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Waste water treatment by up flow anaerobic sludge blanket technology

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Abstract

The water quality monitoring is necessary for the management of river pollution in urban areas .The Khan River is main water body of urban area of Indore city in M.P., which is affected by river Saraswati, Pipllykhan Nala and Palasia Nala that are of 300mm to 1600mm dial. The total length of sewer line is 47km this was laid by I.D.A. under O.D.A. project. A main sewer line of 1200mm dial, which is passing through Indore city up to Kabit Khedi sewage treatment plant. The capacity of plant is 78MLD (in 2012). In this study, the treatment of waste water by up flow anaerobic sludge blanket technology (UASB) to examine the different analytical parameters of waste water like PH value, TSS, BOD and COD. For this purpose physico-chemical and biological methods are used due to minimum temperature of waste water was 23^{0}C, PH–6.0 – 8.5, TSS- 400 + 100 mg/lit, BOD-<200 + 25mg/lit and COD - < 360+50mg/lit etc. Results of the sample water and treated water obtained from the UASB technique have been compared with results of the M.P. Pollution Control Board Report. UASB based 78 MLD follows a complex microorganism to convert organic compounds into Methane and Carbon dioxide.

Keywords: UASB, BOD, water quality monitoring, complex microorganism, COD.

Introduction

For controlling of water pollution, continues water quality monitoring is must due to the rapid industrialization, anthropogenic activities and land use. The impact of river pollution on human health, aquatic ecosystem and other living beings in a biota[1,2]. Water is the most precious gift of nature and most vital for sustenance of life next to air. The earth is also called a "watery planet' and the very existence of life on this planet is because of presence of water. Of the total volume of 1,385 million Km^3 of water in the planet earth 96.5% is salt water (ocean), the fresh water is mostly ice (24 million Km^3) and deeply seated ground water (23.4 million Km^3). Fresh water available as annual stream flow is 46,768Km^3 which is 0.00034% of the total water. Water influences economical, agriculture and industrial growth of any country[3]. The generation of sewage and waste water containing agrochemicals, certain pesticides and surfactants, petrochemicals. Hydrocarbons, heavy metals and radionuclide's are some important examples which are responsible for the origin of waste water[4]. From last many years UASB process are used for the treatment of waste water[5]. In this process anaerobic digestion of waste material is occurred with great releasing of methane gas which is useful as an energy source but also it is a greenhouse gas[6,7].

Indore city has separate sewage system. The sewer lines are laid along the bank of River Khan, Saraswati, and Pipliyakhan Nala and Palasia Nala. It is situated between 22.2 to 23.05 north latitudes and 75.25 to 76.16C east latitudes separate sewage system. The main objective of this plan or treatment method is to identify the present status of waste water treatment in Indore city and to examine the different analytical parameters of waste water[8].

Khan River is tributary of holy river Kshipra. The Khan River flows further 55km northwards side and joins to the river Kshipra at "Triveni Sangam" at Ujjain. Kshipra is one of the main sources of water supply of Ujjain urban and rural areas and has importance of historical as well as holy festivals[9].

Materials and methods

Anaerobic process is completed by the "UASB" technique[10].

Anaerobic digestion in an UASB reactor has four phases: i. Hydrolysis: In this phase formation of fewer complexes, lighter materials (amino acids, sugars, alcohols etc.). By excreted enzymes of fermentative bacteria by heavy, undissolved material (proteins, carbohydrates, fats)[11]. ii. Acidogenesis: In this phase formation of simple compounds (volatile fatty acids, alcohols, lactic acid CO_2, H_2, H_3, H_2S) and new cell material by dissolved compounds[12]. iii. Acetogenesis: In this phase formation of acetate, H_2, CO_2 and new cell material by digestion products. iv. Methanogenesis: In this phase formation of CH_4, CO_2 and new cell material by acetate, hydrogen plus carbonate, format[13].

