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A comparative study of physico-chemical and biological analysis of sewage water

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ABSTRACT

When sewage is untreated and is discharged into any water course will be effected severely. Sewage which has many pathogens and is rich in organic matter and high BOD when released into water course the dissolved oxygen of the stream decreases drastically which effects flora and fauna of the stream and also makes the water unfit for any purpose. Visakhapatnam is a city where nearly 18 lakh (384 per km^2) (Eenadu, dated on 1st April) people resides. The day – to – day sewage which generates in the city has been collected and treated in the municipal sewage treatment plants at Appugar, Port area, Old town and Mudarsalova. Where Appugar plant holds 25 MLD, Port area plant holds 10 MLD, Old town plant holds 38MLD and Mudarsalova plant holds 13MLD of sewage of Visakhapatnam. The sewage treatment plants are not enough to hold the existing huge volume of sewage that is generated in the city. People and tourists are attracted more towards locations like Lumbini Park, Tenneti Park, Tourists Resorts located along the Beach and make frequent visits to those places. Aim of this study is to estimate physico-chemical and biological parameters of the sewage samples from different sewage disposal points along the coast of Visakhapatnam and to identify that objectionable parameters of the sewage ,which should be minimized before it is being disposed off.

KEY WORDS: Sewage water, physico-chemical and biological parameters and discharge points

INTRODUCTION

India faces a turbulent water future, unless water management practices are changed India will face a severe water crisis within the next two decades and will have neither the cash to build new infrastructure nor the water needed by its growing economy and rising population. Water is one of the critical inputs for the sustenance of mankind. Almost 70% of the water resources of India have been polluting due to the discharge of domestic sewage and industrial effluents into natural water source, such as rivers, streams as well as lakes (Sangu and Sharma 1987). About 95% of rural population living in India depends on ground water for domestic use (Moharir et al. 2002) and also for various activities.

Water is the important natural source, which is abundant in nature and cover about 2/3ds of earth surface. However, only 1% of the water resource is available as fresh water (i.e., surface water-rivers, lakes, reams, and ground water) for human consumption and other activities. The major uses of water are for irrigation (30%), thermal power plants (50%), while other uses are domestic (7%) and industrial consumption (~12%) (21).The United Nation's report on "Water for People, Water for Life" (the first ever UN system wide evaluation on global water resources-2003) has put India a poor 120th for water quality among 122 nations covered. Only Belgium and Morocco are ranked worse than India. The quality indicator value was based on quality and quantity of fresh water (especially ground water), waste water treatment facilities, legalities like application of pollution regulations.

Urbanization has given rise to a number of environmental problems such as water supply, wastewater generation and its collection, treatment and disposal in urban areas. In most cases wastewater is let out untreated and it either percolates into the ground and in turn contaminates the groundwater or is discharged into the natural drainage system causing pollution in downstream areas. Sewage and industrial pollution accounts for more than 75 per cent of the surface water contamination in India. Due to negligence, groundwater is also increasingly getting contaminated. In India less than 50% of the urban population has access to sewage disposal system. Most of the existing collecting systems discharge directly to the receiving water without treatment. Garbage, domestic and otherwise, is directly dumped into water bodies or roadside, which can often be washed into streams and lakes. The municipalities' disposes off their treated or partly treated or untreated wastewater into natural drains joining rivers or lakes or used on land for irrigation or fodder cultivation or into sea or combination of these. Toxic chemicals from sewage water transfer to plants and enter in the food chain and affect public health.

Pathogens occurring in the sewage water directly affect the organisms causing diseases. The coliforms group of bacteria comprises mainly species of the genera ***Citrobacter sp***., ***Enterobacter sp.***, ***Escherichia sp.*** and ***Klebsiella sp***. and includes faecal Coliforms, of which ***Escherichia coli*** is the predominant species. ***E.coli***, is most satisfactory indicator parameter in sewage water use and faecal ***Streptococci*** as an indicator in tropical conditions and especially to compare survival with that of Salmonellae species (Shuval et al 1986, Smith et al 1981, Sangu and Sharma 1987, Rao and Rao1995 and www.articlesbase.com).

Treatment of sewage is essential to ensure that the receiving water into which the sewage is ultimately discharged is not significantly polluted. However, the degree of treatment required will vary according to the type of receiving water. Thus, a very high degree of treatment will be required if the sewage discharges to a fishery or upstream of an abstraction point for water supply. A lower level of treatment may be acceptable for discharges to coastal waters where there is rapid dilution and dispersion. The study was estimated various physico-chemical and biological parameters of the sewage samples which were collected at sewage disposal points along the coast of Visakhapatnam and to make sure that the objectionable parameters of the sewage are minimized before it is being disposed off.

