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MONITORING OF WATER QUALITY AND DETERMINATION OF $CaCO_3$ INDEX (LANGLIER INDEX) OF DIFFERENT STATIONS OF RIVER MANDAKINI AT CHITRAKOOT (M.P. PART), INDIA

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ABSTRACT

Calcium is a moderately soft, low melting reactive metal. It occures in its various forms viz chalk or marble ($CaCO_3$), gypsum ($CaSO_4.2H_2O$), anhydride ($CaSO_4$), fluorspar (CaF_2), appetite ($CF_2.Ca_3PO_4$) 3, phosphorite (Ca_3PO_4), floropatite ($3Ca_3PO_4.CaF_2$), etc. On reaction of the above substance, the water gets different types of species i.e. scale, corrosive and saturation. Calcium carbonate($CaCO_3$) saturation indices (Langlier index) is commonly used to find out the above species of calcium. In the present study, 03 samples were collected in each month from the selected stations of the river Mandakini viz. Satianusuiya, Spatikshila and Jankikund. The water samples of the above stations were taken during April, 2008 to March, 2009. Analysis was carried out using the standard methods for examination of water and wastewater (APHA-AWWA). The results of above analysis were fitted in Langlier Index in order to determine calcium speciation. Scale tendency was found to dominate in most of the sampling stations in all months of the study period.

INTRODUCTION

Chitrakoot is famous for its religious significance and is known as the Karma- bhumi of Lord Rama as he spent a major part of his exile here with wife Sita and brother Lakshman. A number of sublime saint personalities are still living in Chitrakoot. The holy hill of Chitrakoot is situated about 8 km to the south west of the Karwi railway station on the Jhansi-Manikpur section of the North Central Railway. The study area stands at Chitrakoot-Satna road. Satna is 73 km a from Chitrakoot town in south direction. Chitrakoot area is a store house of lime stone. As soon as lime stone enters in the water bodies of this area and various reactions occur in water and consequently water obtains different type of aforesaid species of calcium with prevailing problem of calcium hardness. River Mandakini is one of the biggest water bodies of this area. It originates from Kilhora hills, 25 Km from Majhgawan block of Satna district. The river is almost seasonal in the upper reach and during non- monsoon seasons it becomes almost dry in this reach.

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However, at holy spot of Satianusuiya ashram, a number of springs originate from the nearby limestone hillocks, feed the river and make it a perennial stream. Afterwards, it flows through Sphatikshila, Jankikund, Ramghat, Karwi bridge, Suryakund and eventually falls in Yamuna river near Rajapur.

Calcium is a moderately soft, low melting reactive metal. The name of calcium was derived from the Latin word calyx (Lime). It is widely distributed in the earth's crust and is the third most abundant element. It occurs throughout the world in many common minerals. Chemically, it is one of the alkaline earth metal elements. It is never found in uncombined form in the nature. Its popular deposits are chalk or marble ($CaCO_3$), gypsum ($CaSO_4.2H_2O$), anhydride ($CaSO_4$), fluorspar (CaF2), appetite ($CF_2.Ca_3PO_4)_3$, phosphorite (Ca_3PO_4), floropatite ($3Ca_3PO_4.CaF_2$), etc. along with other important compounds like carbide, chloride, cyanamide, hypochlorite, nitrate and sulfide. In aqueous conditions the above substances react with water and produce different types of species viz. scale, corrosive and saturation. Identification and evaluation of these species was made in light of calcium carbonate saturation index (Langlier index). Assessment of these species is used in corrosive control measures as well as $CaCO_3$ scaling in piping and equipments like heat exchangers, water heaters. Water over saturated with respect to $CaCO_3$ tends to precipitate as $CaCO_3$ while water under saturated with respect to $CaCO_3$ tends to dissolve in. Water saturated with $CaCO_3$ neither has the precipitate nor the dissolving tendency. The calcite pollutants on entering change the saturation effects. If value of calcium carbonate saturation index (Langlier index) is positive, negative and zero, then water will has scaling, corrosive and saturation tendencies respectively (Trivedy and Goel, 1986; Mahadev and Hosmani, 2002; Mahadev *et al*., 2003). Considering the above points in mind, the present work was designed to find out Langlier index at three stations i.e., Satianusuiya, Sphatikshila and Jankikund of river Mandakini.

MATERIALS AND METHODS

Sampling stations selected for the study were Satianusuiya, Spatikshila and Jankikund spots of river Mandakini. Details of the sampling stations are described below :

(i) Satianusuiya: Satianusuya is a major monitoring station, as the perennial stream of river Mandakini originates at this place. In short, it is the starting point of actual river Mandakini. The river banks comprise of limestone rocks.

(ii) Sphatikshila: This station is located at 10 km downstream of Satianusuiya and is the second significant pilgrim spot. The river makes a pool in this reach. The renowned University i.e. M.G.C.G.V. is located on western bank of Sphatikshila.

(iii) Jankikund: This sampling site is situated at 13 km downstream from Satianusuiya. This is the third holy spot on the river. In this reach the river is shallow, narrow and has good flow.

