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Treatment of Wastewater Using 5 Different Coagulants To Determine Their Various Efficiencies

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Abstract
Nowadays many water resources are polluted by human activities including household and agricultural wastes and industrial processes. About 90% of the water we use on our daily basis is contaminated in one way or the other and this has a detrimental effect on human and aquatic lives. Here, we aim at the best possible ways of treating this wastewater using five different coagulants and also determining the efficiencies of the coagulants by varying their concentration.

This practical was conducted using a conventional jar test apparatus. The sample was collected from an abattoir area very close to a shallowly dug well at Abakpa. 5ml of the coagulant was added to 20ml of the wastewater. The processes involved were rapid mixing (250rpm) for 3minutes, slow mixing (50rpm) for 10minutes, settling for 20minutes and filtration. The weight of the filter paper was measured before and after filtration for total suspended solid (TSS) calculation. It was found that Aluminium Sulphate was the best for the test as it produced a high TSS with the lowest concentration. The other coagulants were also good and can be used as alternatives to Aluminium Sulphates.

Keywords: Wastewater, Treatment, Ferric chloride, Aluminium sulphate, Magnesium chloride, Ferric sulphate and Moringa Seed

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I. Introduction

Contamination of natural waters has become a major problem in our society. Much of the contamination is the result of heavy solid loadings, both organic and inorganic, being discharged into the waterways. The self purification capacity of the waterway is often overburdened and serious pollution problems arise. Contaminants are from two major sources -- industrial and domestic waste. Present treatment methods for domestic waste water consist of primary and secondary treatment processes. Primary treatment consists of the physical separation of about 35 per cent of the solids from the liquid phase by gravity settling. Standard secondary treatment is a biological process which, in combination with primary treatment, results in an overall solids reduction of about 75 to 90 percent. The high quantities of waste water being discharged in densely populated areas demand a constant high degree of solids removal, often in excess of that which can be obtained by standard biological treatment processes. This high degree of solids removal can often be achieved by chemical coagulation in conjunction with other standard treatment processes.

