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Physico-Chemical Assessment of Surface Water Quality With Respect to Seasonal Variation Around Amarkantak Thermal Power Plant, Chachai, Madhya Pradesh, India.

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Abstract: *The current research is an outcome of periodic physico- chemical observation and analysis of seasonal surface water samples collected from adjacent locations of ATPS, Chachai, (M.P.) India. The surface water quality typically subjects to geo-morphological and environmental conditions which are the key source to assess the alteration in physico chemical properties of water quality of the system and surroundings. In order of determine the Physico-Chemical Quality of Surface water considering the suitability for agriculture and domestic purposes. Hence 5 nos. of surface water samples from five identified locations were collected and analysed followed by summer, monsoon and winter seasons. Significant differences have been observed in the physico-chemical analysis of the collected surface water samples. The pH of the samples varied from 7.28 – 7.98 with conductivity 162-363 µs/cm. Total hardness noted from 102 -178 ppm, while Ca-hardness reported 58-110 ppm and Mg-hardness ranged from 34-72 ppm. Alkalinity of water samples were observed from 104-126 ppm. Total Dissolved Solid of collected water samples varied from 97-236 ppm while in fluctuation in chloride concentration observed in between 12-68 ppm. Adequate seasonal variations observed and reported 14 NTU (min) to 130 NTU (max). The seasonal changes also effected silica concentration of water sample with a range 5.8-76.5 ppm. After analysis of surface water sample, values of seasonal alternation compared against the prescribed limits of BIS-10500:2012.*
Key Words: *surface water, seasonal variation, Physico-chemical analysis, Assessment*

I. Introduction

Water resources have been the most exploited natural system since the world begun and it is used for domestic, agricultural activities and industrial purpose. The usage depends on the quality of Surface water (river, stream, lake and dam etc) and can be served as primary sources especially for thermal power plants. But with the increasing contamination of the surface water, there is now an increasing reliance on water for drinking and domestic purposes. Many of the researchers identified the surface water pollution and their effect on human life. The assessment of drinking water quality in schools of village of Buldhana district explored that the water quality is unsatisfactory **[1]**. An attempt was made to evaluate water condition of Rewa city, M.P., India towards identify the effect of non point source pollution on some surface water samples and reported non suitability of the water quality for drinking purposes **[2]**. Results obtained in investigations revealed that the discharge of untreated industrial effluent and sewage have contributed considerable pollution, hence the water of these rivers is unsafe for consumption or human use. **[3]**

As Per World Health Organization "Water intended for human consumption must be free from harmful micro organism, toxic substances, excessive amount of minerals and organic matter" (WHO, 1996) **[4]**. Assessment of ground water quality of rural parts of kapadwanj .Its physio-chemical analysis of ground water was carried out from twenty sampling stations of rural parts of Kapadwanj region are during the Feb.-July 2012 in order to assess water quality index **[5]**. However several statistical studies have demonstrated a highly significant inverse relationship between cardiovascular disease mortality and water hardness even when other environmental and socioeconomic factors are taken into account **[6]**.

II. Aims and Objectives

Surface Water is considered for assessment to know the extent of contamination by various pollutants which are either intermittently or continuously discharged from ATPS Ash Pond seepage water with a connecting water source known as kalhori nala into adjacent river water system. Hence to evaluate such seasonal physico-chemical variation in surface water following sampling point was selected for current study.

Table No.1: Study Site and Location with Latitude and Longitude of Surface Water Sample Points.

S. No.	Area/Location	Sample ID	Geographical Position
1	SON RIVER (upstream water)	CHSW-1	23º 08'39" **N** and 81º41'25" **E**
2	ATPS PUMP HOUSE	CHSW-2	23º 10'27" **N** and 81º40'07" **E**
3	KALHORI NALA (ATPS ash pond discharge water)	CHSW-3	23º 10'55" **N** and 81º37'36" **E**
4	BEFORE OPM PUMP HOUSE	CHSW-4	23º 11'37" **N** and 81º37'15" **E**
5	BHATURA GHAT	CHSW-5	23º 12'10" **N** and 81º36'49" **E**

The Amarkantak Thermal Power Station in Chachai (M.P.) is a link in Korba-Amarkantak-Satpura power chain and is situated at 23º 10'04" **N** and 81º39'15" **E** falling in Survey of India toposheet nos. 64E, 64F&I. It is interconnected to the 220 KV lines Madhya Pradesh grid line and the Rihand system of Uttar Pradesh through 132 KV lines **[7]**. The key map of study area along with identified locations for Surface water sampling around Amarkantak Thermal Power Plant, Chachai, Madhya Pradesh, is displaying in fig.1.

