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Sewage Quality Assessment of Various Places in Bilaspur City

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Abstract

The quantity, strength and type of sewage depends upon the population, Life style of people and the existence of different types of industries respectively and the amount of treatment required to be given to sewage depends very much upon the source of disposal. In Bilaspur the source of disposal of municipal as well as industrial waste water is Arpa River (Non perennial) which is known as life line of Bilaspur city. The climatic change has already turned the perennial Arpa River into non Perennial River and at this time the Urbanization, Industrial growth and improved standard of living of people of Bilaspur have increased the strength and quantity of sewage in recent years to a point where dilution alone can no longer be relied upon to prevent the undesirable effect of pollution. Hence it is absolutely necessary to study the characteristics and behavior of sewage, to ensure its safe disposal. This study will help us in determining the degree and type of treatment required to a given sewage according to its characteristics and thus to avoid the pollution of the source of its disposal i.e. Arpa river so that the adverse effect of pollution on human health, aquatic life, animals and plants can be eliminated. For the present study we have selected 4 places in Bilaspur City for collection of sewage hence Sample 1 was collected at Vasant Vihar S.E.C.L. Colony, The sample 2 was collected from M/S Narmada Drinks Pvt. Ltd. Sirgitti, The sample 3 was collected at Pachrighat drain. The sample 4 was collected from Nalla near Bannak Chowk Sirgitti. The Chemical tests namely Suspended Solids, Dissolved Solids, Chloride Content, Chemical Oxygen Demand and Physical tests namely pH value, Temperature, Threshold Odour Number (TON) had been performed and the tests results were compared with Indian standards permissible limits. Priority of this journal is to provide our important and valuable information to all people who show interest. The test results indicated that the Sample-1Vasant Vihar is less polluted, Sample-2 Narmada Drinks only requires neutralization of Chloride Content, Sample-3 Pachrighat was polluted and required treatment in summer season for reducing Solids whereas Sample-4 Bannak Nalla was highly polluted and required throughout treatment of higher degree. Out of the four samples the Sample-4 (Nalla near Bannak Chowk) was found to be most polluted sample in terms of Suspended solids, Chloride content, C.O.D., B.O.D. & T.O.N. and the drain containing this sample is being used by local public and is being discharged untreated into Arpa River. This Wastewater must be treated to prevent the Environment and the water bodies.

Keywords: *Water Quality, Water Purification, Wastewater Treatment, C.O.D., B.O.D., Odour Number.*

1. Introduction

When untreated sewage is discharged into some river stream, floating solids present in the discharged sewage may be washed up on to the shore, near the point of disposal, where they decompose and create foul smell and bad odour. The large amount of organic matter present in the discharged sewage also consume the dissolved oxygen from the river stream, causing fish kills and other undesirable effects. In addition to these effects, the discharged sewage will contaminate the river water with pathogenic* bacteria.

Hence, even though municipal sewage is 99.9% water, it requires treatment, if nuisance is to be avoided. The extent and type of treatment required, however, depends upon the character and quality of both sewage and source of disposal. For example, a small community at the seaside might discharge its untreated sewage directly into the ocean without any ill effects, but if the city were located inland on a small stream, a high degree of treatment might be needed, and which type of treatment will be needed will depend upon the chemical and physical characteristics of sewage

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In the olden times, the waste waters from a community were not so much contaminated as they are today. The urbanization, industrial growth, and the improved standards of living, have increased the strength and quantity of municipal sewage in recent years to a point where DILUTION alone can no longer be relied upon to prevent undesirable effects of pollution. In many cases, more advanced treatment of wastewater is essential to prevent undue pollution. This is much more so, when the disposed sewage is likely to contain industrial wastewaters.

Hence, it is absolutely necessary to study the characteristics and behavior of sewage, to ensure its safe disposal. This study will help us in determining the degree and type of treatment required to be given to a particular sewage, and thus to avoid the pollution of the source of its disposal.

1.1 Waste water Characterization

In order to dispose treated wastewater, we must have to consider the nature of the wastewater because the effluent quality depends upon the influent characteristics. The treatment capacity and treatment efficiency of treatment systems are calculated based upon the influent concentrations and the effluent requirements.