A supply of clean water is an essential requirement for the establishment and maintenance of diverse human activities. Water resources provide valuable food through aquatic life and irrigation for agriculture production. However, liquid and solid wastes produced by human settlements and industrial activities pollute most of the water sources throughout the world. Due to massive worldwide increases in the human population, water will become one of the scarcest resources in the 21st century (Day D., 1996). In the year 2015 the majority of the global population (over 5 billion) lived in urban environments (UN, 1997). In the year 2015, there were about 23 megacities with a population of over 10 million each, 18 of which existed in the developing world (Black, 1994). Central to the urbanization phenomena are the problems associated with providing municipal services and water sector infrastructure, including the provision of both fresh water resources and sanitation services. Currently, providing housing, health care, social services, and access to basic human needs infrastructure, such as clean water and the disposal of effluent, presents major challenges to engineers, planners and politicians (Black, 1994; Giles and Brown, 1997). As human numbers increase, greater strains will be placed on available resources and pose even greater threat to environmental sources. A report by the Secretary-General of the United Nations Commission on Sustainable Development (UNCSD, 1997) concluded that there is no sustainability in the current uses of fresh water by either developing or developed nations, and that worldwide, water usage has been growing at more than three times the world's population increase, consequently leading to widespread public health problems, limiting economic and agricultural development and adversely affecting a wide range of ecosystems. Although India occupies only 3.29 million km2 geographical area, which forms 2.4% of the world's land area, it supports over 15% of world's population. The population of India as of March 1, 2001 was 1,027,015,247 persons (Census, 2001). India also has a livestock population of 500 million, which is about 20% of world's total livestock. However, total annual utilizable water resources of the country are 1086 km3 which is only 4% of world's water resources (Kumar et al., 2005).Total annual utilizable resources of surface water and ground water are 690 and 396 km3, respectively (Ministry of Water Resources, 1999). Consequent to rapid growth in population and increasing water demand, stress on water resources in India is increasing and per capita water availability is reducing day by day. In India per capita surface water availability in the years 1991 and 2001 were 2300 m3 (6.3 m3/day) and 1980 m3 (5.7 m3/day) respectively and these are projected to reduce to 1401 and 1191 m3 by the years 2025 and 2050, respectively (Kumar et al., 2005). Total water requirement of the country in 2050 is estimated to be 1450 km3 which is higher than the current availability of 1086 km3. Much of the wastes of civilization enter water bodies through the discharge of waterborne waste from domestic, industrial and non-point sources carrying unwanted and unrecovered substances (Welch, 1992). Although the collection of wastewater dates back to ancient times, its treatment is a relatively recent development dating from the late 1800s and early 1900s (Chow et al., 1972). Modern knowledge of the need for sanitation and treatment of polluted waters however, started with the frequently cited case of John Snow in 1855, in which he proved that a cholera outbreak in London was due to sewage contaminated water obtained from the Thames River (Cooper, 2001). In developed nations, treatment and discharge systems can sharply differ between countries and between rural and urban users, with respect to urban high income and urban low-income users (Doorn et al., 2006). The most common wastewater treatment methods in developed countries are centralized aerobic wastewater treatment plants and lagoons for both domestic and industrial wastewater. Domestic wastewater may be treated in centralized plants, pit latrines, septic systems or disposed of in unmanaged lagoons or waterways, via open or closed sewers (UNEP, 2002). In some cases industrial wastewater is discharged directly into water bodies, while major industrial facilities may have comprehensive inplant treatment (Carter et al., 1999; Doorn et al., 2006). In many developing countries the bulk of domestic and industrial wastewater is discharged without any treatment or after primary treatment only. In Latin America about 15% of collected wastewater passes through treatment plants (with varying levels of actual treatment). In Venezuela, 97% of the country's sewage is discharged raw into the environment (Caribbean Environment Programme, Technical Report, 1998). Even a highly industrialized country such as China discharges about 55 percent of all sewage without treatment (The People's Daily, Friday, November 30, 2001). In a relatively developed Middle Eastern country such as Iran, the majority of Tehran's population has totally untreated sewage injected into the city's groundwater (Tajrishy and Abrishamchi, 2005). In South Africa where some level of wastewater treatment is observed, Momba *et al.,* (2006) reported the poor operational state and inadequate maintenance of most of the municipalities' sewage treatment works as leading to the pollution of various water bodies thereby posing very serious health and socio-economic threats to the dependants of such water bodies. Most of sub-Saharan Africa is without wastewater treatment (Sci-Tech. Encyclopaedia, 2007). Modern civilization, armed with rapidly advancing technology and fast growing economic system is under increasing threat from its own activities causing water pollution, (Singh et al. (1989). India is the seventh largest country in the world with a total landmass of 3.29 million sq. km, population over 1 billion, 29% of which live in urban areas spread over 5162 towns. With enormous natural resources and growing economy India is the second largest pool of technical and scientific personnel in the world. Pollution from small size industries (SSIs) puts the Indian regulators in front of a difficult arbitrage between economic development and environmental sustainability. The uncontrolled growth in urban areas has made planning and expansion of water and sewage systems very difficult and expensive (Looker, 1998). Aerobic activated sludge reactors have been used on a limited scale as bio-scrubbers for the treatment of odorous air (Bowker, 2000). Despite numerous positive reports from full scale applications in North America, little data are available on the actual performance of these systems with wide ranging concerns on reduction of settling efficiency due to changes in filamentous organisms and bacterial flocks (Burgess et al. 2001). These concerns are alleviated in MBRs where gravitational settling of the microbial solution is replaced by physical filtration. Also, the diffusion and bioconversion of odorous gases are a function of contact time, bubble size, and reactor configuration (Burgess et al. 2001). Submerged MBRs incorporate the membrane unit within the bioreactor and rely on gas and liquid scouring to clean the membrane surface. Since modern livestock operations are equipped with blowers and ventilation systems, booster fans could be added to increase outflow pressure. This concept was explored in past research efforts when biofilter beds (compost and wood chips) were tested for odour removal (Mann et al. 2002).

