WATER QUALITY ASSESMENT OF EFFLUENT WATER FROM THERMAL POWER PLANT AND AN INNOVATIVE WAY OF REMOVING IMPURITIES USING MORINGA OLIFERA SEEDS

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Abstract

Safe drinking water is essential to the health and welfare of a community and water from all sources must have some form of purification before consumption. Current operational procedures at many treatment works in developing countries are based on the dosage of chemicals. Naturally occurring coagulants are usually presumed safe for human health while there is a fear of using aluminum salts as they induce Alzheimer's disease. Moringa Olifera is one of the most wide spread plant species that grows quickly at low altitudes in the whole tropical belt, including arid zones. Moringa Olifera seeds are an organic natural polymer and are found to have high coagulation activity even for high turbid water. The objective of this investigation is to analyse effluent from different thermal power plants and heavy metal remediation in contaminated water using cost effective Moringa Olifera seeds as alternative to high cost adsorbent material.

Keywords:

Moringa Olifera, organic natural polymer, adsorbent, thermal power plant, coagulant, effluent.

1. INTRODUCTION

Water is essential for all socio-economic development and for maintaining healthy ecosystems. [1] The industrial sector in India is in booming stage and need huge amount of water, in the absence of which it will get a major setback. In India 70-80% of the total power demand is satisfied with the coal based thermal power stations. The thermal power plants need huge amount of water for different processes such as steam generation, fly ash & bottom ash removal, condenser cooling, auxiliary cooling, cleaning garden etc. and thus it discharge huge amount of water as process waste. Waste from such processes release heavy metals into the environment will have potentially negative impacts on air, soil, ground water and surface water quality, affecting livelihood of local people.[2,3]

Sustainability of good health depends on the purity of water. The presence of toxic heavy metals in drinking water, arising from the discharge of untreated effluents causes various health hazards. About one billion people lack safe drinking water and more than six million people die from diarrhea every year. [4-7] Synthetic polyelectrolytes are used as primary coagulant as well as coagulant aid to improve the strength of particle aggregates, enhance coagulation and deposition (filtration). [8]Naturally occurring coagulants are usually presumed safe for human health while there is a fear by using aluminum salts that may induce Alzheimer's disease. [9] Some studies on natural coagulants have been carried out and various natural coagulants were produced or extracted from microorganisms, animals or plants. [10-12] Recently, however, there has been a resurgence of interest in natural coagulants for water treatment in developing countries. [13]