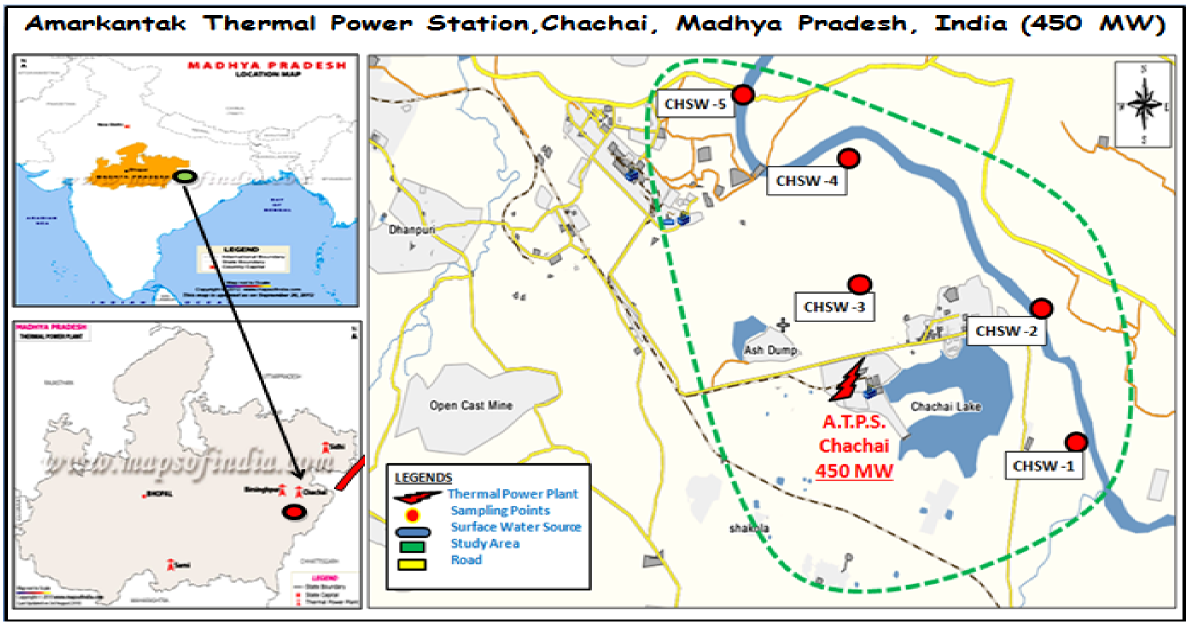

Figure -1: Key map of study area along with identified Surface water Sampling Location.

III. Material and Methods

Total Fifteen numbers of water samples were collected followed by 5 samples in three seasons from different locations adjacent to Amarkantak thermal power plant, Chachai considering it as centre of the current study. The physico-chemical analyses of the samples were performed as per standard methodology prescribed in APHA, 1989 **[8]** and BIS: 3025, 1987 (Reaffirmed 2003) **[9]**. The turbidity of the samples were analyzed with HACH-2100Q and reported in NTU. The pH of the collected samples were observed with a calibrated instrument while conductivity was measured with microprocessor based analyser and reported as corrected values in µs/cm at 25^0C. The Alkalinity, Hardness and chloride concentration were measured with volumetric estimation and reported in mg/l. Silica is evaluated by using spectro-photometric methods of WTW Photo-lab 6100 VIS.