II. Materials And Method

Methods of Samples Collection

A sample of turbid water was collected from abattoir area near Abakpa main market. It is a commercial small settlement near Highway 343, with a few large commercial market and great farmer's shops. The population of the town is exceeding 25,000 people. The number of residents has been recently increasing since some small industrial companies started operating in the town. Majority of the inhabitants depend on groundwater mostly through shallow dug wells. These wells are polluted with a lot of contaminants from various sources.

Materials/Reagent

Materials are Membrane filter, Borosilicate glass, Hand glove, Nose mask, Weighing balance, Towel, Stirrer, Oven, Masking tape, measuring cylinder. REAGENTS include Ferric Chloride Aluminium sulphate, Ferric sulphate, Magnesium Chloride, Moringa seed

Experimental Analysis

Experiment was conducted using conventional jar test apparatus. Five reagents; ferric chloride, aluminium sulphate, magnesium chloride, ferric sulphate and moringa seed with concentration of 460, 365, 395, 547 and 610mg/l respectively were used for the test. Add 5ml of ferric chloride in 20ml of the water. A rapid stirring (250rpm) was done for 3mins, followed by slow stirring (50rpm) for 10mins. The water was allowed to settle for 20mins. After settling, 10ml of the sample was withdrawn for filtration. The sample was filtered using a weighed filter paper. The filter paper was taken to oven drying. The filter paper was reweighed after drying and the weight was noted. The experiment was repeated using aluminium sulphate, magnesium chloride, ferric sulphate and moringa seed. The same procedure was repeated with increased concentration of the reagents.

CALCULATION

$$\boldsymbol{T.S.S = \frac{(A-B)\times 1000mg/l}{volume\ of\ sample}}$$

A = final weight of the filter paper

B = initial weight of the filter paper

III. Results And Discussion

FERRIC CHLORIDE:

Concentration (mg/l)	Initial wt of Filter paper(mg)	Final wt of filter paper(mg)	T.S.S (mg/l)	Percentage T.S.S removal
460	45.58	51.72	614	18
510	45.58	53.55	797	22
560	45.58	55.78	1020	29
610	45.58	56.33	1075	31

