*International Research Journal of Environment Sciences*_____E-ISSN 2319–1414
Vol. **5(2),** 12-18, February **(2016)** *Int. Res. J. Environment Sci.*

Physico-chemical Analysis of Sewage and Well Water of Ahmednagar City, Maharashtra, India

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Available online at: www.isca.in, www.isca.me
Received 29th September 2015, revised 20th October 2015, accepted 27th December 2015

Abstract

In present investigation physico-chemical analysis of sewage and well water of Ahmednagar (Maharashatra) city was done. Samples were collected from different localities of the city during the year 2013. The results of current investigations reveal that all the study parameters are more than reference range of water quality for irrigation. This suggests that the sewage water needs a pretreatment before its usage for irrigation.

Keywords: Sewage, Physico-chemical parameters, Sina River.

Introduction

Water is one of the most valuable resources available to man for his domestic, agriculture and industrial uses, out of which agriculture claims for about two-third of water demand. As existing irrigation sources are insufficient for growing population, shortage of water is being experienced in many parts of the world especially in arid and semi arid regions. Since entire agriculture cannot depend on rainfall alone, sewage water as well as other low quality water resources may become immense important sources of water in areas, where other sources are inadequate.

Sewage water varies widely in its composition. Sewage sludge must be considered as low analysis fertilizers as sewage irrigated lands are well supplied with organic matter and available nutrients too. Sewage sludge ranges from 0.1 to17.6 per cent nitrogen, 0.1 to 14.3 per cent, phorphours and 0.02 to 2.6 per cent potassium content. It has been found that the use of municipal waste water for irrigation purpose leads to rise in pH and EC, organic carbon, total NPK content[1-6]. Many of the research groups have reported the physicochemical analysis of sewage water[7-9]. Many research groups are working on the use of sewage water for irrigation[10,11]. Thus, sewage effluent has agronomic value and potential to improve soil fertility if properly treated and applied for agriculture. Much of the research efforts today are directed towards the study of possible contaminaton of fresh water reservoirs also[12-15].

At present more than 95 percent of vegetable requirement of big cities is met with vegetables being grown on sewage farms. Ahmednagar, the urban district of Maharashta is no exception to it. Being a very rapidly growing city Ahmednagar generates large volume of waste. Urban domestic and industrial effluent initially discharged into the drains its way to streams and tanks and ultimately to river system. The sewage effluents of Ahmednagar city discharged into Sina river are being increasingly used for growing vegetable crops around Ahmednagar city in the cultivated lands of Delhi Gate and Sarasnagar area. This area is mainly using this sewage water as a source of irrigation since 1972 and growing vegetable crops like cabbage, cauliflower and brinjal.

In focuss of this literature survey, in present investigation we have studied the characteristics of sewage water from locations near to Sina river of Ahmednagar city.

Materials and Methods

Collection of sewage water and well water samples: Total 6 sewage water samples were collected from the fields where this water is lifted for irrigation at Delhi Gate and Sarasnagar area of Ahmednagar city and 11 well water samples were collected from the wells in the adjoining area in the vicinity of the Sina River.

Physicochemical Analysis: In present investigation sewage water analysis was carried out by the methods suggested as per APHA[16]. The analysis is carried out for various parameters like pH, electrical conductivity (EC), Biochemical oxygen demand (BOD), Chemical oxygen demand (COD), Total dissolved solids (TDS), Calcium, Magnesium, Sodium and Potassium, Sulphate, Carbonates, Bicarbonates and Chlorides, Ammonical nitrogen (NH_4^+-N) and Nitrate-Nitrogen (NO_3^--N), Phosphorous.

Results and Discussion

In the present investigation, the characteristic properties of sewage water which is being used for irrigation to vegetable crops in the adjoining areas of Sina river of Ahmednagar city were studied. The results of the study are summarized in table