Efficiency = [(Cin - Cout)/Cin] 100
Where:
Cin = Influent concentration (typically mg/L)
Cout = Effluent concentration (typically mg/L)
And Efficiency is expressed as a percentage (%)

Also, the treatment capacity over time for biochemical processes is usually modeled as a first-order equation such that

Ct/C0 = e-kt
Where:
Ct = Concentration at time, t (typically in mg/L)
C0 = Initial concentration at time = 0 (typically in mg/L)
k = reaction rate constant (typically in days-1)
t = time (typically in days)

For the purposes of explaining the importance of wastewater characteristics here, the ideas that the wastewater strength (concentration of contaminants),availability of the contaminants as a food source, and the characteristic of being easily metabolized or being difficult to metabolize are all important factors to be considered for designing the treatment processes.

1.2 Chemical Characterization of Sewage

Tests conducted for determining the chemical characteristics of sewage help in indicating

The stage of sewage decomposition ;
Strength of sewage ;
Impact on Environment

Type of treatment required for making it safe to the point of disposal. Chemical analysis is therefore, carried out on sewage in order to determine its Chemical Characteristics. It includes TESTS for determining:

Total solids, suspended solids, and settle able solids;
pH value ;
Chloride Content ;
Nitrogen Content ;
Presence of Fats, Oil and Grease ;
Sulphides, Sulphates and H2S gas ;
Dissolved Oxygen ;
Chemical Oxygen Demand ;
Bio-chemical Oxygen Demand;

While the Physical Characterization involves following:

Tests :
Temperature
Odour
Turbidity
Color

1.3 Various Applications of Treated Waste Effluent

The different sustainable ways of disposing the treated wastewater are discussed below.

1.3.1 Application on Land for Ground Water Recharge

Recharge of groundwater is one of the ways of reusing wastewater particularly since the groundwater table tends to lower. A crack-free, 3m thick soil layer above groundwater is sufficient to prevent organic pollution. Pollution by mineral deposition is far more frequent, as salts like nitrate and phosphate being soluble in water cannot be removed by physical filtration when passing through soil or sand layers.

1.3.2 Application on Land for Irrigation

Treated wastewater, if handled properly, can be of high value as it contains several nutrients and is a vital source of fertilizer, hence Treated domestic wastewater is ideal for irrigating community parks, flower beds in gardens and other farm lands/agricultural areas. For an irrigation rate of 2m per year (20,000 cum/ha) which is commonly required for Hyderabad (semi-arid areas), even well-treated wastewater with concentrations as 15 mg/l of total nitrogen and 3 mg/l total phosphorous provides 300 kg N and 60 kg/hectare via irrigation without additional cost; at the same time the same amount of groundwater is saved.

1.3.3 Discharge into Lakes/Ponds/Water Bodies

Wastewater is full of nutrients, which can directly be used by algae, water plants and lower animals, which then could become fish feed. Hyderabad is famous for its beautiful lakes. In all, there were more than 150 lakes in Hyderabad Metropolitan Area. But due to the development most of the lakes disappeared. In the Draft Master Plan for 2020, it is proposed to increase the area of water bodies to 95.44 sq. km. from the existing 84.3 sq. km. One way of achieving this is by channeling all our treated water, storm water etc into the closest lake in the vicinity.

1.3.4 Use of Treated Waste Water for Construction Activities

Water if treated up to the required standards can effectively be used for construction purposes. However, it is the general perception noticed among the architects, builders, engineers and other construction companies that the recycled water cannot be used for construction activities viz., mixing, curing, etc due to its hardness and recommend only fresh (soft) water for these purposes. (Cement is mainly composed of tri-calcium silicate, di-calcium silicate, tri-calcium aluminate and tetra-calcium alumina -ferrite formed at a very high temperature in rotary kiln. Some additives such as calcium sulphate are added to impart special properties to it. Hence water with hardness in tune of 400 mg/L can be used as calcium carbonate is used for curing the cement). Hence all construction activities use bore water

(ground water) for this purpose, which is causing severe stress on ground water levels. Bureau of Indian Standards (BIS) have outlined a code for construction water quality (IS 456:2000).