Table 3.1

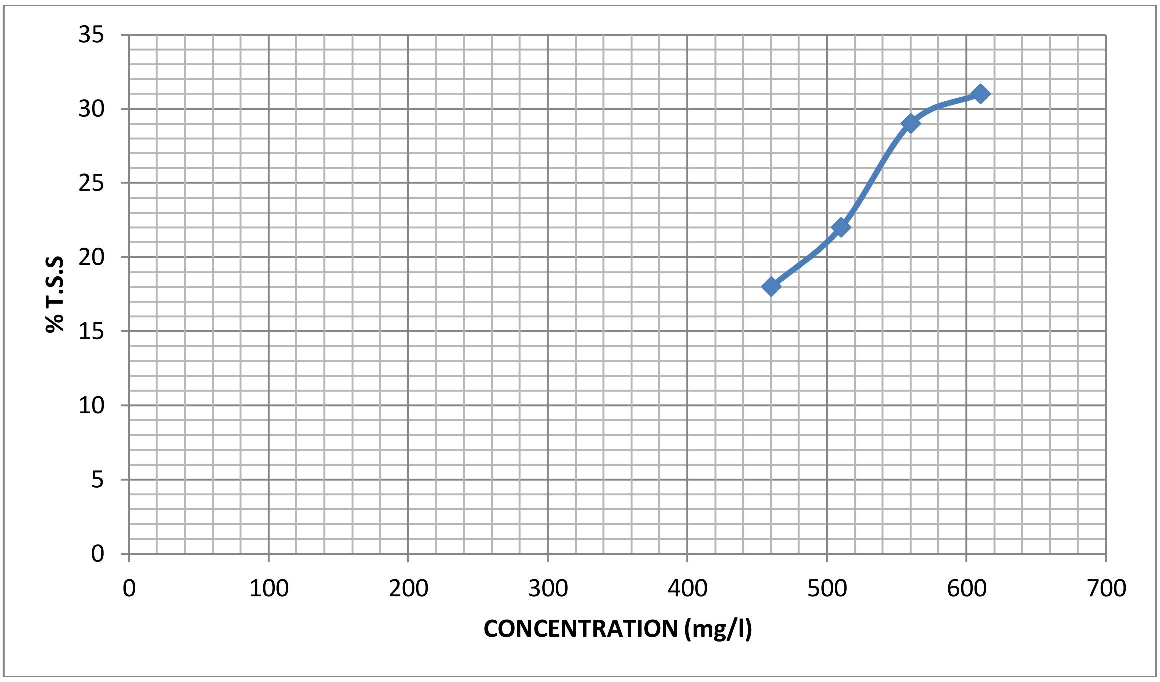

Figure 3.1

3.2 ALUMINIUM SULPHATE

Concentration (mg/l)	Initial wt of filter paper(mg)	Final wt of filter paper(mg)	T.S.S (mg/l)	% T.S.S removal
365	45.58	50.98	540	18
415	45.58	52.67	709	23
465	45.58	53.99	841	28
515	45.58	55.10	952	31

