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Use of biosanitizer for removal of carbonates and bicarbonates

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Abstract

The physico-chemical anlaysis of groundwater at Kalmeshwar, Nagpur District in India was carried out. The results based on electrical conductivity, total dissolved solids (TDS), chloride and alkalinity revealed that nearly all the water samples were found to be highly polluted. A treatment process comprising the usage of biosanitizer was applied in restoring the polluted groundwater into potable one. By this approach, a reduction of bicarbonate and carbonate content in the ground water was achieved by 90% and 45 % respectively. Our investigation can be helpful for municipal administrators and in water resource management.

Keywords: Biosanitizer, biocatalyst, carbonates, bicarbonates, TDS, water treatment, groundwater, India.

Introduction

The quality of water is of utmost importance. The chemical, physical and bacterial characteristics of groundwater determines its usefulness for municipal, commercial, industrial, agricultural and domestic water usage (Tatawat & Singh, 2007). Because of continuous growth in population, rapid industrialization and the accompanying technologies involving waste disposals, the rate of discharge of the pollutants into the environment is far exceeding the treatment capacities. The study carried out in the Kalmeshwar industrial and town area is the case study in this direction.

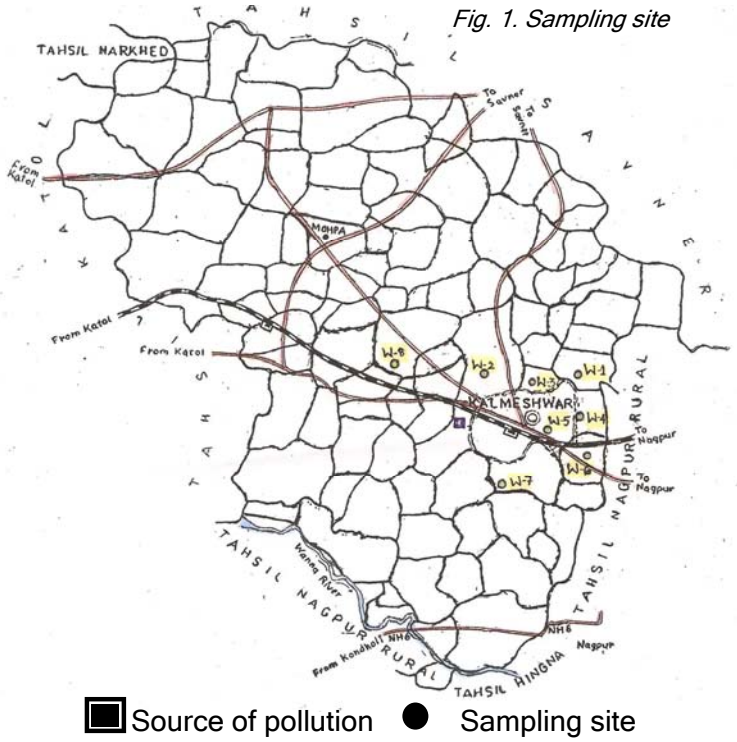
Kalmeshwar is located about 20 km north-west of Nagpur, a fast developing city in Central India. The Maharashtra Industrial Development Corporation (MIDC) developed an industrial area in Kalmeshwar. The area supports many industries involved in the manufacturing of iron sheets, basic alloys, chemicals, coal products, general engineering equipments and pharmaceuticals (Sharma *et al*., 2002; Malviya *et al*., 2008). The study area is of 10 sq km, covered by 1 m thick fertile black clayey soil. Geologically, the area is underlain by Deccan trap lava of 50- 60 m thickness and 4-7 m weathered mantle. The water level varies 3- 10 m below ground level during pre-monsoon and 1.5- 8.5 m during post-monsoon period. The average hydraulic gradient is 1.5 m/km with ground level flow towards north-east direction (Subbarao & Nawale, 1998; Malviya *et al*., 2008). The location of sampling stations with respect to distance and direction from the source of pollution is given in (Fig. 1,Table1)

Materials and methods

The monitoring of water quality was carried out for about two and a half years between Aug 2006 to Nov 2008 from eight groundwater sources in Kalmeshwar region of Nagpur District. The sampling sites were selected within 5 km radius from an iron industry, the source of pollution in the district. Analysis was carried out for assessment of 20 parameters including mineral, demand, nutrient, bacteriological and metal analysis. Parameters including pH, temperature, dissolved oxygen, turbidity and electrical conductivity were monitored on site. Sampling, analysis and preservation of water samples were carried out as per Standard Methods for the Examination of Water and Wastewater (Standard Methods, APHA, AWWA, 2005).