2. Methodology

2.1 Importance of Tests

2.1.1. Total Solids, Suspended Solids

Sewage generally contain very small amount of solids in relation to the huge quantity of water (99.9%). As a general rule, the presence of inorganic solids in sewage is not harmful. They require only mechanical appliances for their removal in the treatment plant. On the other hand, suspended and dissolved organic solids are responsible for creating nuisance, if disposed of untreated. The amount of various kinds of Solids helps in determining the Strength of Sewage as follows:

Table 1 - Strength of Sewage for Samples

Types of Solid	Strength of Sewage		
	Weak	Weak	Weak
Total Solids	400	400	400
Suspended Solids			
1. Total	100	100	100
2. Volatile	75	75	75
Settleable Solids	2.5	2.5	2.5
Fats, Oil and Grease	6	6	6

2.1.2. pH Value

The determination of pH value of sewage is important because of the fact that efficiency of certain treatment methods depends upon the availability of a suitable pH value. The ph value can be measured quickly and automatically with the help of the potentiometer. The fresh sewage is generally alkaline in nature with ph more than 7 but as time passes, its pH tends to fall due to production of acid by bacterial action in an aerobic or nitrification processes. The pH however rises upon the treatment of sewage.

2.1.3. Chloride Contents

Chlorides are generally found present in municipal sewage and derive from the kitchen wastes, human feces and urinary discharges etc. The normal chloride content of domestic sewage is 120mg/l whereas, the permissible chloride content for water supplies is 250mg/l.Hence the chloride content of a given sewage is found to be high, it indicates the presence of industrial wastes or infiltration of sea water, there by indicating the strength of sewage.

2.1.4. Nitrogen Contents

The presence of nitrogen in sewage indicates the presence of organic matter, and may occur in one or more of the following forms:

Free ammonia
Albuminoidal
Nitrogen
Nitrites
Nitrates

The amount of free ammonia present in sewage can be easily measured by simply boiling the sewage, and measuring the ammonia gas which is consequently liberated. The amount of nitrites or nitrate presents in sewage sample can be measured by color matching methods.

2.1.5. Presence of Fats, Oils and Greases

Greases, fats and oils are derived in sewage from the discharges of animals and vegetable matter, or from the industries like garages, kitchens of hotel and restaurants, etc. Such matter from the scum on the top of the sedimentation tanks and clog the voids of the filtering media. They thus interfere with the normal treatment methods and hence need proper detection and removal.

2.1.6. Sulphides, Sulphates and Hydrogen Sulphide Gas

Sulphides and Sulphates are formed due to the decomposition of various sulphur containing substances present in sewage. This decomposition also leads to evolution of hydrogen sulphide gas, causing bad smells and odors, besides causing corrosion of concrete sewer pipes.The quantity of Hydrogen sulphide gas in raw sewage is below 1ppm, obnoxious odors are not felt.

2.1.7. Dissolved Oxygen

The determination of dissolved oxygen present in sewage is very important, because while discharging the treated sewage into some river stream, it is necessary to ensure at least 4ppm of DO in it, as otherwise, fish are likely to be killed, creating nuisance near the vicinity of disposal. The DO test performed on sewage before treatment, helps in indicating the condition of sewage. It is well known that only very fresh sewage contains some dissolved oxygen, which is soon depleted by aerobic decomposition. Also, the dissolved oxygen in fresh sewage depends upon temperature. If the temperature of sewage is more the DO content will be less. The solubility of oxygen in sewage is 95% of that in distilled water.

2.1.8. Chemical Oxygen Demand

The oxygen required to oxidize the organic matter present in a given waste water can be theoretically computed, if the organics present in waste water are known. The COD of a raw water or a waste water is, therefore, determined by performing a laboratory test on the given water with a strong oxidant like dichromate solution.