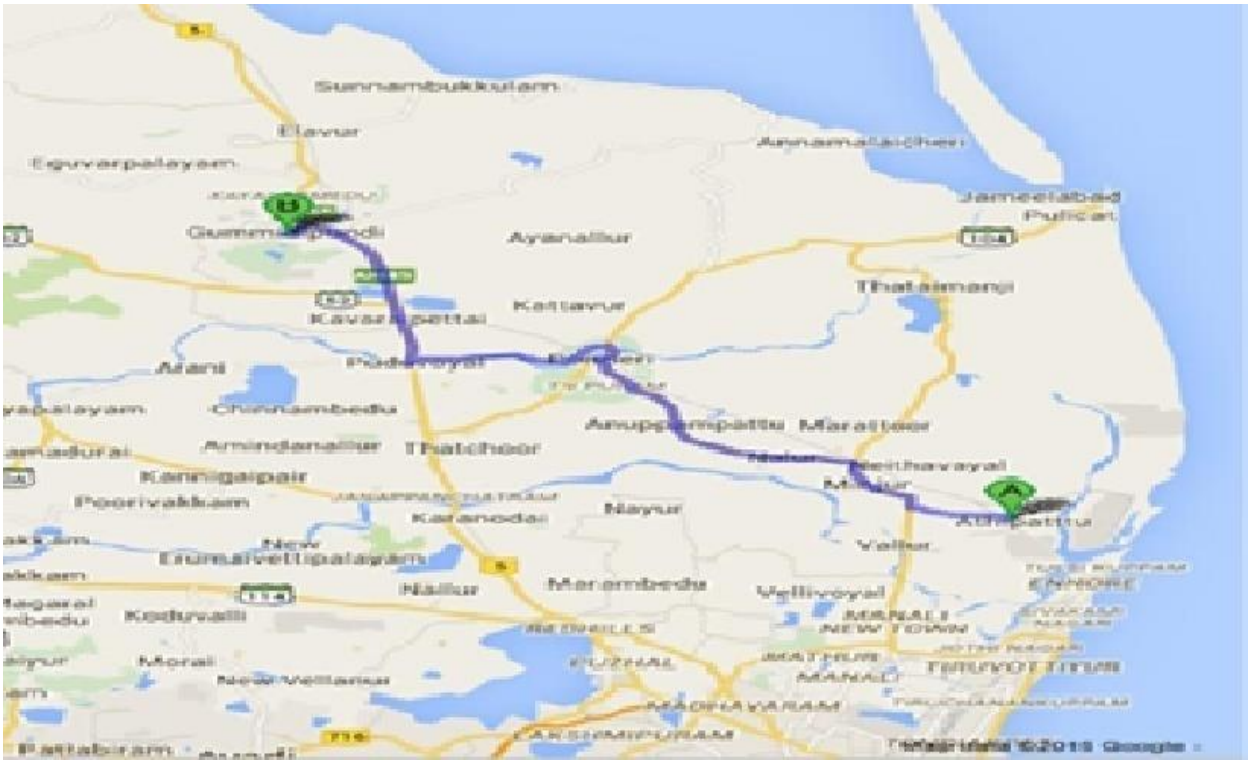
Moringa oleifera is one of the most wide spread plant species that grows quickly at low altitudes in the whole tropical belt, including arid zones. It can grow on mediums oils having relatively low humidity.**[14]** Moringa oleifera seeds are an organic natural polymer **[15]**.has presented Moringa oleifera as a coagulant and many village women used it at home to clear the turbid water. [16] Most of these methods are often ineffective or uneconomical when heavy metal concentrations are higher. Most of the water treatments require higher expenditure. [17] Chemical coagulants require higher cost and has some drawback after treatments such as p^H changes. The present investigation is to analyse effluent from different thermal power plants and heavy metal remediation in contaminated water by utilizing locally available cost effective Moringa Olifera seeds as alternative to high cost adsorbent material.

2. MATERIALS AND METHODS

2.1 STUDY AREA

The study area covers a part of Thiruvallur district. It lies between Attipattu and Gummidipoondi. Which covers an area of about 500 km and the monthly mean temperature varies from 28^0C to 45^0C. Geologically, the area covers the following.

- ❖ Gummidipoondi
- ❖ Vallur



2.2 SAMPLE COLLECTION

The industrial wastewater samples were collected in plastic containers, previously cleaned by washing in non-ionic detergent, followed by rinsing with tap water and later soaked in 10% HNO_3 for 24 hours and finally rinsed with deionized water prior to usage. During sampling, sample bottles were rinsed with sample water three times and then filled to the brim. The samples were labeled and transported to the laboratory, stored in the refrigerator at about 4 ^{0}C prior to analysis. [18]

2.3 WATER QUALITY PARAMETERS

The water samples were analyzed for various physical and chemical quality parameters such as p^H, Electrical conductivity (EC), Turbidity, Residual free chlorine, Total hardness, Calcium hardness, Magnesium hardness, Alkalinity, Chloride, Iron, Organic

matter, Total dissolved solid (TDS), Total suspended solid (TSS), Dissolved oxygen (DO), Bio chemical oxygen demand (BOD) and Chemical oxygen demands (COD).

2.4 MATERIALS

2.4.1 Instruments

pH meter, Conductivity meter with electrode, Magnetic stirrer, Spectrophotometer and Hot air oven.

2.4.2 Apparatus required

Standard flask, Beaker, Measuring jar, Nessler's tube, Burette, Pipette, Conical flask, BOD Incubator, BOD bottles, COD Digester.

2.4.3 Chemicals Required

Buffer solutions, Potassium chloride, Hexamethylenetetramine, Hydrazine sulphate, Chlorotex reagent, Erichrome Black-T, EDTA, sulphuric acid, Phenolphthalein, Sodium azide, Starch indicator, Sodium thiosulphate, Potassium dichromate, Ferrous ammonium sulphate, Silver sulphate, Mercury sulphate, Ferroin indicator, Potassium permanganate, Silver nitrate etc.