The analyses for all the 20 physico-chemical parameters for 8 samples are given in Table 2. The analysis results were checked for correctness by use of

Fig. 1. Sampling site



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an automated workbook for checking correctness of water analyses (Bassin, 2007). The respective values for all the 20 parameters were compared with standard limit recommended by Indian Standards for drinking water (Indian Standards IS 10500: 1993).

Biosanitizer

Biosanitizer (Bhawalkar, 2007; Bhawalkar,& Bhawalkar, 2008; Malviya *et al*., 2008) is a catalyst produced from natural ingredients and is a simple tool to manage toxic organics and inorganic converting the waste ingredients into resources. It is available in granular form. The action is known as 'biosanitization' and controls pathogens too, because pathogens prefer inorganic and toxic organic pollution. Biosanitizer locks the inorganic content of the wastes and cracks the toxic organics to produce safe organics, and also produces active oxygen that takes care of chemical oxygen demand (COD) & biochemical oxygen demand (BOD), retaining food organics during the treatment.

Biosanitizer features: Biosanitizer is a nano forest. It converts diverse of pollution into resources, at speed that can be 1,000 times higher than the natural ecosystem. No issue of production of sludge or green house gases and no need of machinery and electricity. It is a self operating and self improving system (Bhawalkar, 2007, Bhawalkar,& Bhawalkar, 2008; Kadbe, 2008).

Biosanitizer applications: It can be put in wells, bore wells, ponds, lakes or in water storage tanks; Produces clean bio-water without pathogens, toxic chemicals and inorganic pollutants; Resists corrosion and contamination; Does not allow mosquito breeding and produces high quality farm produce (Kadbe, 2008; Bhawalkar, 2007, Bhawalkar,& Bhawalkar, 2008).

Table 1. The location of sampling stations with respect to distance and direction from the source of pollution

Sample code	Distance from the source of pollution (km)	Direction
W1	5.0	ENE
W2	2.5	NE
W3	3.0	ENE
W4	4.0	E
W5	3.5	E
W6	5.0	ESE
W7	4.0	SSE
W8	3.5	NW

Biosanitizer dosage is optimized using jar test. Biosanitizer dose in the range of 2.5- 15.0 mg per litre with increment of 2.5 mg/l was tested for optimization. Biosanitizer dosage was directly added to the jars containing one litre carbonate solution of known concentration. After addition of biosanitizer granules, the solution was stirred for 2 min. and left idle for reactor to take place. Biosanitizer granules operate from the bottom of the container and keep on producing oxygen. This drives the natural reactions converting the salty/brackish water to sweet water. The mechanism is similar to that used by the coconut tree in converting saline/brackish water into sweet coconut water. The optimum doze of biosanitizer is found to be 10 mg / l.

Ten litres each of the eight water samples were used for biosanitizer treatment and the treated water samples were analyzed for different physico-chemical parameters every second day for two months. The analyses result of biosanitizer treatment is shown in Tables 2 (a) – 2 (h) and percent removal efficiency of bicarbonates and carbonates is given in Fig. 2, 3 respectively.

Results and discussions

The pH of the water samples is in the range 6.4 – 7.6 as presented in Table 2. The TDS concentration of the samples are in the range 491-13530 mg/l indicating high degree of mineralization. The concentration of HCO_3, Cl, SO_4 and Fe lies in the range of 150-384 mg/l, 15-4655 mg/l, 19-374 mg/l and 0.12-4.3 mg/l, respectively. Sample

Table 2. Analyses results for samples (W1 to W8)