Table 3.2

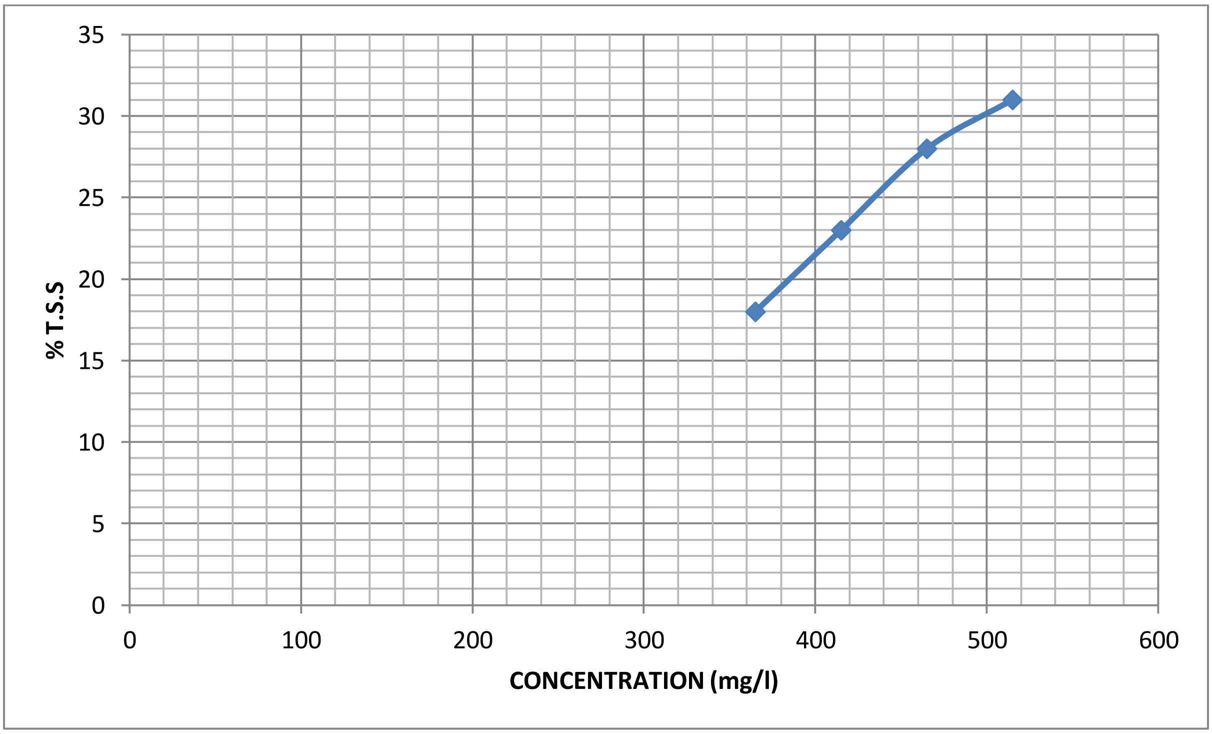

Figure 3.2

3.3 MAGNESIUM CHLORIDE

Concentration (mg/l)	Initial wt of filter paper(mg)	Final wt of filter paper(mg)	T.S.S (mg/l)	T.S.S removal %
395	45.58	49.64	406	16
445	45.58	51.98	550	21
495	45.58	52.98	740	29
545	45.58	54.22	864	34