Sample Sewage Characteristics: Sample water were collected in February to October month, 2012 (01/02/2012 to 15/04/2012) from the Khan River of Indore city, India. Raw sewage characteristics were as follows:

Minimum waste water temperature	23^0C
pH	6.0- 8.5
Suspended Solids, less than	400+ 100mg/lit
BOD, less than	200 +25mg/lit
COD, less than	360 + 50mg/lit
Total Kjedahl's Nitrogen	3 mg/lit
Sulphates	40 + 20mg/lit
Faecal Coliform Count	4.0 x 10^5 MPN/100 ml

Treatment Process: Physico-chemical and biological treatments are used to remove impurities from raw water. In order to achieve different levels of contaminants removal, individual sewage water treatment procedures are classified as primary, secondary and tertiary waste water treatment[14,15].

The following physico–chemical parameters of the spent wash were analyzed using standard methods and are as follow.

Temperature: Due to biological activity of bacteria, sewage temperature is slightly higher than normal water. Its range is 20 to 25^0 C which an ideal value of temperature for the biological activity[16].

pH Value: It may be acidic or basic ,when formation of acid and sewage becomes relatively stable after the oxidation process respectively. This value useful for the determination of quantity of coagulants[17].

Alkalinity: Usually, water shows alkalinity due to presence of salts of weak acids and strong bases like carbonates, bicarbonates and hydroxides i.e. alkalinity is a measure of a waste water's capacity to neutralize.

Total Suspended Solids: It includes all suspended particles in water which not pass through a filter. These are present in sewage waste water and industrial waste water[18,19].

Chemical Oxygen Demand (COD): It is a measure the amount of oxygen required for oxidation of organic compounds which are present in water by means of chemical reactions, involving oxidizing substances like K2Cr2 O_7 and $KMnO_4$.

Biological Oxygen Demand (BOD): It can be defined as oxygen required for micro-organism to stabilize biologically decomposable organic matter in sewage water under aerobic conditions. It is measurement of the amount of biochemically degradable organic matter, greater the amount of oxygen required to degrade it biologically, hence more the BOD[20,21].

Process for determination of BOD: i. 5 liters of distilled water were treated by bubbling compressed air for 1-2 days to attained dissolved oxygen saturation. ii. Now added 5ml of phosphate buffer $MgSO_4$, $CaCl_2$ and $FeCl_3$ for each liter of diluted water and shaked well. iii. Added 2 ml of settled sewage. Then 1 ml and 0.5 ml of the carefully mixed sample were added in different bottles. iv. One bottle was kept for determination of initial Dissolved Oxygen (DO) and other bottles were kept in the incubator for 5 days maintained at 20^0C.
Calculation: Dissolved Oxygen of the sample at the start of experiment (D_1), Dissolved Oxygen of the sample after 5 days (D_2)[22,23].

BOD mg/lit = ($D_1 - D_2$).

Process of determination of COD: Standard dichromate oxidation method 20 ml of sample is taken in a flask of the reflux unit along with 10 ml off $K_2Cr_2O_7$, pinch of Ag_2SO_4 and $HgSO_4$. The flask is attached to the condenser and heated on a hot water bath for about 2.3 hrs to reflux the contents. Now this flask was cooled and the contents were diluted by 100 ml distilled water now few drops ferroin indicator solution were added and then the contents were titrated against ferrous ammonium sulphate solution. At the time of completion of reaction i.e. end point, the color of the contents to reddish blue[24].
Calculation: COD= 8000 (B-S) N/ Sample volume (ml).

Where: B= Used Volume of FAS in the blank sample, S=Used Volume of FAS in the original sample, N= FAS Normality.

Process for determination of Alkalinity: i. Taken 100 ml of sample in a conical flask. ii. Added 2 drops of phenolphthalein, iii. Solution remained colorless, phenolphthalein alkalinity was absent (PA= 0) and the total alkalinity was determined. If the color change to pink titrates it with 0.1N HCl unit color diapered at end point. This is the phenolphthalein alkalinity (PA). iv. Titrated against with 0.1 N HCl and point in color changed from yellow to pink. v. This was total alkalinity (TA)[25].
Calculation: PA (milligram/L) = A X Normality X1000X50/Volume of Sample (ml), TA (milligram/L) = B X Normality X 1000 X 50 /Volume of Sample (ml).