2.5 METHODS

pH of the water sample was determined by ELECTROMETRIC Method, using combined glass electrode.

Conductivity is measured with a probe and meter. A voltage is applied between the two electrodes in the probe immersed in the sample water. The drop in voltage caused by the resistance of the water is used to calculate the conductivity per milli second.

Conductivity (G), the inverse of resistivity (R) is determined from the voltage and current values according to Ohm's law.

$$R=V/I$$

$$G=1/R = I/V.$$

Turbidity of the water sample was determined by NEPHELOMETRIC Method.

Turbidity is based on the comparison of the intensity of light scattered by the sample under defined conditions with the intensity of the light scattered by a standard reference suspension under the same conditions. The turbidity of the sample is thus measured from the amount of light scattered by the sample taking a reference with standard turbidity suspension. Formazin polymer is used as the primary standard reference suspension.

Residual free chlorine of the water sample was determined by Chlorotex Method.

The sample is mixed with chlorotex reagent and colour developed was compared with standard chart.

Faint pink & milky98	**CHLORINE in ppm**
White, milky	Nil
	0.1
Pink	**0.2**
Red	**0.5**
Purple	**0.6**
Violet	**0.8**
Blue	**1.0 & above**

Total, permanent and temporary hardness of water samples were determined by EDTA method using EBT as the indicator.

Alkalinity (OH^-, CO_3^{2-}an HCO_3^-) of water samples can be determined by titrating the sample with sulphuric acid of known values of pH, volume and concentration using phenolphthalein as the indicator.

Chlorides present in water can be easily determined by titrating the water sample with silver nitrate solution. The silver nitrate reacts with chloride ion according to 1 mole of $AgNO_3$ reacts with 1 mole of chloride. The titrant concentration is generally 0.01N. Silver chloride is precipitated quantitatively, before red silver chromate is formed. The end point of titration is indicated by formation of red silver chromate from excess silver nitrate. The results are expressed in mg/l of chloride

Iron content of water sample was determined using Spectrophotometer.

Potassium permanganate consumption method was used to determine organic matter present in water sample.

Total solids were determined by evaporation. The suspended and dissolved solids are separated by filtration and individually determined. The suspended solids are dried and weighed.

TSS in ppm = weight of residue in grams / volume of sample taken in ml X 10^6

CONDUCTIVITY TO TDS

TDS, in ppm = factor X conductivity

The factor varies from 0.55 to 0.70. The factor had to be determined once using the evaporation method and can be used to determine TDS for similar samples from conductivity

Dissolved oxygen (DO)present in the samples can be determined by making it to react under alkaline condition with indigo carmine to produce a progressive colour change from yellow to green through red to blue and blue to green. The colour developed in the samples are compared with colour developed with standards.

To determine BOD, the sample is filled in an airtight bottle and incubated at specific temperature for 5 days. The dissolved oxygen (DO) content of the samples is determined before and after five days of incubation at 20 ^{0}C and the BOD is calculated from the difference between initial and final DO.

Biochemical Oxygen Demand

$$= (D_1-D_2) – (C_1-C_2)\ F / P$$

Where,

D_1 = Initial dissolved oxygen content of the diluted sample

D_2 = Dissolved oxygen content of the diluted sample after incubation

C_1 = Initial dissolved oxygen content of the seeded diluted water.

C_2 = Dissolved oxygen content of the seeded diluted sample after incubation

P = Decimal fraction of the sample used.

COD of the water samples was determined using $K_2Cr_2O_7$/ H_2SO_4 as the oxidizing agent. The organic matter present in sample gets oxidised completely by potassium dichromate ($K_2Cr_2O_7$) in the presence of sulphuric acid (H_2SO_4), silver sulphate ($AgSO_4$) and mercury sulphate ($HgSO_4$) to produce CO_2 and H_2O. The sample is refluxed with a known amount of potassium dichromate ($K_2Cr_2O_7$) in the sulphuric acid medium and the excess potassium dichromate ($K_2Cr_2O_7$) is determined by titration against ferrous ammonium sulphate, using ferroin as an indicator. The dichromate consumed by the samples is equivalent to the amount of O_2 required to oxidise the organic matter.