2.1.9. Bio Chemical Oxygen Demand

The organic matter, in fact is of two types that is which is biologically oxidized is called biologically active and that which cannot be oxidized biologically is called biologically inactive. While testing a waste water, we are interested in finding out the amount of biologically active organic matter present in it, whereas the COD test give us the total of biologically active as well as biologically inactive organic matter. Hence, further testing is carried out to determine the BOD of sewage, which directly gives us the amount of biologically active organic matter present in sewage. If sufficient oxygen is available in waste water, the useful aerobic bacteria will flourish and cause the aerobic biological decomposition if waste water, which will continue until oxidation is complicated. The amount of oxygen consumed in this process is the BOD.

Polluted waters will continue to absorb oxygen for many months, and it is not practically feasible to determine this ultimate oxygen demand. Hence, the BOD of water during 5 days 20°C is generally taken as the standard demand, and is about 68% of the total demand. A 10day BOD is about 90% of the total.

3. Sample Collection

3.1 Places of Collection of Samples

3.1.1 Sample Number 1. Vasant Vihar Colony

The sample is taken from the inlet of the Waste effluent treatment plant of Vasant Vihar which is a residential colony of S.E.C.L. BILASPUR employees. The waste water drains out from this colony is treated at D.E.T.P. (DOMESTIC EFFLUENT TREATMENT PLANT) which is situated in Vasant Vihar Colony. The waste water contains Domestic waste only as it is a residential colony and no other industry is discharging their Waste Effluent into the drain of Vasant Vihar. The treated waste water from DETP plant discharges its effluent at Pachrighat through its drains.

3.1.2 Sample Number 2. M/S Narmada Drinks Pvt. Ltd. I/A Sirgitti

M/S Narmada drinks Pvt. Ltd. Is a cold drink industry situated in Sirgitti near Bannak Chowk in Bilaspur. The purpose of testing its waste effluent is to know how much pollution it is giving to the local environment besides the production of cold drinks The discharge effluent of this industry is free from Odour and Color but may be contaminated with certain harmful ingredients like Nitrogen and other harmful compounds.

3.1.3 Sample Number 3. Pachrighat (Arpa river basin) Sanichari Rapta

Pachrighat is situated near Sanichari Rapta (Arpa river) , Golbazar market in Bilaspur. It is a discharging point of Municipal Sewer Drains which runs in Bilaspur. This drain includes domestic as well as industrial wastes as it crosses Nehru Nagar, Vhrihaspati market, Golbazar market, SIMS, and other landmarks of Bilaspur. Hence this is the reason that the Waste Water draining from this must contain both the Industrial and Domestic wastes. The local people over there are using Arpa River for their domestic uses like bathing and watering of vegetations. The place from where they use water from River is very closer to the point of disposal.

3.1.4 Sample Number 4. Bannak Nalla, Bannak Chowk Sirgitti

Sirgitti is a well known industrial area of Bilaspur district; here various industries like M/S Narmada Drinks Pvt. Ltd., Om Oils, Golchha Oxides, Vandana Power Plant and many other industries are situated. These industries are discharging their treated waste effluent into a small stream flowing nearby. The local public uses that stream for their domestic purpose. The purpose of sampling this stream is to study the ingredient s present in mixed industrial sewage, The degree of treatment given by the industries the effect of wastewater on Environment & treatment required for the sewage disposed by above mentioned industries.

3.2 Physical Characteristics of Samples

The samples are collected in Winter Season between nov-2011 to jan-2012 and the physical as well as the Chemical Characterization test results is subjected to seasonal variation. However at the time of sampling the samples are found with the following Physical Characteristics.

Table 2 - Types of Solids

Sample No.	Name of sample	S1	S2	S3 = S1- S2
1	Vasant Vihar	1770	1080	690
2	Narmada Drinks	1268	60	1208
3	Pachrighat	2110	1280	830
4	Bannak Nalla	2440	1320	1120

Analysis of solids (Unit mg/liter)

Here:-

S1 = total solids present in sample got by evaporating 100ml of sample and then weighting the dry residual left.
S2 = total filterable or suspended solids present in sample got by filtering it through filter paper and then weighting the dry residual left on filter paper.