Parameters	W 1	W 2	W 3	W 4	W 5	W 6	W 7	W 8
pH	6.5 - 7.3	7.0 - 7.6	6.6 - 7.4	6.8 - 7.3	6.8 - 7.4	6.9 - 7.3	6.8 - 7.5	6.8 - 7.3
DO	0 - 0.6	1.1 - 4.0	1.8 - 3.8	1.2 - 5.2	0.2 - 4.2	0 - 3.6	3.1 - 4.2	2.6 - 4.7
Conductivity	8390 - 20500	1160 - 2520	4500 - 17050	3900-11230	2070 - 4350	1865 - 5170	750 - 2330	2470 - 5060
TDS	5538 -13530	761 - 1662	3150 - 11253	2573-7409	1365 - 2869	1232 - 3413	491 - 1634	1731 - 3336
COD	94 - 360	8 - 32	172 -327	112 - 274	32 - 94	98 - 214	<8 - 32	48 - 146
BOD	13 - 46	<5 - 8	24 - 39	16 - 33	<5 - 12	14 - 31	<5 - 5	7 - 26
Alkalinity	164 - 380	150 - 258	195 - 292	165 - 236	166 - 338	250 - 384	210 - 332	150 - 252
Hardness	2180 - 6200	360 - 650	1450 - 5500	1670-3380	840 - 1500	892 - 1780	300 - 1690	880 - 2600
Ca^{++}	496 - 1740	79 - 176	332 - 1160	332 - 744	188 - 299	204 - 391	77 - 304	219 - 416
Mg^{++}	225 - 519	7 - 60	149 - 630	187 - 406	84 - 206	86 - 250	27 - 223	38 - 250
Na^{+}	375 - 2986	64 -393	376 - 2361	205 - 1645	163 - 567	163 - 725	19 - 184	210 - 653
K^{+}	8 - 61	1 - 8	8 - 48	4 - 33	3 - 16	3 - 15	1 - 6	4 - 13
Chloride	560 - 4655	56 - 500	540 - 3554	290 - 2548	190 - 776	140 - 913	15 - 50	260 - 864
Sulphate	23 - 242	35 - 159	39 - 206	31 - 87	49 - 154	31 - 374	19 - 74	75 - 219
Phosphate	0.22 - 0.42	BDL - 0.21	0.13 - 0.22	0.08 - 0.15	BDL - 0.17	0.10 - 0.19	0.11 - 0.30	0.28 - 2.6
Nitrate	0.21 - 0.90	0.9 - 3.5	1.18 - 2.10	0.9 - 2.2	1.4 - 2.6	3.8 - 9.0	7.1 - 9.2	2.2 - 3.6
Fluoride	0.11 - 0.34	0.12 - 0.31	0.09 - 0.33	BDL - 0.32	BDL - 0.34	BDL - 0.35	BDL - 0.33	0.09 - 0.36
Iron	0.81 - 3.80	0.45 - 2.2	0.42 - 2.70	0.26 - 2.70	0.27 - 3.10	0.12 - 2.30	0.44 - 2.70	0.19 - 4.30
Lead	0.038 - 0.424	BDL - 0.01	0.064 - 0.174	0.068-0.221	0.041- 0.123	0.007 - 0.144	BDL - 0.30	0.020 - 0.087
Coliforms	> 1100	7 - 21	> 1100	7 - 23	14 - 43	15 - 93	9 - 23	20 - 240

All parameter are in mg/l except pH, conductivity and coli forms; unit for conductivity is µS/cm while for coli forms is MPN/100 ml.

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W 1 shows the maximum concentration of TDS (5538 – 13530 mg/l) and chlorides (560 – 4655 mg/l), while W 7 shows the least concentration of TDS (750 – 2330 mg/l) and chlorides (15 – 50 mg/l). Table 3 presents the performance data (average of three sets of biosanitizer treatment). The data clearly indicate that biosanitizer works continuously reducing the alkalinity and hardness thereby reduction in TDS but with marginal increase in chloride and sulphates.

Fig. 2 & 3 shows the percent efficiency removal in bicarbonates and carbonates respectively. It can be concluded that the maximum removal efficiency for bicarbonates and carbonates can be achieved within 7 days. The removal efficiency for bicarbonates is around 90 % while for carbonates removal is in the range 40– 45%.

Table 3 (b). Analyses results for sample (W2) with use of biosanitizer

Parameters	W-2						
	Values without biosanitizer	Values with use of biosanitizer					
		After 1 day	After 3 days	After 5 days	After 7 days	After 15 days	After 1 Month
pH	7.0	7.0	7.0	7.0	7.0	7.0	7.0
Conductivity	1490	1440	1350	1330	1280	1240	1235
TDS	1000	1038	930	904	871	846	840
Alkalinity as HCO_3	268	224	164	120	64	59	55
Total hardness as CO_3	534	506	410	364	312	309	305
Calcium as $CaCO_3$	410	374	328	299	287	247	238
Magnesium as $MgCO_3$	124	132	82	65	25	62	67
Ca^{++}	164	149	131	120	115	99	95
Mg^{++}	30	32	19	16	6	15	16
Na^{+}	179	206	198	203	204	197	199
K^{+}	4	4	4	4	9	6	8
Chloride	220	265	250	254	261	260	264
Sulphate	76	79	84	87	89	79	76

All parameter are in mg/l accept for pH, conductivity and coli forms; unit for conductivity is µS/cm