Where: A= Volume of HCl used with only phenolphthalein, B = Total volume of HCl used with only phenolphthalein and methyl orange, N= Normality of HCl.

Process for determination of Total Suspended Solid (TSS): i. Taken a known amount of sample (in ml/gm) in pre weighted dish (a gm), ii. Dryed in an oven at 105^0C (till constant weight), iii. Cooled in desiccators, iv. weighted the dish again (b gm), v. Calculated total solids by formula[26].

Calculation: Total Solid (gm/lit or gm/Kg) = (b-a) X 1000 / Quantity of sample (gm /ml)[27].

Results and discussion

The following results obtained from the present examination of different physico–chemical viz color, pH, Alkalinity, COD, BOD and TSS in the different tables from 1 to 5 and Figures, the flow rate of raw water, treated water parameter were analyzed during Feb-2012 to April -2012[28,29].

Table-1: pH value of Sample Water, Treated Water of Indore City.

Sampling Week	Sample Water	Treated Water
Week I	1.652	1.717
	2.71	2.798
Week II	1.73	1.776
	2.745	2.767
Week III	1.723	1.78
	2.745	2.745
Week IV	1.803	1.765
	2.845	2.744
Week V	1.852	1.763
	2.85	2.723

Table-2: Biological Oxygen Demand (BOD) observed in Sample Water, Treated Water of Indore City.

Sampling Week	Sample Water (mg/l)	Treated Water (mg/l)
Week I	1.109	1.28
	2.89	2.29
Week II	1.110	1.30
	2.107	2.29
Week III	1.98	1.27
	2.105	2.25
Week IV	1.100	1.30
	2.101	2.29
Week V	1.104	1.27
	2.106	2.32

Table-3: Chemical Oxygen Demand (COD) observed in Sample Water, Treated Water of Indore City:

Sampling Week	Sample Water (mg/l)	Treated Water (mg/l)
Week I	1.250	1.101
	2.265	2.104
Week II	1.360	1.110
	2.260	2.103
Week III	1.275	1.105
	2.299	2.106
Week IV	1.265	1.101
	2.290	2.105
Week V	1.248	1.90
	2.236	2.102

Table-4: Alkalinity of Sample Water, Treated Water of Indore City.

Sampling Week	Sample Water (mg/l)	Treated Water (mg/l)
Week I	1.390	1.315
	2.395	2.320
Week II	1.398	1.330
	2.410	2.300
Week III	1.400	1.340
	2.402	2.348
Week IV	1.410	1.332
	2.420	2.333
Week V	1.414	1.345
	2.430	2.348