Three samples were collected in each month of the selected sites (i.e., Satianusuiya, Spatikshila and Jankikund) of river Mandakini. The water samples were taken monthly during April, 2008 to March, 2009. Samples were collected in pre-cleaned polypropylene bottles with necessary precautions. Glasswares used in the study were of high quality borosilicate brand (Schott duran, Germany). Chemicals used were of AR/ GR grade and obtained from Qualigen/ E-Merck/Himedia. The Standard methods (APHA-AWWA,1992) were employed for monitoring and speciation of calcium. Parameters investigated were temperature, total dissolved solids (TDS), calcium hardness, alkalinity and pH. The water temperature was measured at sampling sites while other parameters were determined in the laboratory.

RESULTS AND DISCUSSION

Values of temperature, TDS, calcium hardness and total alkalinity were determined by the standard methods (APHA-AWWA,1992). The results of above parameters (Tables 1- 3) were fitted in Langlier Index in order to calculate calcium speciation. Langlier index (LI) was calculated using the following formula (Langlier,1936):

LI = [pH-pHS]

where pH and pHs are normal and saturation pH of the water sample respectively. pHs was determined using the follwing eqution:

pHs = [9.3+(A+B)- (C+D)]

where A , B, C and D are multiplication factors to the values of temperature, TDS, calcium hardness and alkalinity respectively.The stationwise results are as follows :

(i) Satianusuiya: In each month of the study period only scaling deposition tendency was found in Satianusuiya water (Table 1). Minimum scale ten-

Table 1. Monthly Variation of Langlier's Index and Related Factors : River Mandakini at Satianusuiya

Month	Water Temp. (^{0}C)	A	TDS (mg/L)	B	Ca Hardness (mg/L)	C	Total Alkalinity (mg/L)	D	pH	pHs	Langlier Index	Tendency of water
April, 2008	26.5	2.0	340	0.1	237	2.0	245	2.4	7.5	7.0	0.5	Scaling
May, 2008	30	1.9	360	0.1	268	2.0	274	2.5	7.9	6.8	1.1	Scaling
June, 2008	32	1.8	404	0.2	270	2.0	285	2.4	7.7	6.9	0.8	Scaling
July, 2008	34	1.8	410	0.2	285	2.1	292	2.5	7.9	6.7	1.2	Scaling
Aug., 2008	32	1.8	406	0.2	270	2.0	278	2.5	7.8	6.8	1.0	Scaling
Sept., 2008	34	1.8	415	0.2	292	2.1	302	2.5	8.0	6.7	1.3	Scaling
Oct.,2008	28	1.9	348	0.1	248	2.0	258	2.4	7.6	6.9	0.7	Scaling
Nov.,2008	29	1.9	355	0.1	255	2.0	264	2.4	7.7	6.9	0.8	Scaling
Dec., 2008	25	2.0	335	0.1	218	1.9	230	2.4	7.6	7.1	0.5	Scaling
Jan., 2009	22	2.1	330	0.1	190	1.9	196	2.3	7.4	7.3	0.1	Scaling
Feb., 2009	20	2.1	326	0.1	178	1.9	188	2.3	7.4	7.3	0.1	Scaling
March, 2009	29	1.9	360	0.1	258	2.0	260	2.4	7.8	6.9	0.9	Scaling

Table 2. Monthly Variation of Langlier's Index and Related Factors : River Mandakini at Sphatikshila

Month	Water Temp. (^{0}C)	A	TDS (mg/L)	B (mg/L)	Ca Hardness (mg/L)	C	Total Alkalinity (mg/L)	D	pH	pHs	Langlier Index	Tendency of water
April,2008	27.0	1.9	342	0.1	244	2.0	255	2.4	7.8	6.9	0.9	Scaling
May, 2008	31.0	1.9	362	0.1	269	2.0	278	2.5	7.8	6.8	1.0	Scaling
June, 2008	33.0	1.8	404	0.2	275	2.0	282	2.5	7.8	6.8	1.0	Scaling
July, 2008	34.0	1.8	418	0.2	286	2.1	297	2.5	7.7	6.7	1.0	Scaling
Aug., 2008	32.0	1.8	405	0.2	272	2.0	278	2.5	7.9	6.8	1.1	Scaling
Sept.,2008	34.0	1.8	412	0.2	285	2.1	298	2.5	8.0	6.7	1.3	Scaling
Oct.,2008	28.0	1.9	350	0.1	198	1.9	194	2.3	6.8	7.1	-0.3	Corrosive
Nov.,2008	21.5	2.1	330	0.1	215	1.9	212	2.3	6.9	7.3	-0.4	Corrosive
Dec., 2008	23.5	2.0	336	0.1	220	1.9	218	2.4	7.5	7.1	0.4	Scaling
Jan.,2009	18.0	2.1	320	0.1	188	1.9	196	2.3	7.3	7.3	0	Saturated
Feb., 2009	19.5	2.1	325	0.1	174	1.8	182	2.3	7.4	7.4	0	Saturated
March,2009	20.5	2.1	330	0.1	255	2.0	262	2.4	7.6	7.1	0.5	Scaling

dency i.e. 0.1 was found in Jan. and Feb., 2009 and maximum i.e. 1.3 in Sept., 2008. Satianusuiya is that spot where river Mandakini originate through hill mainly limestone rocks consequently more extent of calcium in water of this station. Obviously scale formation tendency prevails at this station.