Table 3 (c). Analyses results for sample (W3) with use of biosanitizer

Parameters	W-3						
	Values without biosanitizer	Values with use of biosanitizer					
		After 1 day	After 3 days	After 5 days	After 7 days	After 15 days	After 1 Month
pH	7.2	7.0	7.0	7.0	7.0	7.0	7.0
Conductivity	8495	8255	8160	7900	7760	7910	7970
TDS	5777	5698	5549	5365	5311	5380	5418
Alkalinity as HCO_3	292	144	88	64	47	44	40
Total hardness as CO_3	2680	2560	2400	2180	2050	2035	2010
Calcium as $CaCO_3$	1740	1530	1515	1310	1180	1245	1195
Magnesium as $MgCO_3$	940	1030	885	870	870	790	815
Ca^{++}	696	612	606	524	472	488	478
Mg^{++}	225	247	212	209	209	190	196
Na^{+}	1253	1248	1244	1255	1285	1321	1334
K^{+}	25	38	38	39	40	41	44
Chloride	1865	1873	1868	1882	1931	1983	2011
Sulphate	137	144	142	148	145	151	148

All parameter are in mg/l accept for pH, conductivity and coli forms; unit for conductivity is µS/cm

Table 3 (a). Analyses results for sample (W1) with use of biosanitizer

Parameters	W-1						
	Values without biosanitizer	Values with use of biosanitizer					
		After 1 day	After 3 days	After 5 days	After 7 days	After 15 days	After 1 Month
pH	7.1	7.1	7.1	7.0	7.0	7.0	7.0
Conductivity	13910	13810	13330	12875	12450	12225	12050
TDS	9320	9254	9064	8736	8468	8435	8437
Alkalinity as HCO_3	286	140	64	56	36	32	30
Total hardness as CO_3	5200	5080	4840	4420	4110	4066	4025
Calcium as $CaCO_3$	4000	3803	3540	3540	2960	2887	2857
Magnesium as $MgCO_3$	1200	1277	1300	880	1150	1197	1168
Ca^{++}	1600	1521	1416	1416	1184	1155	1143
Mg^{++}	288	306	312	211	276	283	280
Na^{+}	1647	1672	1691	1700	1733	1736	1754
K^{+}	42	43	43	44	44	47	45
Chloride	2528	2564	2581	2601	2647	2654	2681
Sulphate	95	102	117	113	118	121	120

All parameter are in mg/l accept for pH, conductivity and coli forms; unit for conductivity is µS/cm

Conclusion

The groundwater in Kalmeshwar town area was highly polluted as the TDS (2000 mg/L), total carbonates (600 mg/L), chlorides (1000 mg/L), calcium (200 mg/L), magnesium (100 mg/L) and iron (1.0 mg/L) have crossed the maximum permissible limits of ISO for drinking water (Indian Standards IS 10500 : 1993). Application of biosanitizer has improved the quality of water by reducing the values of bicarbonates and carbonates due to which the washing ability of water has increased. Along with reduction in bicarbonates and carbonates there is marginal increase in chlorides and sulphates. As the values of increased parameters are well within the permissible limits except for W-1, W-3 and W-4 this increase in chlorides and sulphates can be neglected. The maximum removal efficiency for bicarbonates and carbonates can be achieved within 7 days. The removal efficiency for bicarbonates is around 90 % while for carbonates removal is in the range 40 – 45 percent. Water can be treated to safe levels through use of biosanitizer. Thus, the biosanitizer can be one of the solutions for the next generation in water treatment. Studies for determining the reason for increase in chlorides and sulphates are in progress.

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Table 3 (d). Analyses results for sample (W4) with use of biosanitizer

Parameters	W-4						
	Values without biosanitizer	Values with use of biosanitizer					
		After 1 day	After 3 days	After 5 days	After 7 days	After 15 days	After 1 Month
pH	7.0	7.0	7.0	7.0	6.9	6.9	6.9
Conductivity	8140	8190	7840	7575	7430	7565	7510
TDS	5455	5567	5255	5151	5038	5143	5122
Alkalinity as HCO_3	164	147	123	98	58	49	46
Total hardness as CO_3	2380	2350	2040	1695	1510	1470	1405
Calcium as $CaCO_3$	1710	1410	1345	1280	1060	1075	1065
Magnesium as $MgCO_3$	670	940	695	415	450	395	340
Ca^{++}	684	564	538	512	424	430	426
Mg^{++}	161	226	167	97	108	95	82
Na^{+}	1223	1287	1272	1350	1375	1428	1438
K^{+}	25	33	32	35	35	37	40
Chloride	1882	1990	1965	2090	2118	2204	2227
Sulphate	52	56	57	57	71	68	65

All parameter are in mg/l accept for pH, conductivity and coli forms; unit for conductivity is µS/cm