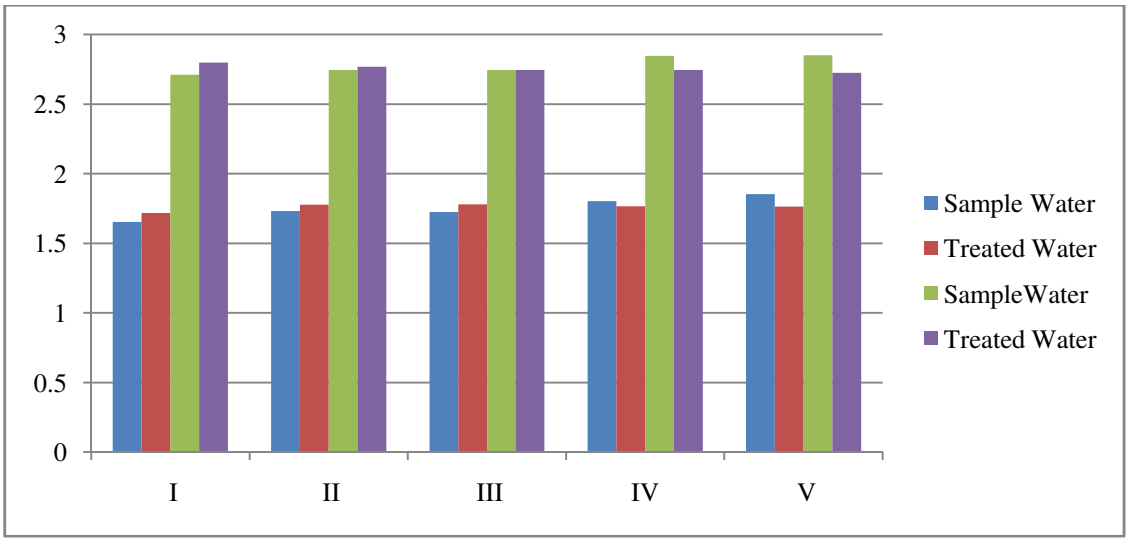

Figure-1: pH of Sample Water, Treated Water.

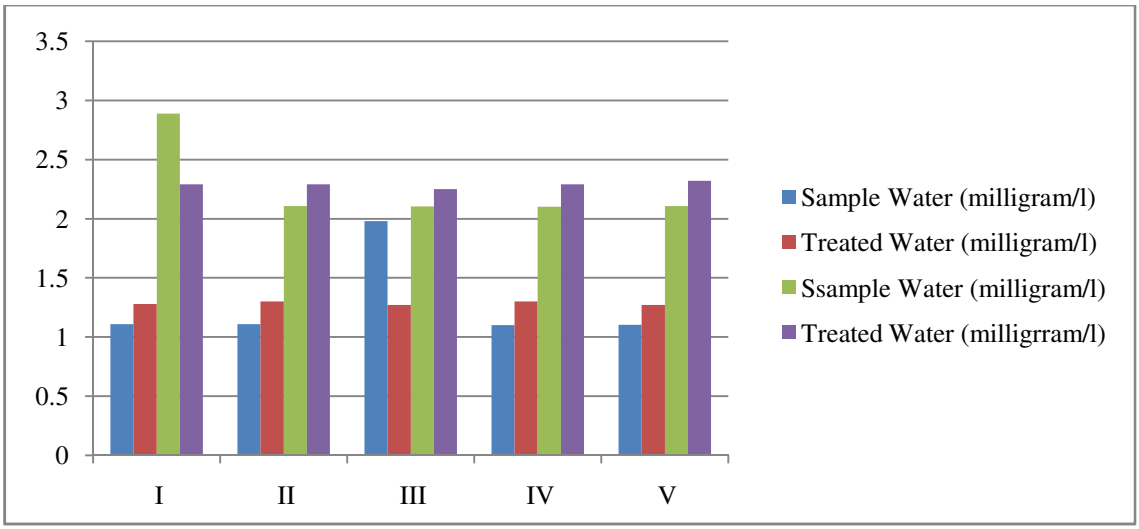

Figure-2: Biological Oxygen Demand (BOD) observed in Raw Water, Treated Water.