MATERIAL AND METHODS

Study Area:-

Vishakhapatnam was situated in between 17° 40’ 30’’ and 17° 40’ 45’’ North latitude and 83° 16’ 15’’ and 83° 21’ 30’’ East longitude. The present study was carried out at some selected sampling sites based on the sewage outlets along the coast. The study was conducted by collecting sewage samples from Dolphin's nose to Bheemili.

Sample collection:-

The sewage samples were collected at selected disposal points around the coast of Visakhapatnam, great care was taken during collection of the sample. The clean plastic bottles of one liter capacity were rinsed three times with water before filling sample, after the samples were collected, the stopper was placed tightly. The samples were brought to the laboratory and analyzed. Whenever delay was unavoidable, the samples were refrigerated. The analysis of the sewage samples were carried out in Environmental Monitoring laboratory, GITAM Institute of science, GITAM University by carrying out a series of tests in systematic manner.

The Physico-Chemical and biological parameters of the sewage samples analyzed in triplicate by adapting standard procedures from manual of American Public Health Association (APHA 1988 and 1992). The sewage samples were analyzed for the following Physico-Chemical and biological parameters.

1) Temperature (^{o}C)
2) pH
3) Conductivity (mmhos/cm)

4) Turbidity (NTU)
5) Total solids(mg/l)
6) Total Dissolved Solids (mg/l)
7) Total Suspended Solids (mg/l)
8) Total Hardness (mg/l)
9) Calcium Hardness (mg/l)
10) Magnesium Hardness (mg/l)
11) Chlorides (mg/l)
12) Alkalinity (mg/l)
13) Nitrates (mg/l)
14) Sulphates (mg/l)
15) Phosphates (mg/l)
16) Dissolved Oxygen (mg/l)
17) Bio-chemical Oxygen Demand (mg/l)
18) Chemical Oxygen Demand (mg/l) and
19) Microbial Count

RESULTS AND DISCUSSIONS:

The physico-chemical and biological characteristics of sewage samples at selected sewage discharge points were given in table 1.

Temperature is an important biological significant factor, which plays an important role in the metabolic activities in the organism. The temperature was ranged from $19.5^{o}C$ to $22.5^{o}C$ during the study period

pH is a measure of the intensity of acidity or alkalinity and is also a measure of the concentration of hydrogen ions in the water. It has no direct adverse effect on health, however, all values, below 4.0 will produce sour taste and value above 8.5 shows bitter taste (Karunakaran 2008).The study was observed that the pH value ranged between5.87 to 8.67 was found to be alkaline. P^{H} is one of the most important factors that serve as an index of the pollution.

Conductivity is the measure of capacity of a substance to conduct the electric current. Most of the salts in water are present in their ionic forms and capable of conducting current and conductivity is a good indicator to assess sewage water quality. During study period the EC was observed maximum in W_4 (538.00 µmhos) which is moderately saline in nature, having varying ionic concentrations and minimum in W_8 (107 µmhos) i.e., Sewage water of low salinity is generally composed of higher proportions of calcium, magnesium and bicarbonate ions.

Alkalinity of water is a measure of its capacity to neutralize acids. Alkaline values provide guidance in applying proper doses of chemicals to water and in waste water treatment processes particularly in coagulation, softening and operational control of anaerobic digestion. There is no standard value for total alkalinity. The total alkalinity value indicates poor water quality. The high value of alkalinity is probably either due to salinity rich effluents in sewage water. The sewage samples showed alkalinity of 175mg/l (W2) to 287mg/l (W4) indicating more alkaline in condition.

Hardness in water is due to cations that are the divalent ions like calcium and magnesium. The hardness in water is derived largely from contact with the soil and rock formations. Calcium and Magnesium hardness is caused by greatest portion of the hardness occurring in natural waters. Hardness of water is objectionable from the view point of water used for laundry and domestic purposes, since the processes consume a large quantity of soap. Total Hardness reported that ranged from 130mg/l (W5) to 380 mg/l (W9).Where calcium hardness ranged from 90 mg/l to 280mg/l and magnesium hardness ranged from 55mg/l (W5) to 120mg/l (W1).

The determination of total dissolved solids is a measure of all salts in solution. Since EC of water is a function of the concentration of dissolved constituents, an estimate of total dissolved solids in ppm, in a fresh water sample can be made using the relationship, specific conductance of micromhos at $25^{o}C$ x A = dissolved solids in ppm. ‘A’ has a value between 0.55 and 0.75, if the value is higher than this value, indicates that the water is saline. If the value is lower than the value indicating that the water will be in acidic condition. The present study observed that total solids (suspended and dissolved) ranged between 1200mg/l (W7) to 2880mg/l (W2). It was observed that water with high electrical values was rich in Sodium and Chloride ions and further it was noted that the electrical conductivity was higher in sewage water samples.