Table 3 (g). Analyses results for sample (W7) with use of biosanitizer

Parameters	W-7						
	Values without biosanitizer	Values with use of biosanitizer					
		After 1 day	After 3 days	After 5 days	After 7 days	After 15 days	After 1 Month
pH	7.1	7.1	7.1	7.0	7.0	7.0	7.0
Conductivity	920	870	760	530	450	450	435
TDS	624	591	508	348	297	298	286
Alkalinity as HCO_3	264	246	210	132	102	94	89
Total hardness as CO_3	312	276	256	224	194	192	189
Calcium as $CaCO_3$	174	144	100	71	78	76	79
Magnesium as $MgCO_3$	138	132	156	153	116	116	110
Ca^{++}	70	58	40	28	31	30	32
Mg^{++}	33	32	37	37	29	28	26
Na^{+}	134	133	110	55	42	43	38
K^{+}	3	4	3	2	2	1	2
Chloride	27	26	27	28	28	33	30
Sulphate	35	38	35	37	42	48	45

All parameter are in mg/l accept for pH, conductivity and coli forms; unit for conductivity is µS/cm

Table 3 (e). Analyses results for sample (W5) with use of biosanitizer

Parameters	W-5						
	Values without biosanitizer	Values with use of biosanitizer					
		After 1 day	After 3 days	After 5 days	After 7 days	After 15 days	After 1 Month
pH	7.0	7.0	7.0	7.0	7.0	6.9	6.9
Conductivity	2925	2980	2905	2805	2800	2670	2620
TDS	1990	2024	1978	1916	1921	1787	1778
Alkalinity as HCO_3	322	302	226	134	78	73	80
Total hardness as CO_3	760	730	645	587	510	500	490
Calcium as $CaCO_3$	552	533	454	432	357	370	358
Magnesium as $MgCO_3$	208	197	191	164	153	130	132
Ca^{++}	221	213	181	169	143	148	143
Mg^{++}	50	72	46	39	37	31	32
Na^{+}	480	505	518	516	541	497	495
K^{+}	10	13	11	10	14	10	12
Chloride	700	736	751	745	784	725	721
Sulphate	73	77	85	87	93	75	81

All parameter are in mg/l accept for pH, conductivity and coli forms; unit for conductivity is µS/cm

Ph.D. course.

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Table 3 (f). Analyses results for sample (W6) with use of biosanitizer

Parameters	W-6						
	Values without biosanitizer	Values with use of biosanitizer					
		After 1 day	After 3 days	After 5 days	After 7 days	After 15 days	After 1 Month
pH	7.0	7.0	7.0	7.0	7.0	7.0	7.0
Conductivity	4015	3855	3780	3770	3775	3835	3825
TDS	2732	2622	2570	2583	2596	2618	2600
Alkalinity as HCO_3	340	328	270	174	92	88	85
Total hardness as CO_3	964	832	728	651	595	588	585
Calcium as $CaCO_3$	486	476	408	338	298	335	328
Magnesium as $MgCO_3$	478	356	320	313	297	253	257
Ca^{++}	194	190	163	135	119	134	131
Mg^{++}	115	85	77	75	71	61	62
Na^{+}	683	684	701	736	758	765	757
K^{+}	14	17	15	15	19	20	22
Chloride	860	882	890	941	976	984	981
Sulphate	288	267	289	292	298	302	296

All parameter are in mg/l accept for pH, conductivity and coli forms; unit for conductivity is µS/cm

Table 3 (h). Analyses results for sample (W8) with use of biosanitizer

Parameters	W-8						
	Values without biosanitizer	Values with use of biosanitizer					
		After 1 day	After 3 days	After 5 days	After 7 days	After 15 days	After 1 Month
pH	7.1	7.1	7.1	7.0	7.0	7.0	7.0
Conductivity	3060	3090	2960	2840	2860	2855	2880
TDS	2081	2131	2014	1923	1975	1914	1932
Alkalinity as HCO_3	270	196	116	88	72	68	65
Total hardness as CO_3	1092	1020	952	800	762	753	748
Calcium as $CaCO_3$	752	670	596	520	497	512	508
Magnesium as $MgCO_3$	340	350	356	280	265	241	240
Ca^{++}	301	268	238	208	199	205	203
Mg^{++}	82	84	85	67	63	58	57
Na^{+}	386	434	417	435	469	447	455
K^{+}	10	11	11	11	13	11	13
Chloride	510	580	555	585	641	600	616
Sulphate	136	142	139	138	135	141	142

All parameter are in mg/l accept for pH, conductivity and coli forms; unit for conductivity is µS/cm

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