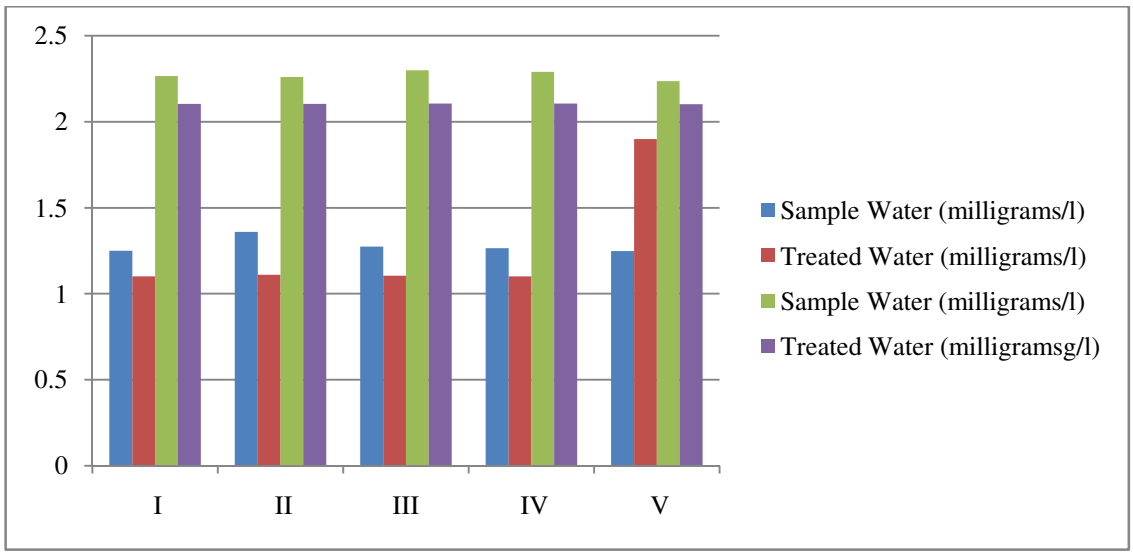

Figure-3: Chemical Oxygen Demand (COD) observed in Raw Water, Treated Water.

Table-5: Total Suspended Solid (TSS) of Sample Water, Treated Water of Indore City.

Sampling Week	Sample Water (mg/l)	Treated Water (mg/l)
Week I	1.145	1.45
	2.152	2.42
Week II	1.138	1.45
	2.128	2.48
Week III	1.150	1.46
	2.140	2.42
Week IV	1.112	1.40
	2.120	2.44
Week V	1.162	1.50
	2.142	2.42

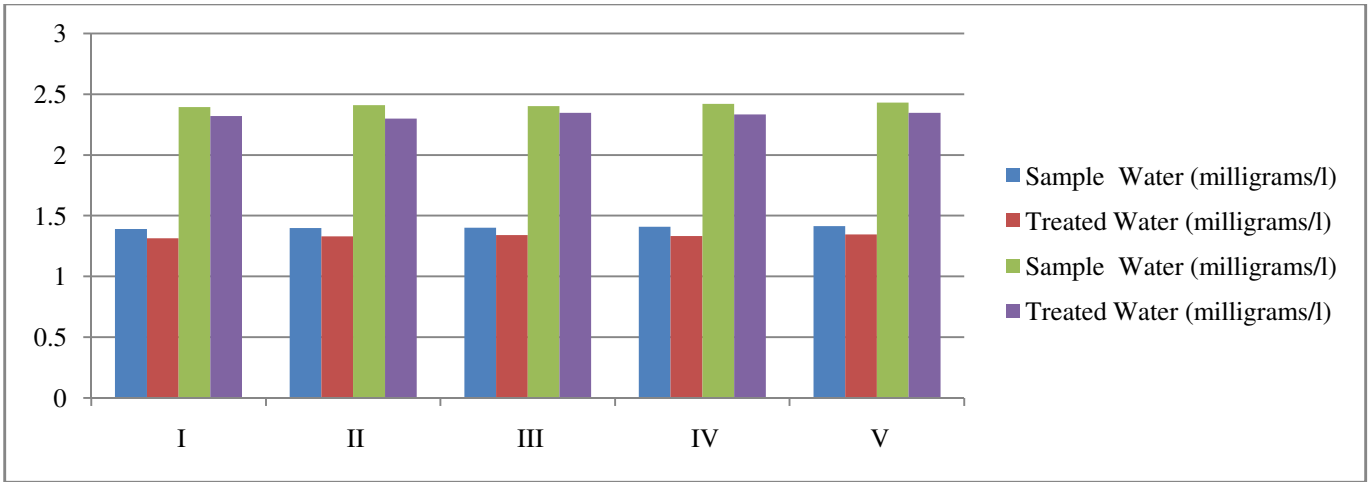

Figure-4: Alkalinity of Raw Water, Treated Water.