Table-1
Characteristics of Sewage water

Parameter	**Delhi Gate 1**	**Delhi Gate 2**	**Delhi Gate 3**	**Delhi Gate 4**	**Sarasnagar -1**	**Sarasnagar-2**
pH	7.90	7.70	8.40	8.70	8.18	8.90
EC, dSm^{-1}	1.450	1.500	1.680	1.175	1.530	1.981
BOD, mgL^{-1}	260	220	190	170	240	140
COD, mgL^{-1}	790	950	740	970	864	950
TDS, mgL^{-1}	930	1080	1220	430	840	1100
Ca^{2+} meL^{-1}	3.4	3.6	4.3	3.2	4.9	2.7
Mg^{2+} meL^{-1}	1.2	0.9	1.2	0.8	0.9	4.7
Na^{+} meL^{-1}	6.96	7.80	8.50	5.95	7.78	10.72
K^{+} meL^{-1}	0.90	0.19	0.73	0.55	0.70	0.76
$C1^{-}$ meL^{-1}	5.6	4.8	5.5	4.7	5.9	6.8
SO_4^{2-} meL^{-1}	1.360	0.675	2.180	1.586	5.870	1.530
CO_3^{2-} meL^{-1}	Tr.	Tr.	Tr.	Tr.	Tr.	0.8
HCO_3^{2-} meL^{1}	7.67	7.34	8.4	8.3	7.9	11.5
Phosphorus mgL^{-1}	13.78	15.87	14.65	25.9	14.8	15.87
NO_3^{-} $NmgL^{-1}$	6.84	6.46	4.91	24.87	7.78	31.56
NH_4^{+} mgL^{-1}	51.06	45.86	38.28	22.7	45.96	29.19
SAR $(mmolL^{1})^{1/2}$	4.910	5.550	5.226	4.417	4.723	5.912
RSC meL^{-1}	3.43	3.54	3.10	4.30	2.50	4.60

Table-2
Characteristics of Well water

Parameter	**Delhi Gate 1**	**Delhi Gate 2**	**Delhi Gate 3**	**Delhi Gate 4**	**Delhi Gate 5**	**Saras Nagar 1**	**Saras Nagar -2**	**Nepti 1**	**Nepti 2**	**Nepti 3**	**Nagapur 1**
pH	8.20	8.50	8.70	8.60	8.90	7.80	8.90	8.30	8.30	8.50	8.50
EC, dSm^{-1}	2.87	2.68	2.54	4.55	5.91	2.68	2.93	1.79	1.50	3.10	0.95
BOD, mgL^{-1}	70	65	45	45	52	40	80	65	90	55	50
COD, mgL^{-1}	220	780	656	730	710	240	666	692	690	695	645
TDS, mgL^{-1}	1700	1700	1100	3100	4200	1600	1600	1400	1200	1300	700
Ca^{2+} meL^{-1}	5.9	6.6	3.1	4.1	2.9	6.8	4.1	5.8	5.9	13.6	3.7
Mg^{2+} meL^{-1}	2.4	6.3	4.1	2.8	6.1	2.9	5.6	4.8	0.9	8.2	2.6
Na^{+} meL^{-1}	16.20	15.80	14.10	25.10	34.16	16.48	16.50	10	7.90	18.20	5.60
K^{+} meL^{-1}	0.090	0.380	0.350	0.270	0.245	0.090	0.240	0.24	0.27	0.230	0.69
$C1^{-}$ meL^{-1}	7.8	10.6	9.8	16.7	16.2	7.8	7.5	7.6	7.4	10.1	4.9
SO_4^{2-} meL^{-1}	6.975	4.394	3.466	13.781	16.29	4.50	9.270	2.40	3.44	15.55	0.23
CO_3^{2-} meL^{-1}	0.8	3.4	1.5	1.6	3.7	0.7	0.6	2.1	1.2	0.8	1.2
$HCO_3^{2-}meL^{1}$	13.8	13.7	9.6	15.8	10.2	13.9	9.1	5.2	3.6	5.7	6.2
Phosphorus mgL^{-1}	6.8	14.6	14.26	10.95	0.92	7.85	4.83	3.56	4.78	5.92	4.33
NO_3 $NmgL^{-1}$	5.43	5.62	4.21	1.62	2.89	0.78	0.65	2.84	0.86	3.1	3.1
NH_4^{-} mgL^{-1}	4.2	0.98	4.32	03	.05	4.56	0.96	0.1	0.2	0.1	0.1
SAR $(mm01L^{1})^{1/2}$	8.90	7.43	7.86	13.85	17.01	7.35	3.7	4.2	4.45	5.85	3.82
RSC meL^{-1}	6.92	1.4	2.9	8.6	1.9	5.5	1.0	0.6	0.5	0.6	0.8