IV. Result and Discussion

The Physico-chemical data of the 15 number of surface water samples collected in three seasons referring summer **(S)**, monsoon **(M)** and winter **(W)** are presented in Table-2, Table-3 and Table-4 respectively. Water samples were analysed with standard laboratory practices for total 12 parameters and summarised hereunder.

Table-2: Physico-Chemical Analysis of Surface Water Sample in summer.

S. No.		Parametrs	Unit	BIS-10500	CHSW 1	CHSW 2	CHSW 3	CHSW 4	CHSW 5
Physical Parameter	1	Taste	-	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable
	2	Odour	-	Odourless	Odourless	Odourless	Odourless	Odourless	Odourless
	3	Turbidity	NTU	5	15	22	70	14	67
	4	Conductivity	µs/cm	750	260	273	363	258	338
	5	TDS	mg/l	500	156	164	218	155	203
	6	pH	-	6.5 - 8.5	7.98	7.92	7.85	7.80	7.80
Chemical Parameter	7	T H	mg/l	300	110	108	178	120	126
	8	Ca Hardness		-	68	66	110	74	78
	9	Mg Hardness		-	38	42	68	46	48
	10	ALK	mg/l	200	126	120	124	110	114
	11	Cl	mg/l	250	12	16	24	22	54
	12	Si	mg/l	-	5.75	5.95	38.40	14.37	12.95

Table-3: Physico-Chemical Analysis of Surface Water Sample in Monsoon.

S. No.		Parametrs	Unit	BIS-10500	CHSW 1	CHSW 2	CHSW 3	CHSW 4	CHSW 5
Physical Parameter	1	Taste	-	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable
	2	Odour	-	Odourless	Odourless	Odourless	Odourless	Odourless	Odourless
		Turbidity	NTU	5	110	120	115	126	230
	4	Conductivity	µs/cm	750	194	196	363	250	268
	5	TDS	mg/l	500	126	127	236	163	174
	6	pH	-	6.5 - 8.5	7.90	7.86	7.77	7.70	7.61
Chemical Parameter	7	T Hhardness	mg/l	300	102	104	162	110	114
	8	Ca Hardness	mg/l	-	66.3	67.6	105.3	71.5	74.1
	9	Mg Hardness	mg/l	-	35.7	36.4	56.7	38.5	39.9
	10	ALK	mg/l	200	106	104	108	114	122
	11	Cl	mg/l	250	14	18	32	26	68
	12	Si	mg/l	-	9.68	10.40	41.36	16.81	17.22

Table-4: Physico-Chemical Analysis of Surface Water Sample in winter.

S. No.		Parametrs	Unit	BIS-10500	CHSW 1	CHSW 2	CHSW 3	CHSW 4	CHSW 5
Physical Parameter	1	Taste	-	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable
	2	Odour	-	Odourless	Odourless	Odourless	Odourless	Odourless	Odourless
	3	Turbidity	NTU	5	32	36	88	62	80
	4	Conductivity	µs/cm	750	162	164	286	172	184
	5	TDS	mg/l	500	97	98	172	103	110
	6	pH	-	6.5 - 8.5	7.84	7.86	7.41	7.70	7.21
Chemical Parameter	7	T H	mg/l	300	106	110	170	110	120
	8	Ca Hardness	mg/l	-	69	72	114	76	78
	9	Mg Hardness	mg/l	-	37	38	56	34	42
	10	ALK	mg/l	200	108	112	122	108	110
	11	Cl	mg/l	250	13	16	28	20	58
	12	Si	mg/l	-	11.01	11.65	76.50	18.13	16.74

Table no.5: Correlation Matrix for Different Physico-Chemical Parameters of Surface water.