Table 3.3

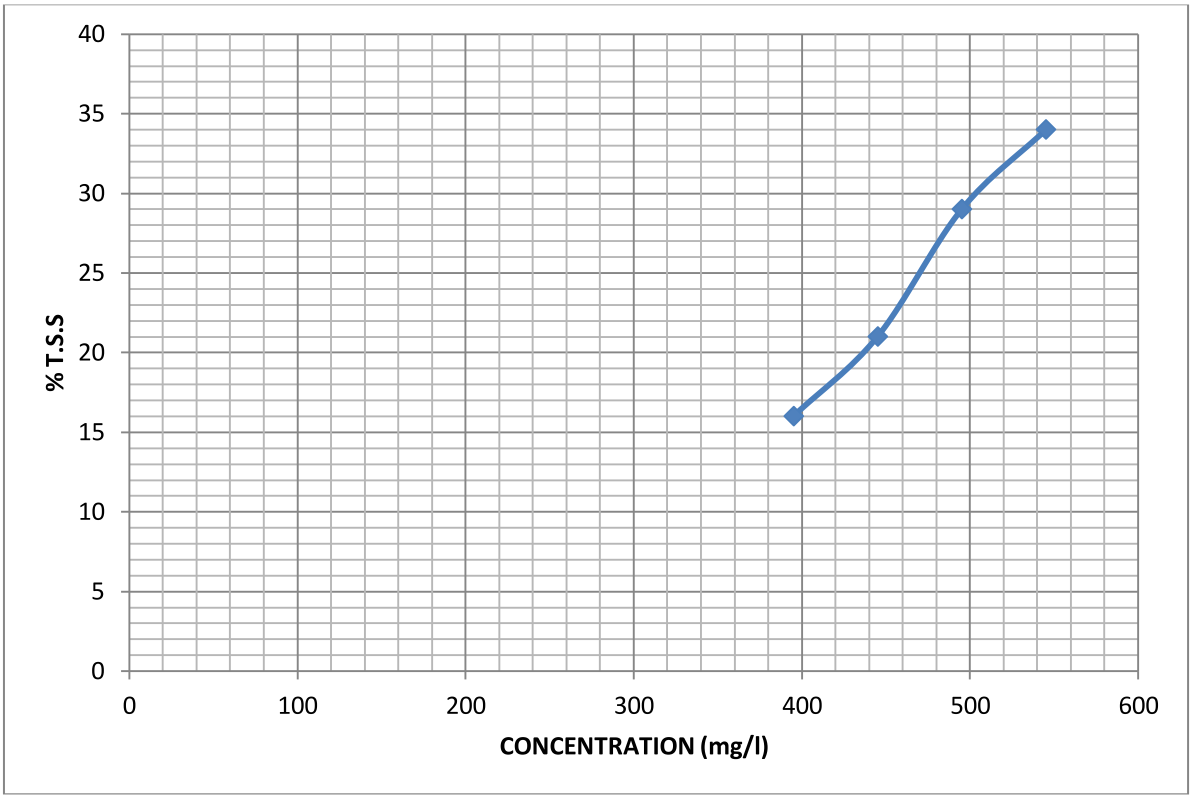

Figure3.3

3.4 FERRIC SULPHATE

Concentration (mg/l)	Initial wt of filter paper(mg)	Final wt of filter paper(mg)	T.S.S (mg/l)	T.S.S removal %
547	45.58	49.99	441	16
597	45.58	51.84	626	23
647	45.58	53.01	743	28
697	45.58	54.34	876	33

Table3.4

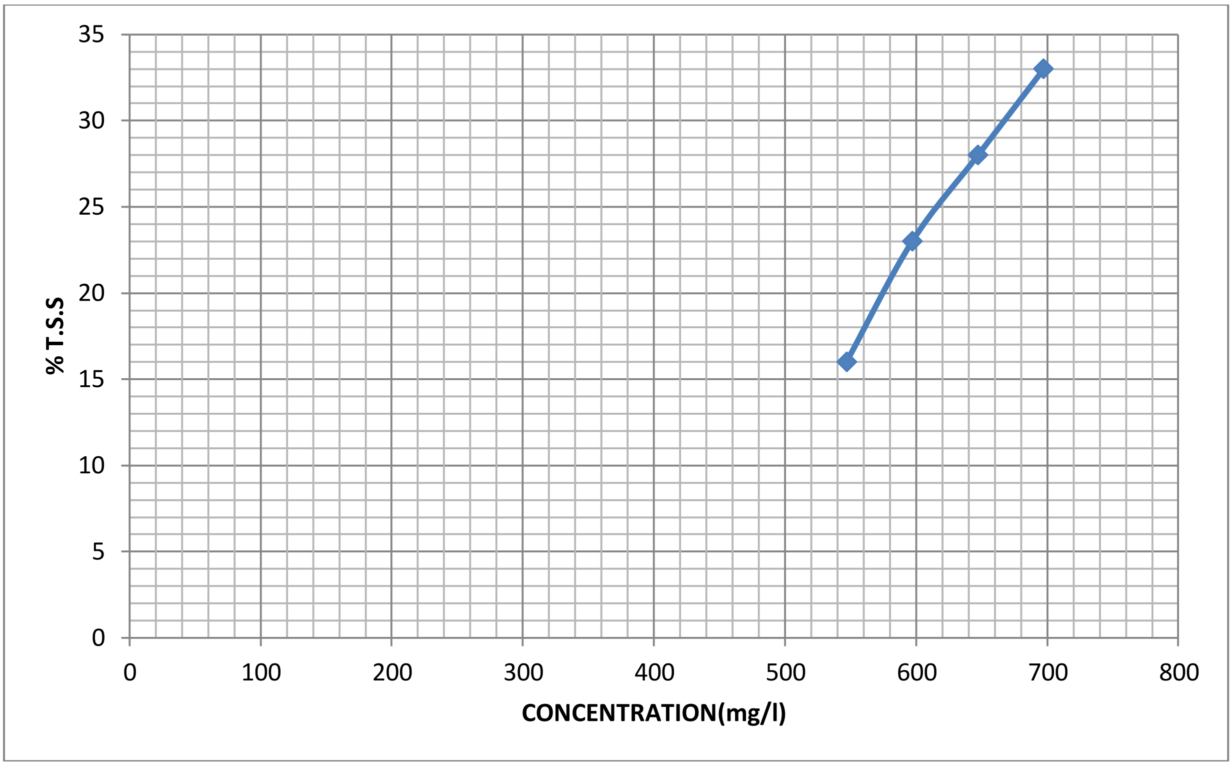

Figure 3.4

3.5 MORINGA SEED

Concentration (mg/l)	Initial wt of filter paper(mg)	Final wt of filter paper(mg)	T.S.S (mg/l)	T.S.S removal %
610	45.58	48.53	295	15
660	45.58	49.81	423	22
710	45.58	51.22	564	29
760	45.58	54.12	854	34