3. RESULTS AND DISCUSSION

3.1 RESULTS

The analytical data were compared with the standard specification (TNPCB). On the basis of the parameters the suitability criteria were determined. The range values of analyzed parameters with standard specification are tabulated.

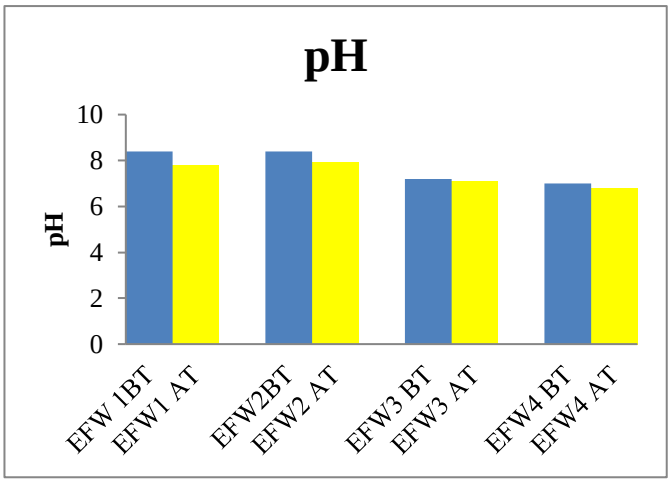
INDUSTRIAL WASTE WATER QUALITY ANALYSIS REPORT

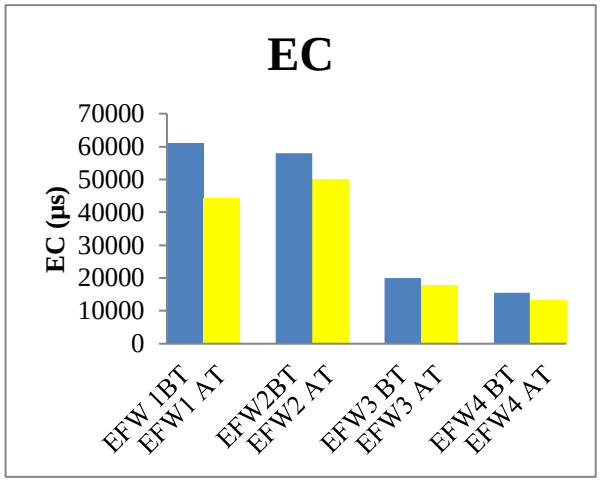
parameters	EFW1		EFW2		EFW3		EFW4		SDTF		
	BT	AT	BT	AT	BT	AT	BT	AT	ISW	PS	OLI
P^H	8.4	7.8	8.4	7.9	7.2	7.1	7	6.8	5.5 - 9	5.5 – 9	5.5 - 9
Electrical conductivity (µs)	60860	44310	57940	50140	19890	17840	15490	13375	-	-	-
Turbidity (NTU)	2.9	2	3.4	2.5	2.1	1.4	1.9	1.5	-	-	-
Residual free chlorine (ppm)	NIL	NIL	NIL	NIL	NIL	NIL	Nil	Nill	-	-	-
Total Hardness (ppm)	7360	5440	6480	5970	380	320	348	290	-	-	-
Ca- Hardness (ppm)	1320	1120	1140	1080	62	54	72	61	-	-	-
Mg- Hardness (ppm)	6040	4320	5340	4890	318	266	276	229	-	-	-
P- Alkality (ppm)	26	NIL	28	NIL	NIL	NIL	Nil	Nill	-	-	-
M- Alkality (ppm)	110	124	118	120	96	112	90	110	-	-	-
Chloride (ppm)	21868	15449	21480	12684	1740	1286	1688	1186	1000	1000	1000
Iron(ppm)	18	6	17	5.32	13	4.15	11	3.1	-	-	-
Organic mater (ppm)	0.8	0.5	1.1	0.8	0.7	0.5	0.4	0.2	-	-	-
TDS (ppm)	42602	48168	44239	49846	29347	31962	28642	30184	2100	2100	2100
TSS (ppm)	17.8	29.2	16.3	24.8	9.2	18	8.8	14	100	600	200
DO (PPm)	4.0	3.1	4.2	3.5	2.9	2.0	3.2	2.2	-	-	-
COD (ppm)	1640	180	1520	160	1570	170	1540	175	250	-	-
BOD (ppm)	139	100	131	120	25	11	20	8	30	350	100