	NTU	Cond.	TDS	pH	T H	CaH	MgH	ALK	Cl	Si
NTU	**1**									
Cond.	0.140	**1**								
TDS	0.185	**0.998**	**1**							
pH	-0.335	0.089	0.089	**1**						
T H	0.164	0.697	0.696	-0.259	**1**					
CaH	0.209	0.817	0.817	-0.205	**0.959**	**1**				
MgH	-0.135	0.529	0.246	-0.326	**0.883**	0.787	**1**			
ALK	-0.385	0.246	0.374	0.098	0.242	0.252	0.420	**1**		
Cl	0.444	0.246	0.246	-0.642	0.081	0.173	0.089	-0.140	**1**	
Si	0.045	0.149	0.135	-0.560	0.588	0.456	0.718	0.377	0.027	**1**

The physico-chemical properties were subsequently varied followed by summer **(S)**, Monsoon **(M)** and winter **(W)** Seasons. Turbidity varies from 14-67 NTU (S), 110-230 NTU (M) and 32-88 NTU (W) shown in fig.-2. The fluctuation in turbidity is based on the soil Texture and disposal of untreated effluent by various medium. The conductivity of water samples ranged from 260-363 μscm-1 (S), 194-363 μscm-1 (M) and 162-286 μscm-1 (W) shown in fig.-3. Conductivity indicates the presence of dissolved solids and contaminants especially electrolytes.

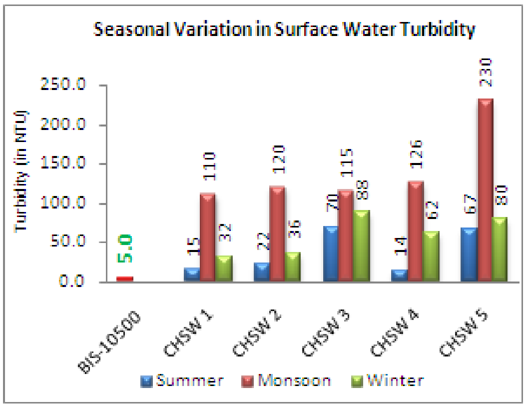

Fig.-2 Distribution scale of Turbidity

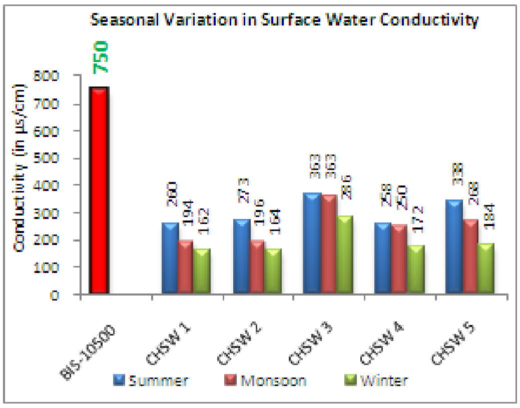

Fig.-3 Distribution scale of Conductivity

The result shown in fig.-4 describes seasonal variation of total dissolved solids (TDS), which is being reported from 160-225 mgL-1 (S), 126-236 mgL-1 (M) and 97-172 mgL-1 (W). The pH values of the Surface water ranged from 7.80-7.98 mgL-1 (S), 7.61-7.90 mgL-1 (M) and 7.21-7.86 mgL-1 (W) shown in fig.-5.