Table 3.5

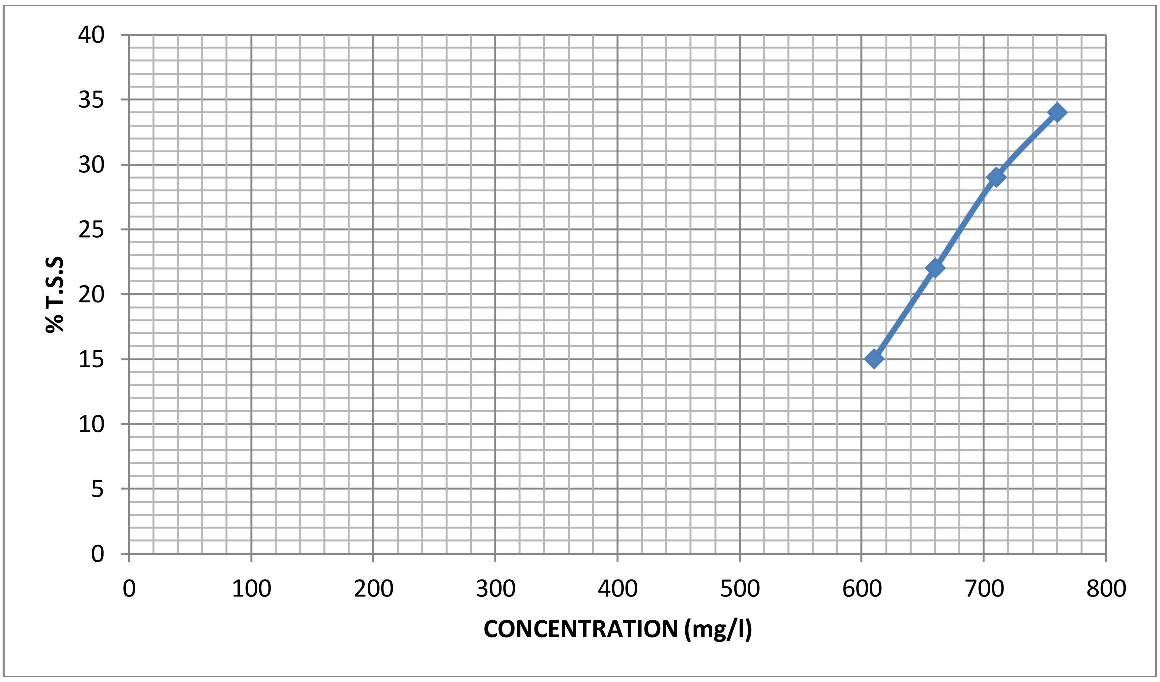

Figure 3.5

IV. Discussion

The jar test was used to study the efficiency of various coagulant in the treatment of wastewater. The concentrations of each coagulant were increased after the first test and the results were as shown above. **F**rom the tables and figures above, it is clear that the efficiency of TSS removal increases with increase in concentration of coagulants. From table4.1, by increasing the concentration of ferric chloride from 460mg/l to 510mg/l, the TSS increased from 614mg/l to 797mg/l. The graphs show the relationships between concentration of coagulants and % TSS removal.

V. Conclusion And Recommendation

CONCLUSION

From the results, Alum is the best coagulant for the coagulation studies because of its efficiency, ease in handling and relative low cost. It is by far the most widely used coagulant today.

Alum treatment does not interfere with the operation of following biological process such as anaerobic sludge digestion and activated sludge. Alum does have the following **disadvantages**:

1. May cause pounding if carried over onto a trickling filter process.
2. Neutralization may be needed after the coagulation process resulting in higher chemical costs.