Table-3
Average composition of Sewage water

Parameter	Range	Mean	Sr No	Trace elements	Range	Mean
pH	7.70-8.90	7.9	10	Cl^-, meL^{-1}	4.7-6.8	5.75
EC, dSm^{-1}	1.175-1.981	1.373	11	SO_4^{2-}, meL^{-1}	0.675-5.870	3.27
BOD, mgL^{-1}	140-260	155	12	CO_3^{2-}, meL^{-1}	Tr-0.8	0.4
COD, mgL^{-1}	740-970	820	13	HCO_3^-, meL^{-1}	7.34-11.50	9.42
TDS, mgL^{-1}	430-1100	800	14	Phosphorus, mgL^{-1}	14.80-25.90	20.35
Ca^{2+}, meL^{-1}	2.70-4.90	3.35	15	NO_3^-N, mgL^{-1}	4.91-31.56	18.235
Mg^{2+}, meL^{-1}	0.80-4.70	2.75	16	NH_4^+, mgL^{-1}	22.60-51.06	36.83
Na^+, meL^{-1}	5.95-10.72	8.34	17	SAR, $(mmo1L^{-1})^{1/2}$	4.417-5.912	5.164
K^+, meL^{-1}	0.19-0.90	0.545	18	RSC, meL^{-1}	2.50-4.60	3.55

Table-4
Average composition of well water

Parameter	Range	Mean	Sr No	Trace elements	Range	Mean
pH	7.80-8.90	8.35	10	Cl^-, meL^{-1}	4.9-16.7	10.8
EC, dSm^{-1}	0.950-5.910	3.43	11	SO_4^{2-}, meL^{-1}	0.23-16.29	8.26
BOD, mgL^{-1}	40-90	65	12	CO_3^{2-}, meL^{-1}	0.6-3.7	2.15
COD, mgL^{-1}	220-780	500	13	HCO_3^-, meL^{-1}	3.6-15.8	9.7
TDS, mgL^{-1}	700-4200	2450	14	Phosphorus, mgL^{-1}	0.90-14.60	7.75
Ca^{2+}, meL^{-1}	2.9-13.6	8.25	15	NO_3^-N, mgL^{-1}	0.65-5.62	3.135
Mg^{2+}, meL^{-1}	0.9-8.2	4.55	16	NH_4^+, mgL^{-1}	0.05-4.56	2.305
Na^+, meL^{-1}	5.60-34.16	19.88	17	RSC, meL^{-1}	3.7-17.01	10.4
K^+, meL^{-1}	0.09-0.69	0.39	18	SAR, $(mmo1L^{-1})^{1/2}$	0.5-6.92	3.485

Table-5
Recommended water quality guidelines

Parameter	Recommended maximum concentration	Parameter	Recommended maximum concentration
pH	6.5-8.5	$C1^-$, mgL^{-1}	600
EC, dSm^{-1}	<0.7	HCO_3^-, meL^{-1}	1.5
TDS, mgL^{-1}	<450	SAR, $(mmoL^1)^{1/2}$	15
Ca^{2+}, mgL^{-1}	400	RSC, meL^{-1}	<1.25
Mg^{2+}, mgL^{-1}	60	BOD, mgL^{-1}	100
Na^+, meL^{-1}	<3	NO_3^-N, mgL^{-1}	5
SO_4^{2-}, mgL^{-1}	1000	-	-

pH: The pH of sewage water ranged from 7.7 to 8.9 with an average value of 7.9 (Table-3) which is within safe limit of 6.0-8.5 as suggested by the United States of Salinity Laboratory Staff (1954) for irrigation water. The pH of well water in the adjoining area ranged from 7.8 to 8.9 (Table-4) with an average value of 8.35 which is slightly higher than sewage water. This might be due to dissolved percolated basic salts in well.

Electrical conductivity (EC): The electrical conductivity of sewage water ranged from 1.175-1.981dSm^{-1}. Thus, the EC of sewage water is higher than this recommended level indicating the chances of development of salinity under continuous utilization of sewage water.

The EC of well water in the adjoining area ranged from 0.950-5.910 dSm^{-1}, indicating higher values in comparison with permissible limit suggesting potential soil health hazard.

Biochemical Oxygen Demand (BOD): BOD of sewage water ranged from 140-260 mg L^{-1}, which is more than the recommended maximum concentration of 100 mg L^{-1} for waste water use in agriculture. This might be due to high presence of suspended organic colloids in the effluents. The BOD of well water however ranged from 40-90 mgL^{-1}.

Chemical Oxygen Demand (COD): The chemical oxygen demand (COD) of sewage water ranged from 740-970 mgL^{-1} with an average value 820 mgL^{-1}. The high COD of city effluents suggest that sewage is contaminated with domestic and small scale industrial wastes.

The COD of well waters ranged from 220-780 mgL^{-1}.