The results revealed that Sulphate was ranged from 80.0 mg/l (W_9) to 22.43 mg/l (W_3), (Table-1) which are within permissible limits according toWHO (1984). The amount of Sulphates concentration is high in Parawada sewage discharge point than the other sewage discharge points; this may be due to the source of effluents in Pharma industries. The amounts of Nitrates vary from 0.2 mg/l (W_1) to 5.13 mg/l (W_2) (Table1). The high concentration of Nitrates was recorded in samples of R.K. Beech than the other sewage discharge ponts. Where, the next high concentration of nitrates was recorded near INS Kalinga. The Phosphate concentration in sewage samples were within the range (0.63 mg/l (W6) to 11.4 mg/l (W2) (Table-1). Here Jodugullmmapalem sewage discharge point was recorded less amount of Phosphates than the other sewage discharge points. As per WHO (WHO 1984 & 2004) guidelines there is no specific permissible limit for phosphates.

Dissolved Oxygen level is below detectable level due to decomposition and oxidation of organic matter reduces the solubility of oxygen, which indicates high pollution load on sewage. The deficiency of the oxygen in the sewage is shelter for bacteria and other pathogens which are anaerobic and injurious to human health.

Biological oxygen demand and chemical oxygen demand are the major parameters used as routing surrogate tests for measuring the load of organic carbon into the water environment. In pollution abatement works, organic matter measurement provides a quick and simple method for monitoring pollution levels as well as the accumulation of non-biodegradable or refractory organic materials. (Aziz. and Tebbutt 1980, CPCB, 2004, Fadini et al 2004 and Ali Vahdat et al 2010). The strength of waste water is judged by BOD. This is defined as the amount of oxygen required by bacteria while stabilizing the organic in waste water under aerobic conditions, at a particular time and temperature. This can be referred as BOD5, which accounts for 70% of the total BOD. Values of Biological Oxygen Demand (B.O.D) ranged from 960mg/l (W2) to 2265mg/l (W8).

Chemical oxygen demand (COD) reflects the concentration of organic compounds present in wastewater. This measure the total quantity of oxygen required for oxidation of organics into carbon dioxide and water. The oxidation of organics in wastewater is carried out by the action of strong oxidizing agents. Estimation of COD expresses the total concentration of organics present in the wastewater. Values of Chemical Oxygen Demand ranged from 1154mg/l (W2) to 3265mg/l (W8).BOD to COD ratio reveals the treatability of wastewater. If the ratio of BOD/COD is above 0.5, the wastewater is considered to be highly biodegradable. If the ratio is less than 0.3, the wastewater is deemed to undergo a chemical treatment before the routine biological treatment. The study was observed that all samples were biodegradable. (Table-1)

Major cities in India generate large volumes of wastewater due to their inefficient water management systems. Large amounts of wastewater that can be reused, is letting down into either sewerage drains or nearby aquatic resources. Furthermore, the potential for environmental pollution is greater due to high quantity of waste materials produced namely the organic matter (Kenaga 1974 and Shathele 2009) and generally rich with pathogens of faecal origin, even after the treatment with conventional methods. Few important pathogens in sewage water are bacteria (***E-coli, Salmonellae sp***), Viruses (eg.Poliovirus) and Protozoans are causing various types of diseases especially of faecal oral route (Jianlong Wang and Jiazhuo Wang. 2007). The study has investigated that, Total Bacterial Count (TBC) value ranged from 4.5×104 CFU/ml (W10) to 6.8×105 CFU/ml (W1). The bacteriological analysis determines the probability of sewage. The reason for high number of bacterial colonies might be due to the inadequate maintenance and percolation of sewage. Total Coliforms ranged wa from 1.2×104 CFU/ml (W10) to 9.6×104 CFU/ml (W1). The reason for the high number of coliforms were due to discharge of human and animal faecal matter. Total ***Salmonella-Shigella*** ranged from

1.4×103 CFU/ml (W3) to 6.4×103 CFU/ml (W9) (Hariharan2007, Laws 1979 and Karunakaran 2008)

CONCLUSION:

Even though a lower level of treatment may be acceptable for discharges to coastal waters where there is rapid dilution and dispersion. The study was estimated through physico-chemical and biological parameters of the sewage samples which were collected at sewage disposal points along the coast of Visakhapatnam that are objectionable, and parameters of the sewage are minimized before it is being disposed off

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Table.1 Physico-chemical and biological characteristics of sewage samples at different sampling points.