S3 = total amount of dissolved solids present in sample got simply by subtracting total solids S1 from total suspended solids present in that sample.

Note: the total amount of solids present in sewage depends upon season for rainy season the contamination per liter will be less and vice versa for summer season.

Table 3 – Test for Chloride Content

S.NO.	Volume of AgNO3	Titrate Volume of AgNO3 for samples(V2)			
	Initial Volume	Vasant Vihar	Narmada Drinks	Pachrighat	Bannak Nalla
1	50	18.2	26.4	19.9	27.1
2	50	18.2	26.1	19.7	27.1
3	50	18.0	26.4	19.9	27.3
Final volume	-	18.2	26.4	19.9	25.9

Formula for Calculation of Chloride Content: N1V1=N2V2
Where
N1=normality of sample,
N2= blank corrected normality of AgNO3
V1=volume of sample taken,
V2= titrate volume of AgNO3 Hence
N1=N2V2/V1
Now strength of chloride = normality of sample (N1) X Eq. wt. of Cl-(35.45 grams/litre)
Volume of sample taken (V1) =50ml. for each.

Table 4 - Chloride Content for Samples

S.NO.	Name of sample	Normality of sample N1=N2V2/V1	Cl- Content (in mg/liter)	Eq. Wt. of Cl-
1	Vasant Vihar	(0.048 X 18.2)/ 50= 0.01747	619.38	35450mg/lit
2	Narmada	(0.048 X 26.4)/ 50=	898.44	35450mg/lit

	Drinks	0.02534		
3	Pachrighat	(0.048 X 19.9)/ 50= 0.01910	677.24	35450mg/lit
4	Barnak Nalla	(0.048 X 27.1)/ 50= 0.0260	922.27	35450mg/lit

3.2.3 Calculation of C.O.D.

Volume of Fe(NH4)2SO4.6H2O in blank sample V1 = 11.2 ml

Table 5 - C.O.D. for Samples

Sample NO.	Name of sample	Volume of sample taken X (ml.)	Titrate Volume of Fe(NH4)2SO4.6 H2O V2 (ml.)	C.O.D. of Sample (mg/lit)
1	Vasant Vihar	20	10.2	98
2	Narmada Drinks	20	10.1	107.8
3	Pachrighat	20	9.2	196
4	Barnak Nalla	2	9.9	1274

Here: V_1– Volume of the $Fe(NH_4)2SO_4.6H_2O$ run down in the blank experiment

V_2– Volume of the $Fe(NH_4)2SO_4.6H_2O$ run down in the test experiment of sample

X – Volume of test sample taken

N–Normality of $Fe(NH_4)2SO_4.6H_2O$ solution i.e. 0.245

Obtained Value of C.O.D. of Samples:

3.2.4 Calculation of B.O.D.

The B.O.D. of a sewage sample can be estimated with the help of B.O.D. /C.O.D. ratio. Since the BOD5 is measured which is about 68% of BODu , we can easily state that BOD5/COD ratio should, for fully-biodegradable waste water vary between 0.92 x 0.68 = 0.63 to 1.0 x 0.68 =0.68. Any waste water having its BOD/COD ratio more than 0.63, can hence, be considered to be quite amenable to biological treatment, since it does not contain non-biodegradable organics. So here for our project purpose to predict the BOD5 it will be convenient to take BOD/COD ratio as 0.58 because samples are contaminated with some amount of fixed solids also.

B.O.D. Estimation of Samples

Table-6 B.O.D. for Samples

Sample Name	Vasant Vihar	Narmada Drinks	Pachrihat	Bannak Nalla
B.O.D.	65.84	62.52	113.68	738.92

3.2.5 Calculation of TON (THRESHOLD ODOUR NUMBER)

Table-7 TON for Samples

Sample No.	Name of Sample	Vs (in ml.)	VD (in ml.)	TON
1	Vasant Vihar	20	86	5.3
2	Narmada Drinks	20	0	0
3	Pachrighat	20	99	5.95
4	Bannak Nalla	20	970	49.5

Vs = volume of the sewage sample

V_D = volume of the distilled water added to the sewage sample just to make it odourless

TON= the extent of dilution required to just make the sample free of odour. it is given by the formula TON= $(Vs + V_D)/ Vs$

4. RESULTS

IS:2490- Tolerance Limits For Industrial Effluent Discharge Into Inland Surface Water.