Total Dissolved Solids (TDS): The total dissolved solids of sewage water ranged from 430-1100 mgL^{-1}. The TDS in sewage water is higher as compared to the permissible limit if 450 mgL^{-1}. The value is below the recommended maximum concentration of 3000 mg L^{-1} for irrigation water given by FAO[17]. As per IS[18] specification for city effluent composition, the TDS value of 2100 mg L^{-1} is suggested for the effluents to be discharged on land.

The TDS value of well water ranged from 700-4200 mg L^{-1} indicating very high total dissolved solids in well water due to percolation of salts reaching to ground water.

Cations: The concentration of Ca^{+2} in sewage water ranged from 2.70-4.90 me L^1, Mg^{+2} from 0.80-4.70 meL^{-1}, Na^+ from 5.95-10.72 meL^{-1} and K^+ from 0.19-0.90 meL^{-1} The sewage water thus contains higher concentration of Na+ which may be due to domestic sewage containing detergents.

The concentration of Ca^{+2} in well water ranged from 2.9-13.6 meL^{-1}, Mg^{+2} from 0.9-8.2 meL^{-1}, K^+ from 0.09-0.69 meL^{-1}.

Anions: Among the anions, the chlorides varied from 4.7-6.8 meL^{-1}. The concentration of sulphate in sewage water ranged from 0.675-5.870 meL^{-1}. The bicarbonates varied from 7.34-11.50 meL^{-1}. The carbonates varied from nil to 0.8 meL^{-1}.

The chloride in well water ranged from 4.4 to16.2 meL^{-1}, sulphates from 0.23-16.29 meL^{-1}, bicarbonates from 3.6-15.8 meL^{-1}, carbonates from 0.6-3.7 meL^{-1}.

Thus it was observed that the anions particularly chlorides, bicarbonates and sulphates were of higher magnitude in city sewage effluents and also in the well of adjoining areas. The wells nearer to the Sina river wherein the sewage water is discharged showed higher concentrations of these anions which indicates contamination of ground water in the vicinity of the sewage nala.

Phosphorus: The phosphorus content in sewage water ranged from 14.80-25.90 meL^{-1} while that of well water ranged from 0.90-14.60 meL^{-1}.

Nitrate-Nitrogen (NO_3^- -N): The nitrate nitrogen ranged from 4.91-31.56 mgL^{-1} in sewage water and 0.65-5.62 mgL^{-1} in well water. The nitrate nitrogen in sewage water is higher.

Ammonical nitrogen (NH_4^+ -N): The ammonical nitrogen of sewage water ranged from 22.60-51.06 mgL^{-1}. The higher ammonical N is mainly because of high BOD and COD of the effluents containing considerable amount of suspended organic solids which undergo decomposition anacrobically resulting in more accumulation of NH_4^+-N.

The ammonical nitrogen of well water ranged from 0.05-4.56 mgL^{-1}.

Sodium Adsorption Ratio (SAR): The SAR value of sewage water ranged from 4.417-5.912 which is below the limit of 10. The SAR value of well water in the adjoining area ranged from 0.5-6.92 indicating higher sodium hazard due to well water containing more sodium than that of in the sewage water.

Residual sodium carbonate (RSC): The RSC of sewage water varied from 2.50-4.60 meL^{-1}. The RSC of well water ranged from 3.7-17.01meL^{-1} . Continuous application of either sewage effluents of nearby well waters containing high RSC and SAR may likely create problems of soil health. Alternatively, such water should be given primary and secondary treatments so as to use safely without impairing soil properties and environment quality.

Conclusion

Thus, it was observed that the sewage water had the higher values of EC, BOD, COD, TDS, sodium, bicarbonates, chlorides beyond the permissible limits suggesting use of sewage after primary and secondary treatments. The higher nitrogen, phosphorus, potassium and micronutrients as compared to well waters indicate the utility of sewage as a source of irrigation to agricultural crops.

It was observed that the sewage water was neutral to mildly alkaline (pH 7.70-8.90) in reaction with high electrical conductivity (1.175-1.981 dSm^{-1}), high BOD (> 100 mg L^{-1}) and high COD (740 to 970 mgL^{-1}). The total dissolved solids in sewage effluent were higher (430 to 1100 mg L^{-1}).

The concentration of cations like calcium and magnesium was found below the permissible limits while the concentration of sodium and anions like chlorides, bicarbonates was higher than that of the maximum permissible limit as suggested by NAS (1972) and FAO (1985).