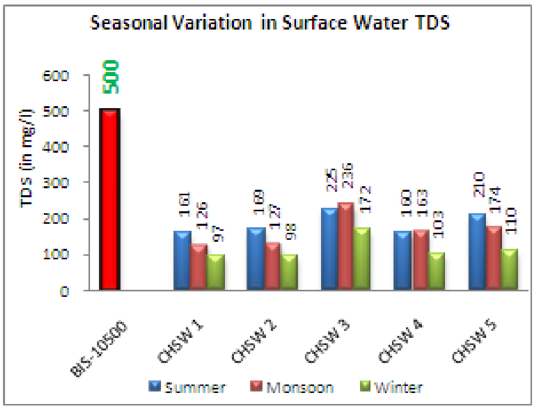

Fig.-4 Distribution scale of Total Dissolved Solid

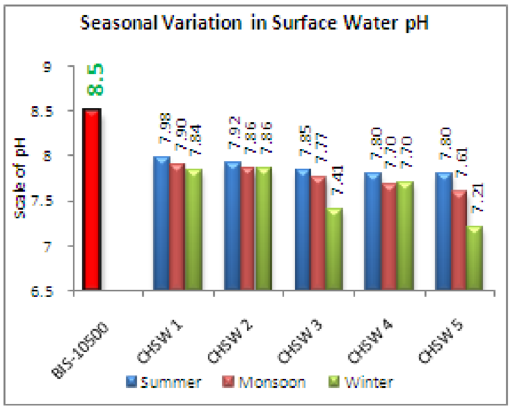

Fig.-5 Distribution scale of pH

The pH values obtained in water samples fall within the recommended standard of 6.0-8.5 **[10]**. Generally, the pH of water is influence by geology of catchments area and buffering capacity of water. The total hardness levels of the samples varied between 108-178 mgL-1 in Summer, 102-162 mgL-1 in monsoon and 106-170 mgL-1 in the winter season and is below the WHO standard of 300 mgL-1 as CaCO3 shown in fig.-6 **[11]**. It is mainly derived from weathering of minerals such as limestone (CaCO3) or dolomite (CaCO3.MgCO3) **[12]**.

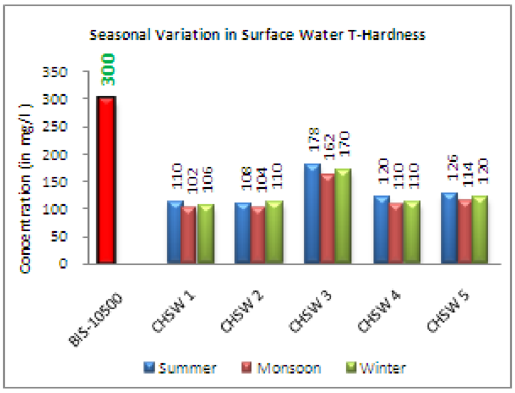

Fig.-6 Distribution scale of Total Hardness

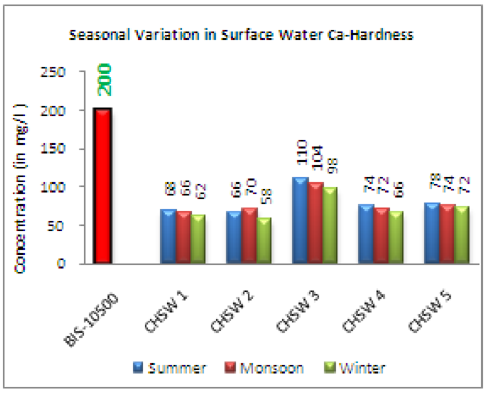

Fig.-7 Distribution scale of Ca-Hardness

The Values of Ca-hardness were reported 68-110 mgL-1 (S), 66-104 mgL-1 (M) and 62-98 mgL-1(W) shown in fig.-7. Mg-hardness observed between 42-68 mgL-1 (S), 34-58 mgL-1 (M) and 54-72 mgL-1 (W) displayed in fig.-8. Alkalinity ranged 42-68 mgL-1 (S), 34-58 mgL-1 (M) and 54-72 mgL-1 (W) respectively presented in fig.-9.

In natural water, alkalinity is caused by three major classes of minerals: hydroxides, carbonates and hydrogen carbonates. In all forms of effluents, alkalinity is due to the presence of salts of weak acid such as ethanoic, propanoic or the presence of ammonia hydroxides.