IS: 3306 - Tolerance Limits For Industrial Effluents Discharge Into Public Sewer Discharge.

IS: 3307 - Tolerance Limits For Various Polluting Constituents Of Waste-Water Effluent For Their Discharge On Land For Irrigation.

Table-8 Standard Limits for Various Tests

Name of Test	Standard Limits IS: 2490	IS: 3306	IS: 3307
Suspended Solids (mg/lit)	100	600	200
Dissolved Solids (mg/lit)	2100	2100	2100
Chloride Content (mg/lit)	1000	1000	600
C.O.D. (mg/lit)	250	-	-
B.O.D. (mg/lit)	30	350	100
pH value (pH meter)	5.5-9	5.5-9	5.5-9
Temperature (oC)	40	45	-
TON Threshold odour number	-	-	-

Table 9: Test Result for Subject

Name of Test	Vasant Vihar Sample 1	Narmada Drinks Sample 2	Pachri Ghat Sample 3	Bannak Nalla Sample 4
Suspended Solids (mg/lit)	1080.0	60.0	1280.0	1320.0
Dissolved Solids (mg/lit)	690.0	1208.0	830.0	1420.0
Chloride Content (mg/lit)	619.38	898.44	677.24	922.27
C.O.D. (mg/lit)	98	107.8	196	1274
B.O.D. (mg/lit)	56.84	62.52	113.68	738.92
pH value (pH meter)	5	8.5	5	8
Temperature (oC)	28	27	27	28
TON Threshold odour number	5.3	0	5.95	49.5

5. Conclusion

In Present Study, the sewage sample of four places namely 1. Vasant Vihar, 2. Narmada drinks, 3. Pachrighat and 4. Bannak Nalla had been tested and the test results were compared with the B.I.S. standards. The following results were obtained:- The Suspended Solids (in mg/liter) of samples were found to be 1080, 60, 1280 and 1320 for Vasant Vihar, Narmada drinks, Pachrighat and Bannak Nalla respectively. The Dissolved Solids (in mg/liter) of samples were found to be 690, 1208, 830 and 1120 for Vasant Vihar, Narmada drinks, Pachrighat and Bannak Nalla respectively.

The Chloride Content (in mg/liter) of samples were found to be 619.38, 898.44, 677.24 and 922.27 for Vasant Vihar, Narmada drinks, Pachrighat and Bannak Nalla respectively. The C.O.D. (in mg/liter) of samples were found to be 98, 107.8, 196 and 1274 respectively for Vasant Vihar, Narmada drinks, Pachrighat and Bannak Nalla. The B.O.D. (in mg/liter) of samples were found to be 56.84, 62.52, 113.68 and 738.92 respectively for Vasant Vihar, Narmada drinks, Pachrighat and Bannak Nalla. The pH Value of samples were found to be 5, 8.5, 5 and 8 pH unit respectively for Vasant Vihar, Narmada drinks, Pachrighat and Bannak Nalla.

The T.O.N. (Threshold Odour Number) of samples were found to be 5.3, 0, 5.95 and 49.5 for Vasant Vihar, Narmada drinks, Pachrighat and Bannak Nalla respectively. Thus on the basis of test results and its comparison with the Indian Standards of different categories it can be concluded that among the four samples of wastewater the “Bannak Nalla” is the most polluted stream (carrying Industrial waste of various industries situated nearby in Sirgitti) and discharging wastewater into the Arpa river near Masturi area, and requires advanced treatment.

The Emphasis must be given to make it safe for disposal into Arpa River and should be carried through sewerage system to prevent the Environment. While in case of Municipal wastewater which is discharged into Arpa river near Sanichari Rapta i.e. Vasant Vihar and Pachrighat, Both are not highly contaminated and can be used for Sewage Farming or on land for irrigation after primary treatment, But the wastewater will require emphasis on treatment in summer season.