The higher contents of nitrate-nitrogen (4.91 to 31.36 mg L^{-1}), ammonical nitrogen (22.60 to 51.06 mg L^{-1}) and phosphorus (14.80 to 25.90 mg L^{-1}) were observed in the sewage water. The sewage water had higher RSC (2.50-4.60 me L^{-1}) and lower SAR (4.417 to 5.912 {mm0l L^{-1}}½).

Acknowledgement

Author is thankful to Management, Ahmednagar Jlha Maratha Vidya Prasarak Samaj and The Principal, New Arts, Commerce and Science College, Ahmednagar for providing necessary research facilities**.**

References

1. Chauhan R.K. (2014). Physicochemical Analysis of untreated Seawage Water of Ladwa town of Kurukshetra district of Haryana and need of waste water treatment plant, *Int. J. Curr. Microbiol. App. Sci*., 3(3), 326-333.

2. Singh S. and Singh K.N. (2010). Physicochemical Analysis of seawage discharged into Varuna river at Varanasi, *curr. World Env.,* 5(1), 201-203

3. Rathore D.S., Rai N. and Ashiya P. (2014). Physico-chemical Analysis of Water of Ayad river at Udaipur, Rajsthan (India), *Int. J. Inno. Res. Sci. Eng. Tech*., 3(4), 11660-11667.

4. Paula P., Mihaela T., Mireala V., Silvia D., Catalil T. and Lucial P.G. (2012). Study of Physico-chemical Characteristics of waste water in an urban agglomeration in Romania, *Sci. World Journal*, doi:10.1100/2012/549028.

5. Azad A.S. Arora B.R., Singh B and Sekhon G.S. (1987). Effect of sewage water on some soil properties. *Indian J. Ecol*. 14(1), 7-13.

6. Datta S.P., Biswas D.R., Saharan N., Ghosh S.K. and Rattan R.K. (2000). Effect of long term application of sewage effluents on organic carbon, bioavailable phosphorus, potassium and heavy metal status of soil and content of heavy metal in crop grown thereon, *J. Indian Soc. Soil Sci*,. 48(4), 836-839.

7. Sharma K.D., Lal N.A. and Pathak P.D. (1981). Water quality of sewage drains entering Yamuna at Agra. *Indian J. Environ Hlth*. 29, 118-122.

8. Som S., Gupta S.K. and Banerjee S.K. (1994). Assessment of the quality of sewage effluents from Howrah sewage treatment plant. *J. Indian Soc. Soil Sci*. 42, 571-575.

9. Goyal P., Lakhiwal S. and Chauhan S.S. (2015). Comparatve Study of Physico-chemcal Characteristics of Water and Soil of Treated and Untreated Waste Water, *Int. Res. J. Environment Sci*., 4(9), 5-9.

10. Maitli P.S., Sah K.D., Gupta S.K. and Banarjee S.K. (1992). Evaluation of sewage sluge as a source of irrigation and manures. *J. Indian Soc. Soil Sci*., 40(1), 168-172.

11. Mitra A. and Gupta S.K. (1999). Effect of sewage water irrigation on essential plant nutrient and pollutant elements status in vegetable growing area around

Calcutta. *J. Indian Soc. Soil Sci*., 47, 99-104,

12. Rout C., Lavaniya A. and Diwakar R.P. (2015). Assessent of Physco-chemical Parameters of River Yamuna at Agra Region of Uttar Pradesh, India, *Int. Res. J. Environment Sci*., 4(9), 25-32.

13. Barde V.S., Piplode S., Thakur V. and Agrawal R. (2015). Physco-chemical Evaluation of Water Quality of Narmada River at Barwani and Khalghat, MP, India, *Int. Res. J. Environment Sci*., 4(3), 12-16.

14. Medona M.R., Nirmala T. and Delphine Rose M.R. (2014). Evaluation of Physcal and Chemical Characteristics of Water at Sothuparai reservoir, Theni District, Tamilnadu, *Int. Res. J. Environment Sci*., 3(8), 36-39.

15. Bharti K.T., Deshmukh D.K., Bharti D.T. and Deshmukh K.K. (2013). Physico-Chemical Determination of Pollution n Groundwater Sources in Sangmner Tahsil, 422605, Dist. Ahmednagar, *Int. Res. J. Environment Sci*., 2(3), 56-58.

16. Franson M.H. (1985). In: Standard methods for the examination of water and waste water. 16th Edn, EPHA-AWWA-WPGF. 525-538.

17. Ayers R.S. and Westcot D.W. (1979). Water quality for Agriculture. Irrigation and Drainage paper, 29. F.A.O., Rome.

18. Indian standards (IS) (1981). Part I, 18, 2490.