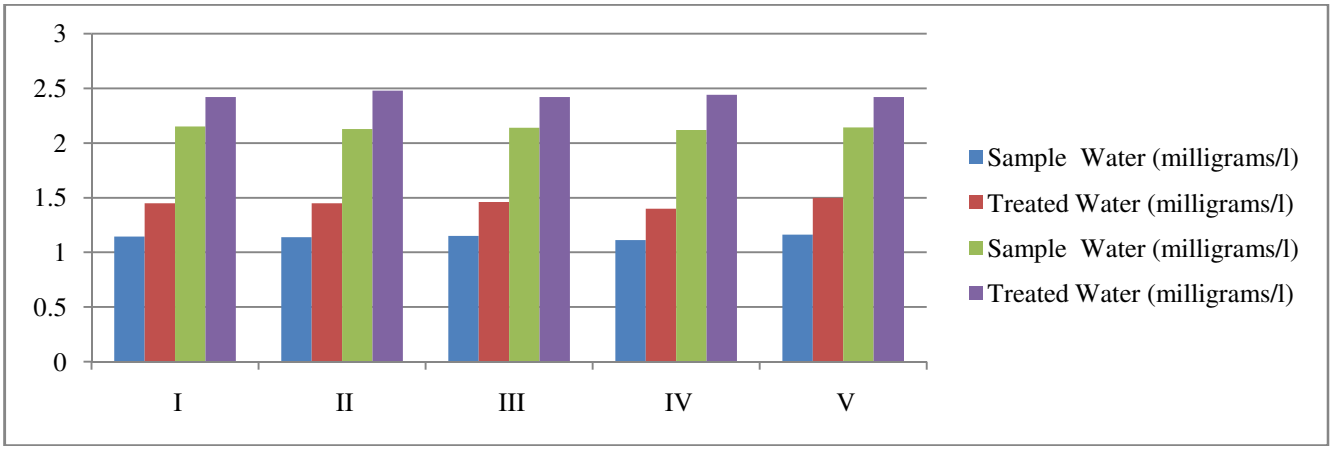

Figure-5: Total Suspended Solid (TSS) of Raw Water, Treated Water.

Table-6: M.P. Pollution Control Board Report of Indore City.

Water Analysis Parameters	Raw Water	Treated Water
pH	7.38	7.63
BOD	170 mg/lit	40 mg/lit
COD	280 mg/lit	90 mg/lit
Alkalinity	450 mg/lit	120 mg/lit
TSS	158 mg/lit	48 mgt/lit

Table-7: Comparison of 78 MLD (UASB) STP Lab Report with M.P. Pollution Control Board Report of Indore City.

Water Analysis Parameter	Comparison of 78 MLD (UASB) STP Lab Report		M.P. Pollution Control Board Analysis Report	
	Sample Water	Treated Water	Sample Water	Treated Water
pH	6.00 to 8.52		7.38	7.63
BOD	89 milligram/lit to 109 milligram/lit	25 milligram/lit to 30 milligram/lit	170 milligram/lit	40 milligram /lit
COD	236 milligram/lit to 290 milligram/lit	90 milligram/lit to 110 milligram/lit	280 milligram/lit	90 milligram/lit
Alkalinity	390 milligram/lit to 430 milligram/lit	300 milligram/lit to 350 milligram /lit	450 milligram/lit	120 milligram/lit
TSS	112 milligram/lit to 162 milligram/lit	40 milligram/lit to 50 milligram/lit	158 milligram/lit	48 milligram /lit

Conclusion

The expectation that anaerobic technology and more specifically the UASB concept would contribute to a cost–effective and efficient solution of environment problems in tropical climates has only been reinforced by the experience of the full scale in 78 MLD at Kabit Khedi Indore, in spite of some initial problems. i. UASB based 78MLD at Kabit Khedi Indore follows a complex of microorganism to convert organic compounds into Methane and Carbon dioxide. It is a stbilize process reducing odor, pathogen and mass reduction. ii. UASB based STP produced an effluent that is being used for unrestricted irrigation.

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