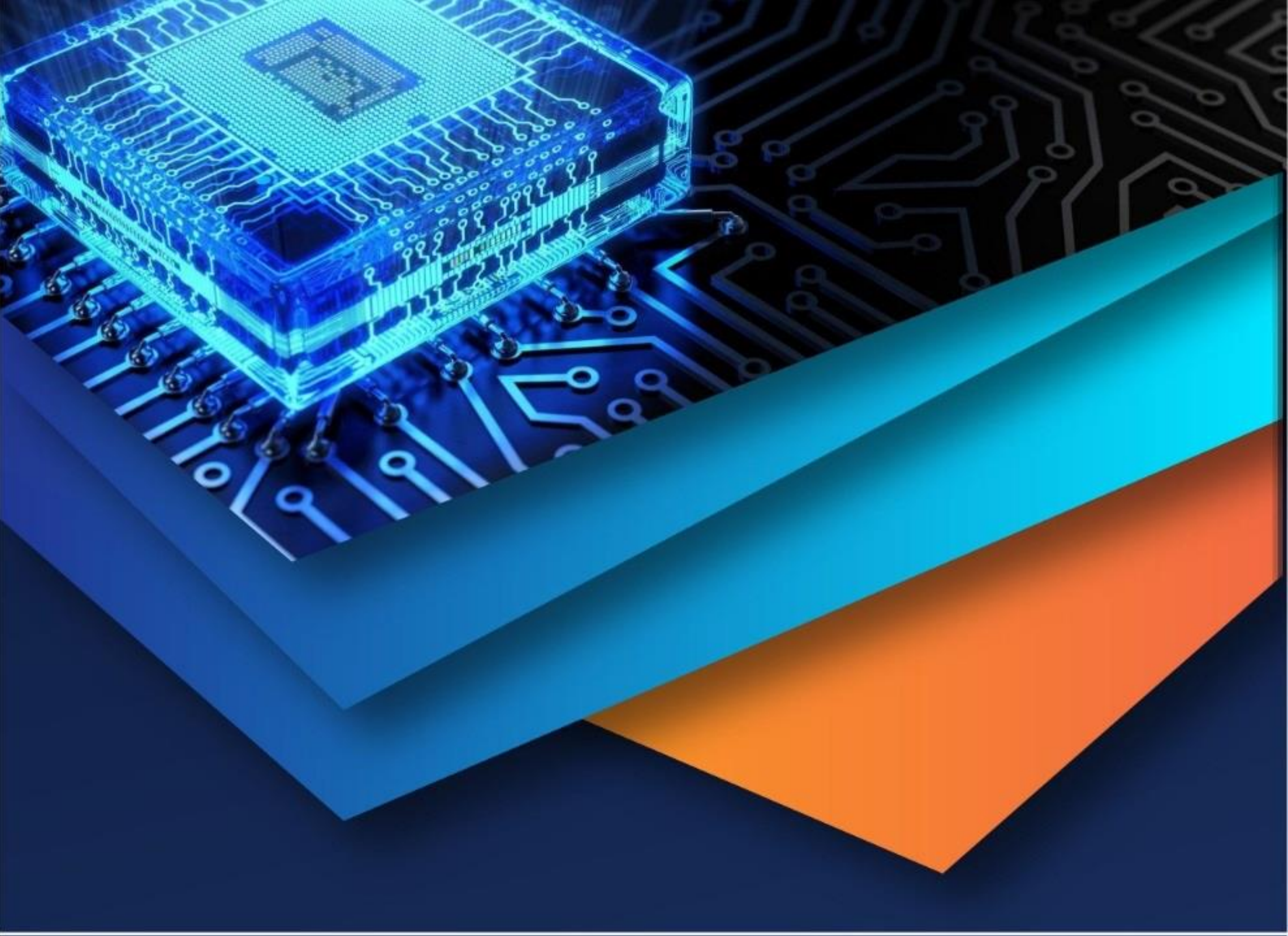

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