S.No	Parameter	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11 (Control)
1)	Temperature ^{0} C	20	21	19.5	19.5	22	22	21.5	21	22.5	22.5	21.5
2)	pH	8.67	5.87	8.21	6.5	6.1	7.0	7.2	7.0	6.5	6.4	6.5
3)	Conductivity (µmhos/cm)	249.00	427.00	242	538.00	442	423	230	107	184	123	232
4)	Alkalinity (mg/l)	208	175	220	287	254	187	182	180	203	230	183
5)	Total Hardness(mg/l)	290	230	350	280	130	250	293	236	380	275	273
6)	Calcium Hardness(mg/l)	170	140	230	165	90	130	200	190	280	209	200
7)	Magnesium	120	70	80	82	55	100	87	56	93	75	65

	Hardness (mg/l)											
8)	Total solids (mg/l)	2400	2880	2500	2100	1997	1995	1200	1324	1365	1423	1225
9)	Total dissolved solids (mg/l)	1600	1960	1300	1354	1654	1595	750	754	760	835	792
10)	Total suspended solids (mg/l)	800	920	1200	850	875	774	700	712	645	600	426
11)	Sulphates (mg/l)	77.2	25.56	22.43	62.43	64.92	48.46	63.56	79.66	80.5	3.86	3.85
12)	Nitrates(mg/l)	0.2	5.13	3.5	0.3	0.2	0.36	3.3	1.73	3.73	0.9	0.45
13)	Phosphates (mg/l)	0.76	11.4	4.266	1.03	0.63	0.66	1.1	1.2	2.23	2.13	1.25
14)	Dissolved oxygen (mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1.5
15)	Biological oxygen demand (mg/l)	1520	960	1920	2054	1931	2154	1965	2265	1589	1635	102
16)	Chemical oxygen demand (mg/l)	1834	1154	2231	2349	2433	2354	2585	3265	2008	2163	124

17)	BOD/COD	0.828	0.831	0.860	0.874	0.793	0.915	0.760	0.693	0.791	0.755	0.87
18	Microbial count											
A)	Total Bacterial Count (CFU/ml)	6.1×10^5	4.8×10^4	6.8×10^5	5.2×10^4	5.3×10^5	6×10^5	4.8×10^5	3.9×10^5	5.5×10^5	4.5×10^4	52×10^2
B)	Total Coliform (CFU/ml)	9.6×10^4	1.6×10^4	10.6×10^4	1.9×10^4	9.3×10^4	8.8×10^4	8.6×10^4	8.2×10^4	5.4×10^4	1.2×10^4	14×10^2
C)	Total Salmonella-Shigella (CFU/ml)	4×10^3	5×10^3	1.4×10^3	5.4×10^3	3.5×10^3	3.8×10^3	5.1×10^3	4.6×10^3	6.4×10^3	3.5×10^3	4×10^2

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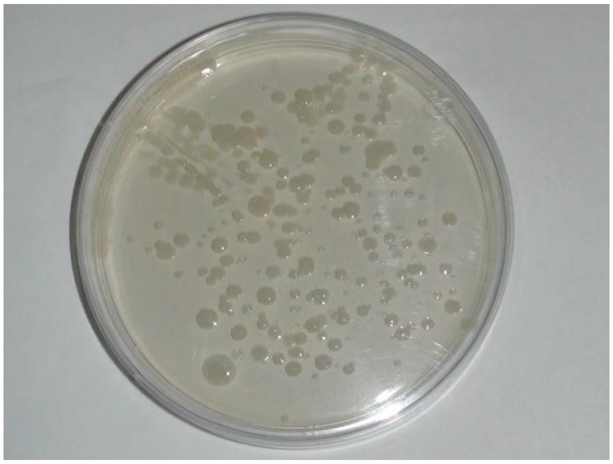

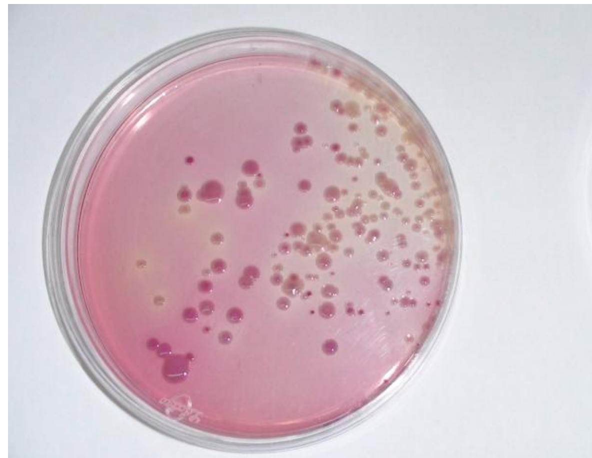

Plate Showing *Total Bacterial Count* **and** **Plate showing *Total Coli form***