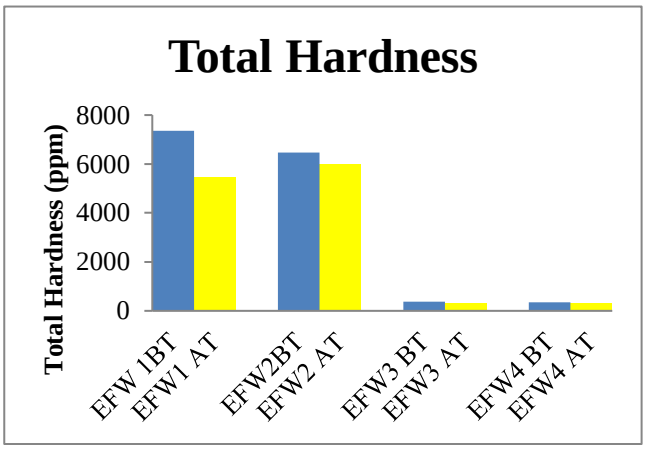
NB; AT- After Treatment; BT - Before Treatment ; ISW - Inland surface water; OLI- On Land for irrigation; PS - Public sewers; EFW1 - NTECL ; EFW2 - TNEB; EFW3 - OPG; EFW4 - SURIYA ; SDTF - Standards for discharge of trade effluent.