Recommendations

It has been recommended that:

1. This study's result can be used as a guideline for substitution of Aluminium Sulphate,
2. Longer period of jar test experiment shall be performed, in order to gain more data for interpretation.
3. Sludge generated from the coagulants have to be analyzed in more parameters to investigate their characteristics.
4. Wastewater should be treated before being discharged into water bodies as it has a lot sludge which can be very harmful human beings and aquatic lives.

References

[1]. Black, M. (1994). Mega - slums: The coming sanitary crisis. London: WaterAid.

[2]. Bowker, R.P.G. (2000). Biological odour control by diffusion into activated sludge basins. Water Science and Technology, 41: 127-132.

[3]. Burgess, J.E., S.A. Parsons and R.M. Stuetz (2001). Developments in odour control and waste gas treatment biotechnology: A review. Biotechnology Advances, 19: 35-63.

[4]. Caribbean Environment Programme Technical Report #40 (1998). Appropriate technology for sewage pollution control in the wider Caribbean Region.

[5]. Carter, C.R., S.F. Tyrrel and P. Howsam (1999). Impact and sustainability of community water supply and sanitation programmes in developing countries. Journal of the Chartered Institution of Water and Environmental Management, 13: 292-296.

[6]. Day, D. (1996). How Australian social policy neglects environments. Australian Journal of Soil and Water Conservation, 9: 3-9.

[7]. Doorn, M.R.J., S. Towprayoon, S. Maria, M. Vieira, W. Irving, C. Palmer, R. Pipatti and C.Wang, (2006). Wastewater treatment and discharge. In 2006 IPCC Guidelines for National Greenhouse Gas Inventories. WMO, UNEP. pp. 5: 1-6.

[8]. Giles, H. and B. Brown (1997). And not a drop to drink. Water and sanitation services in the developing world. Geography, 82: 97-109.

[9]. Gupta, G.S., G. Prasad, and V.N. Singh (1990). Removal of chrome dye from aqueous solutions by mixed adsorbents: fly ash and coal. Water Research, 24: 45–50.

[10]. Khouri, N., J.M. Kalbermatten and C. Bartone (1994). The reuse of wastewater in agriculture: A guide for planners. UNDP - World Bank Water and Sanitation Program. Washington, DC: The World Bank.

[11]. Looker, N. (1998). Municipal Wastewater Management in Latin America and the Caribbean, R.J.

[12]. Burnside International Limited, Published for Roundtable on Municipal Water for the Canadian Environment Industry Association.

[13]. Mann, D.D., J.C. DeBruyn and Q. Zhang (2002). Design and evaluation of an open biofilter for treatment of odour from swine barns during sub-zero ambient temperatures. Canadian Biosystems Engineering, 44: 21-26.

[14]. Momba, M.N.B., A.N. Osode and M. Sibewu (2006). The impact of inadequate wastewater treatment on the receiving water bodies case study: Buffalo City and Nkonkonbe Municipalities of the Eastern Cape Province. Water S.A., 32: 687-692.

[15]. Sci-Tech.Encyclopaedia, (2007). http://www.answers.com/topic/sewagetreatment.

[16]. Singh, B., S.P.S. Brar and S. R. Bishnoi (1998). Quality of drain water of Punjab, Indian Journal of Environmental Health. 31: 262-266.

[17]. Tajrishi, M. and A. Abrishamchi (2005). Integrated Approach to Water and Wastewater Management for Tehran, Iran, "Water Conservation, Reuse and Recycling: Proceedings of an Iranian-American Workshop 2005", the National Academies Press, Washington, D.C.

[18]. The People's Daily, Friday, November 30, 2001, Beijing. World Bank supports China's wastewater treatment.

[19]. United States Environmental Protection Agency (2004). U.S. EPA. Primer for Municipal Wastewater treatment systems. Washington, DC. EPA 832-R-04-001.

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