(ii) Sphatikshila : In 12 month of study period the scale, corrosive and saturation tendencies were observed in 4, 2 and 2 months respectively (Table 2). Corrosive tendency was observed in Oct. and Nov., 2008 due to stagnant water and weed growth therein. On decaying of weed formation of organic matter takes place. This organic matter reacts with dissolved oxygen of water and forms CO_2 . If extent of CO_2 increase in water, pH will decrease. It was observed that saturation tendency prevailed in Jan. and Feb., 2009 which was due to elimination of weed growth through environmental awareness programme run by MGCGV staff and students at Sphatikshila. Consequently water was clean during Jan, and Feb., 2009 producing favorable conditions for saturation purpose.

(iii) Jankikund: Out of 12 month study period, the scale tendency was noticed in 9 months in water of this station (Table 3). Corrosive tendency was found only in July-Aug., 2008. It was due to more dilution owing to abundance of rain water consequently low calcium extent. Temperature and pH also supported the corrosive tendency. Similar findings were reported by Mahadev *et al.*, 2004.

Table 3. Monthly Variation of Langlier's Index and Related Factors : River Mandakini at Jankikund

Month	Water Temp. (^{0}C)	A	TDS (mg/L)	B (mg/L)	Ca Hard-ness (mg/L)	C	Total Alka-linity (mg/L)	D	pH	pHs	Lang-lier Index	Ten-dency of water
April, 2008	27.0	1.9	368	0.1	184	1.9	198	2.3	7.8	7.1	0.7	Scaling
May, 2008	32.5	1.8	392	0.1	192	1.9	208	2.3	7.8	7.0	0.8	Scaling
June, 2008	34.5	1.8	430	0.1	222	1.9	230	2.4	8.0	6.9	1.1	Scaling
July, 2008	35.0	1.8	435	0.2	206	1.9	190	2.3	6.9	7.1	-0.2	Corrosive
Aug., 2008	33.5	1.8	424	0.2	196	1.9	184	2.3	7.0	7.1	-0.1	Corrosive
Sept., 2008	35.0	1.8	436	0.2	210	1.9	196	2.3	6.9	7.1	-0.2	Corrosive
Oct., 2008	29.5	1.9	372	0.1	158	1.8	165	2.2	7.9	7.4	0.5	Scaling
Nov.,2008	24.0	2.0	364	0.1	160	1.8	168	2.2	7.8	7.4	0.4	Scaling
Dec., 2008	23.5	2.0	358	0.1	159	1.8	150	2.2	7.8	7.4	0.3	Scaling
Jan., 2009	19.0	2.1	355	0.1	154	1.8	145	2.2	7.6	7.5	0.1	Scaling
Feb., 2009	18.0	2.1	345	0.1	142	1.8	156	2.2	7.6	7.6	0.2	Scaling
March, 2009	21.5	2.1	356	0.1	155	1.8	148	2.2	7.7	7.6	0.3	Scaling

CONCLUSIONS

The findings of the above study showed that scaling tendency was found to dominate at all stations of river mandakini during the study period. Water quality was not fit for drinking due to high extent of calcium. High concentration of calcium creates stone formation problem and jointness disease in foots of consumers. Hard water forms incrustation in utensils, scale in boilers, hot water pipes and heaters. The finding may be shared with the public health engineering (P.H.I.) authorities and municipal corporation (M.C.) so that they will play their role in improving the quality of water for a safe and healthy life of the surrounding peoples.

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REFERENCES

APHA-AWWA.1992. *Standard Method for Examination of Water and Wastewater*, 18th ed., American Public Health Association, Washington, DC.

Hosmani, S.P. and Kumar, V.L.1996. Calcium carbonate saturation index and its influence on phytoplankton. *Poll. Res.* 15 (3) : 285-288.

Mahadev, J. and Hosmani, S.P. 2002. Langlier index and its relation to phytoplankton in 2 lakes of Mysore City. *Nature Env. Poll. Tech.* 1(1) : 19-21.

Mahadev, J., Nagarathna and Hosmani, S.P. 2004. Studies on water quality with significance of calcium carbonate saturation index in two water bodies of Mysore. *Indian J. Env. Prot.* 24 (9) : 678-683.

Hosmani, S.P, Nagarathna and Mahadev, J. 2002. Scale forming and corrosive tendencies of water in 20 lakes of Mandya District and its relation to phytoplankton. *Indian J. Env. Prot.* 22 (8) : 852-857.

Trivedy, R.K. and Goel, P.K. 1986. *Chemical and Biological Methods for Water Pollution Studies*. Environmental Publication, Karad, 94-96.

Langlier, W.F. 1936. The analytical control of anti corrosive water treatment. *J. Am. Water Works Association*. 28 : 1500.