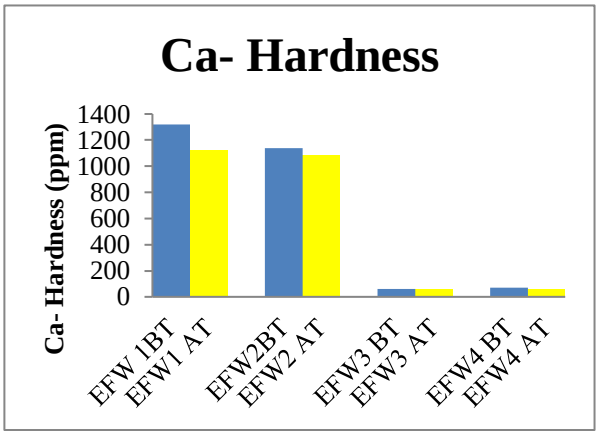
COMPARISON OF EFFLUENT QUALITY

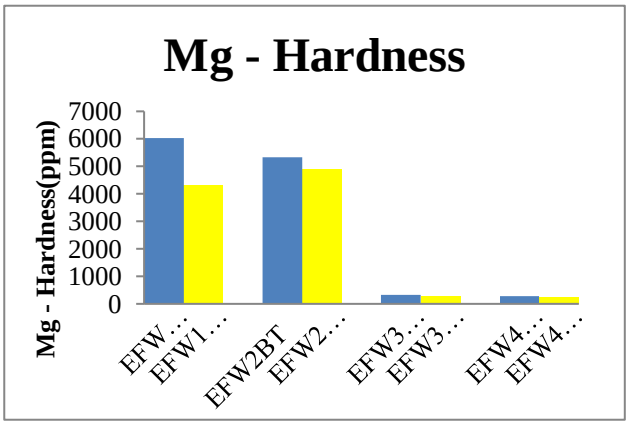
ANALYSIS REPORT USING BAR DIAGRAM

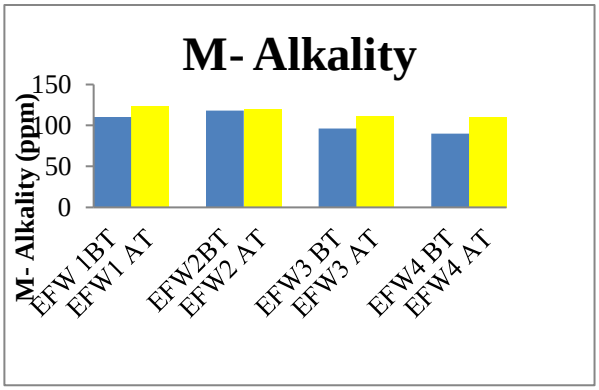


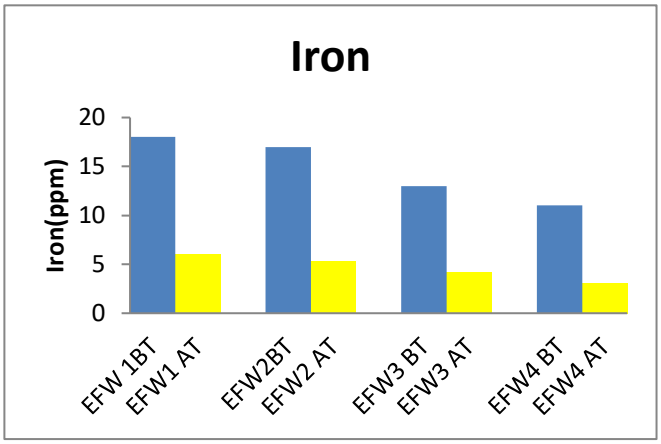


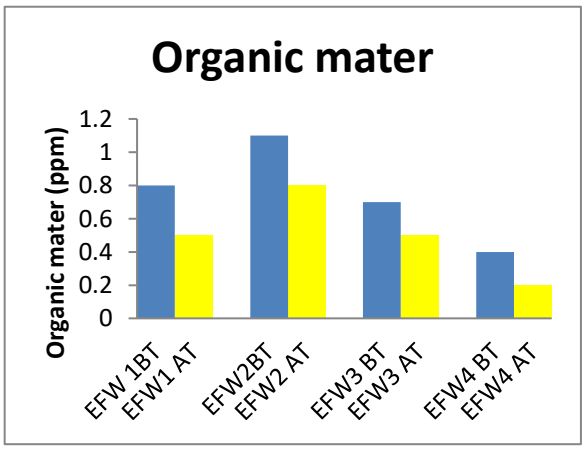


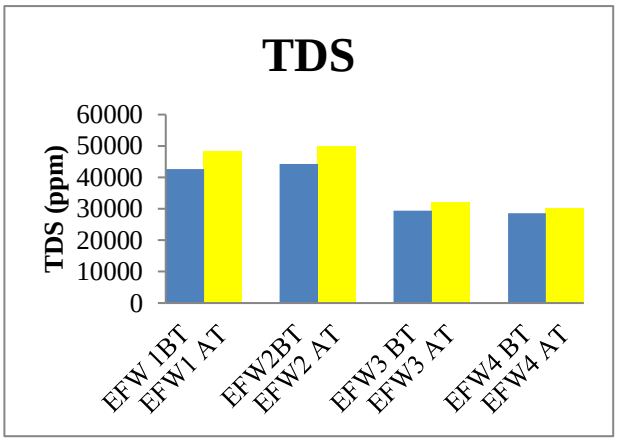


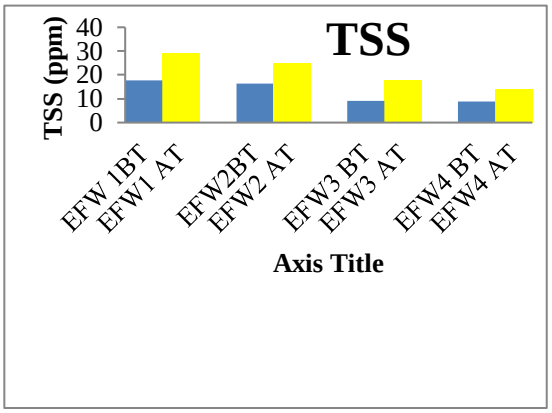


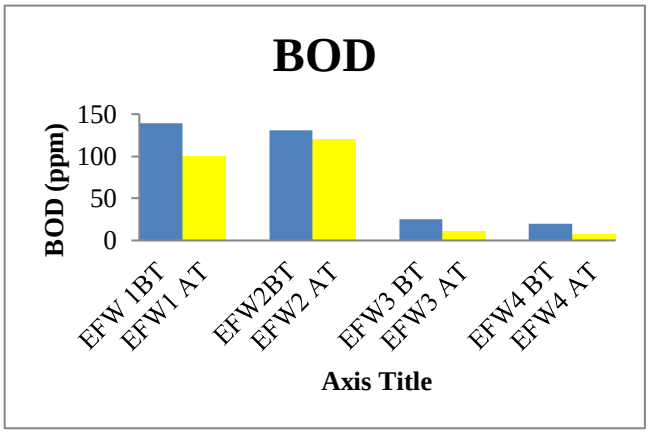


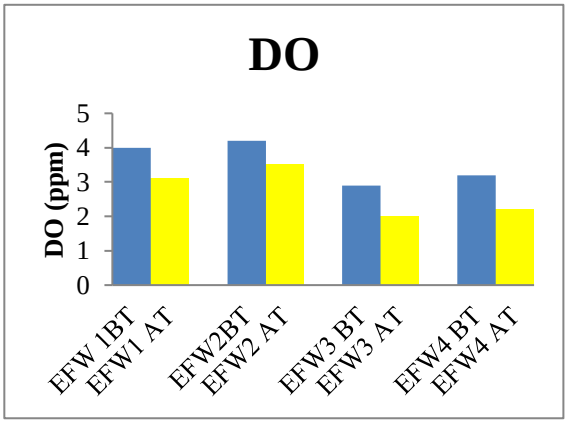












3.2 DISCUSSION

3.2.1 p^H VALUE

p^H is a measure of intensity of acidity or alkalinity and measures the concentration of hydrogen ions in water . It has no direct adverse affect on health, however a low value below 4.0 will produce sour taste and higher value above 8.5 shows alkaline taste. A p^H range of 6.5 – 8.5 is normally acceptable as per guidelines suggested by ISI & WHO & IS. In the present investigation p^H of the samples ranges from 7.2 to 8.4. But after treatment by using by Moringa seeds, pH range is reduced to the extent of 7.1 to 7.8. The investigated samples are lying well within the acceptable range of p^H.

3.2.2 ELECTREICAL CONUCTIVITY

The salt concentration is generally measured by determining the electrical conductivity of water. It was found that waste water collected from Thermal power plants, which are using sea water for their industrial processes show a very high value of electrical conductivity than those using ground water. It was accounted to be due to more salt content in sea water than ground water but a vast reduction in EC value was observed after treatment with MO seeds, indicating its excellent coagulating and adsorbent nature.

3.2.3 TURBIDITY

It reflects the transparency of water which is caused by the suspended particles. In natural water it is caused by clay silt, organic matter and other microscopic organisms where as in effluent water it is caused by the particulate waste generated by industrial processes. In the study area turbidity of the investigated samples range from 2.1- 3.4 NTU before treatment where as turbidity