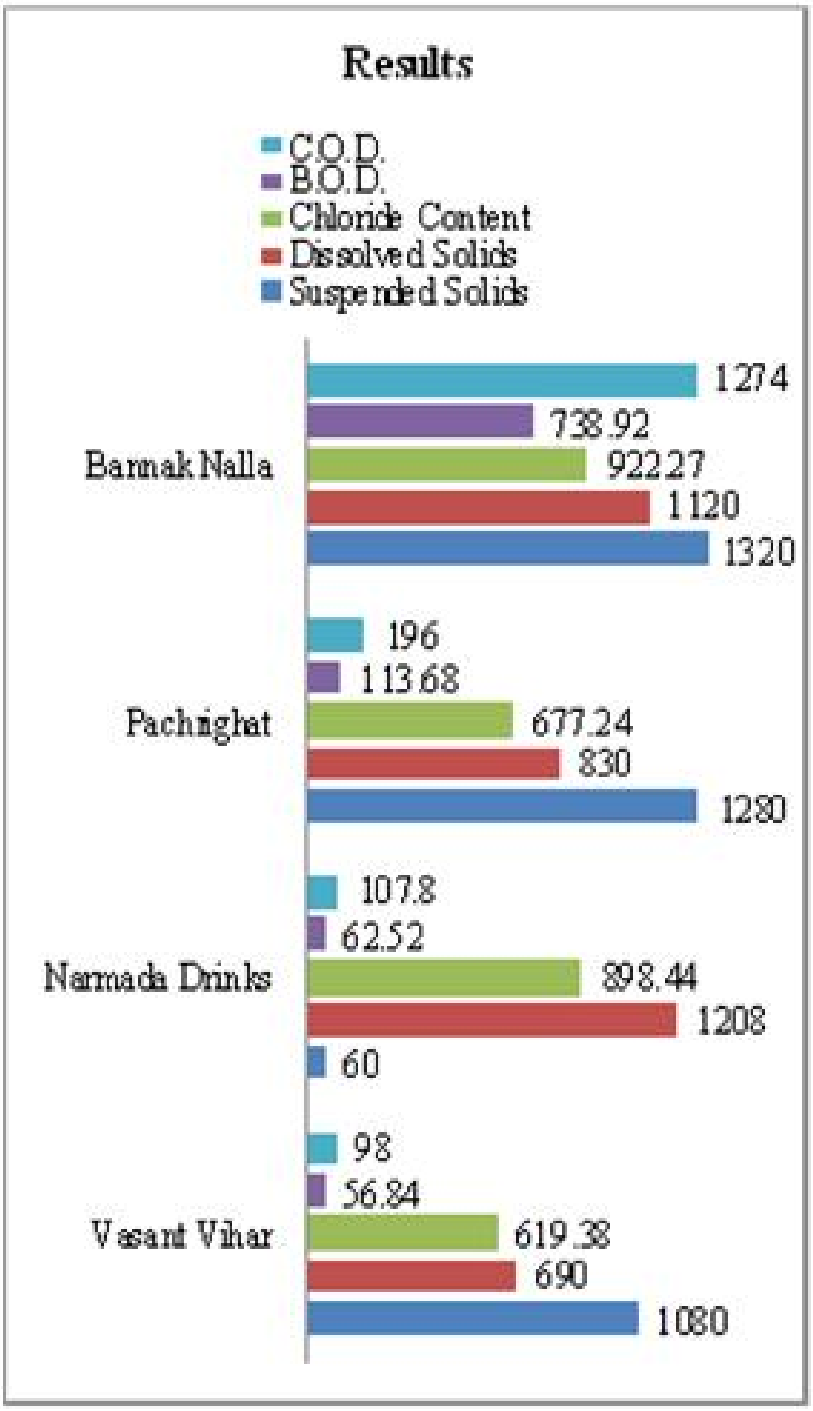

Fig. 1. Graphical Representation of Results

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