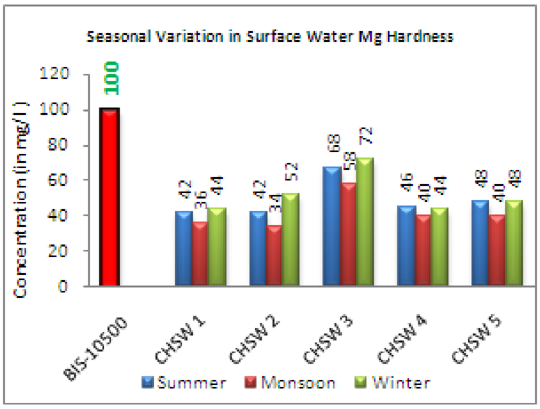

Fig.-8 Distribution scale of Ma-Hardness

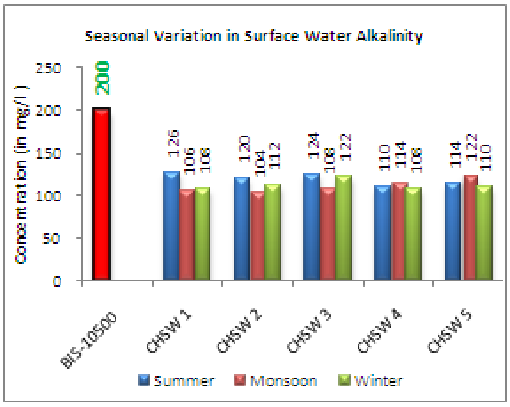

Fig.-9 Distribution scale of Alkalinity

The concentration of the chloride in all the study sites are well within the acceptable limits for the water, recorded as 12-54 mgL-1 (S), 14-68 mgL-1 (M) and 13-58 mgL-1 (W) shown in fig.-10.

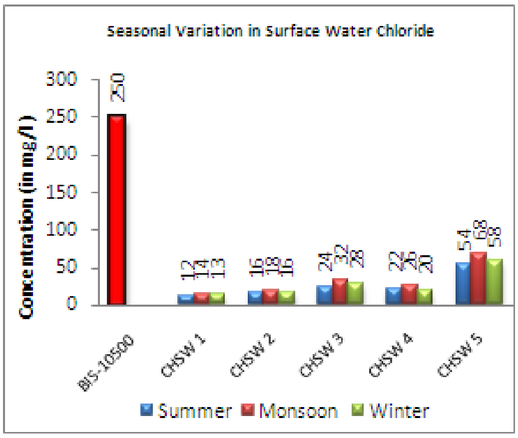

Fig.-10 Distribution scale of Chloride

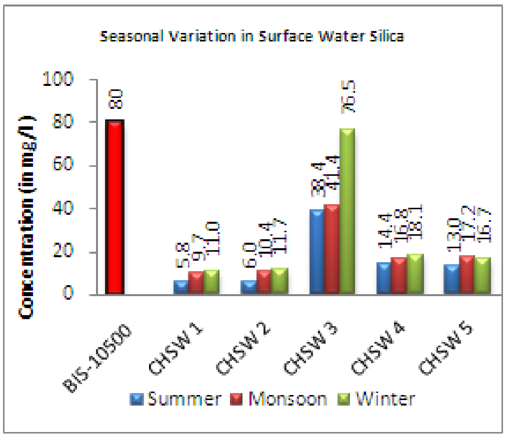

Fig.-11 Distribution scale of Silica however no any guidelines are there for concentration of silica in drinking water standard till date, but some recommendation shown that >80 mgL-1 concentration may cause adverse condition for human health **[13]**. The silica concentrations in all the sites were reported between 5.8-38.4 mgL-1 (S), 9.7-17.2 mgL-1 (M) and 11.0-76.5 mgL-1 (W) summarised and presented in fig.-11 respectively.

V. Conclusion

The current study of surface water samples concludes that not much significant seasonal variations were observed for selected 12 parameters only, except Turbidity during the period of investigation. The turbidity of water samples for all five locations was recorded higher against the prescribed limit. Higher turbid water 110 $NTU_{(min)}$-230 $NTU_{(max)}$ in monsoon season is tolerable and well understood because of runoff water, but in summer 14 $NTU_{(min)}$-67 $NTU_{(max)}$ 32 $NTU_{(min)}$-88 $NTU_{(max)}$ in winter seasons conceivably exaggerate by either intermittent or continuous discharge of Adjacent ATPS Ash Pond surfeit water with a connecting source known as Kalhori Nala into surface water system. Previous research studies have also summarized the adverse effect and water pollution due to ATPS fly ash dykes **[14]**.

Therefore, on the basis of physico-chemical analysis of identified sampling location it can be suggested that water may be use for domestic purpose after pre-treatment and purification of water by standard methodology prescribed by CGWB and CPCB. It is also advisable that ATPS should strictly adhere the Zero Liquid Discharge of such effluent in to the surrounding of power station by adapting Ash water recovery System. Thus the power generation and environment conservation could be balanced together.

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