range is reduced to large extent in the range of 1.4 to 2.5 NTU. This suggests the coagulating nature of MO seeds, which is safe for human health. Turbidity doesn't cause direct health impacts but is an indicator of biological contamination, as viruses, parasites and bacteria to attach themselves as small particles. It also reduces the effectiveness of chlorination, as chlorine will combine with the particles and less will be available to combine with the pathogens.

3.2.4 RESIDUAL FREE CHLORINE

A small amount of chlorine in water is good, since it kills most pathogens that can make us sick. Many cities around the world add chlorine to their water to make it safe for people to drink. High amount of chlorine can irritate our skin and eyes if we touch it. The strong smell of chlorine can also hurt our throat and lungs if we breathe it. The investigated samples

were found to be free from residual free chlorine.

3.2.5 TOTAL HARDNESS

Hardness is due to the presence of calcium and magnesium salts in water. A very high value of hardness in the range of 6480-7360ppm was observed in the study area of NTECL & TNEB which is due to the usage of sea water for their industrial processes whereas in OPG and SURIYADEV power plants a low value of hardness in the range of 340 to 380 was observed, which is due to the utilization of ground water for their industrial processes. An extreme reduction in the value of total hardness, calcium & magnesium content were observed after treatment, which is due to the more effective coagulating and adsorbent character of MO seeds.[19]

3.2.6 ALKALINITY

No phenolphthalein alkalinity was observed in the study area where as Methyl Orange alkalinity range from 96 to 110 mg/liter. Surprisingly an increase in value of Methyl Orange alkalinity was observed after treatment with MO seeds. This may be due to the water soluble proteins present in MO seeds which in solution carry an overall positive charge. When added to raw water proteins bind to negatively charged particulates which increases alkalinity.

3.2.7 CHLORIDE

Chloride in excess (> 250 mg/l) imparts a salty taste to water and people who are not accustomed to high Chlorides can be subjected to laxative effects. Chloride toxicity has not been observed in humans except in the special case of impaired sodium chloride metabolism, e.g. in congestive heart failure. Healthy individuals can tolerate the intake of large quantities of chloride provided that there is a concomitant intake of fresh water. The investigated samples are found to have chloride content in the rage of 1740 – 21480ppm. It was found that power plants using sea water for their industrial processes are found to have an extreme amount of chloride than those using underground water. An extreme reduction in chloride content in the range of 1286 -12684 was observed after treatment with MO seeds due to the coagulation of positively charged protein with negatively charged chloride ion. [20]

3.2.8 IRON

Iron in water does not cause danger to human health or environment but gives rust colour, metallic taste and can stain linen and food industry products. But molecular studies show that iron toxicity causes toxic effect on intracellular organelles, particularly mitochondria and lysosomes. Excess iron intake

can cause cellular damage and alteration of genetic structure of phenotype

The investigated samples were found to have iron content in the range of 13 – 18 ppm before treatment where as an extreme reduction in the range of iron content in the order to 4- 6 ppm was observed after treatment, which is indicating an excellent adsorbent character of MO seeds and better results were observed in the removal of iron compared to other impurities. Hence Moringa Olifera seeds may be used for the complete removal of iron from water

3.2.9 TOTAL DISSOLVED SOLIDS

It may be considered as salinity indicator which is due to the presence of calcium, magnesium, sodium, potassium, bicarbonate, sulphate, etc. In the study area TDS varies from 29347 - 44239. A very high value of TDS is due to the presence of more dissolved salt.

3.2.10 DISSOLVED OXYGEN (DO)

Dissolved oxygen content in water reflects the physical and biological processes prevailing in water and is influenced by aquatic vegetation. Low oxygen content in water is usually associated with organic pollutants. A very low range of i.e. 3.4 to 4.5ppm oxygen content was observed in effluent but these values are improved to some extent in the range of 5.0 to 6.0ppm after treating with MO seeds.

3.2.11 BIOLOGICAL OXYGEN DEMAND (BOD)

The BOD values indicate the amount of organic waste present in the water. BOD gives a quantitative index of the degradable organic substances in water and is used as a measure of waste strength. The investigated samples have BOD values in the range of 25 – 139 mg/l, but an extreme reduction in the value of BOD of 11 – 100 ppm was observed after treatment indicating an excellent coagulating effect of MO seed. [21]

3.2.12 CHEMICAL OXYGEN DEMAND (COD)

The COD level indicates the amount of toxicity in water. [22] The analyzed COD values of the sampling sites varied from 4.5 to 9.0ppm. The analyzed COD values were found to be higher than the BOD values. This indicates the ample presence of chemically oxidisable substances of which the majorities are non biodegradable.

4. CONCLUSION

Effluents of four different thermal power plant from Thiruvallur district were collected and its pollutants were analyzed by measuring different water quality parameters such as pH, EC, Turbidity, FRC, TDS, TSS, Calcium hardness and Magnesium hardness, alkalinity, chloride, iron, organic matter, DO, BOD, & COD using standard methods. Conventional

technologies for the removal of heavy metal ion such as chemical precipitation, ion exchange, membrane separation, reverse osmosis and electro chemical treatment are often ineffective or uneconomical when heavy metal concentrations are higher and also can cause health hazards and environmental pollution. Such problems can be rectified by using multipurpose tree i.e. Moringa Olifera. The seed kernels contains significant quantities of low molecular weight, water soluble proteins, they can act similar to synthetic positively charged polymer coagulant. When added to waste water, the proteins bind to the negatively charged particulates that make raw water turbid. Under proper agitation they bound particulates grow in size to form the floes, which can be left to settle by gravity or be removed by filtration. Better results were received after treating effluent with Moringa Olifera seeds.

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