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Analysis Of Physic-Chemical Characteristics Of Polluted Water Samples And Evaluation Of Wqi Values From Industries Effluent In Tiruchirapalli, India

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ABSTRACT
Water Quality Index values were also computed to evaluate the pollution load of waste water. Almost all the water quality parameters of the dyeing effluents have been found to be very high and well above the permissible limit as suggested by Bureau of Indian Standards[1]. Effluent of dyeing samples were collected from common effluent treatment plants (CETPs) at Tiruchirapalli and analysed monthly for a period of 12 months in order to understand various physic-chemical characteristics of the water samples Ratios like Kellys[2], Magnesium, Sodium Absorption and percent sodium are well above the prescribed limits for irrigation and public use. Correlation studies have been carried out by using least squares method. The values of correlation co-efficients (range of r = -0.683 to 0.999).have been computed for correlations between all possible pair of physic-chemical water quality parameters of dyeing units effluents. Statistically significant correlations are noted between the pairs of water quality parameters as EC and TDS (r= 0.980), WQI and Na (r= 0.998), TH and Mg (=0.974), EC and Na (r= 0.870). Linear relationships have been developed for these correlations. Such correlation equations are found to be highly useful in predicting the water quality parameters.

Keywords: Water quality parameters, Water Quality Index, Dyeing effluent, Correlations.

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I. INTRODUCTION

Tiruchirapalli has more than 600 dyeing and bleaching units which produce 8.8 crore litres of effluent after primary treatment (only colour has been removed from the effluent, but the total dissolved solids remain as such in the effluents) are being let into the nearby Cauvery river. Tamil Nadu Pollution Control Board (TNPCB) stipulates that the total dissolved solids (TDS) in the water discharged into the river should not be more than 2100 ppm. But the effluents from the most of the treatment plants have more than 7500ppm. Textile industry of Tiruchirapalli uses bleaching liquids, soda, ash, caustic soda, sulphuric acid, hydrochloric acid sodium peroxide and various other chemicals for their treatment processes. Other harmful substances include a number of wastages many based benzidine or heavy metals both known to be toxic. Most of the chemicals are not retained on finished hosiery goods but are discharged as effluent. The effluents smell terrible and contain very high dissolved solids. The discharge of the untreated effluents from wastages the main cause for the fast degradation of water resources at Tiruchirapalli.

Correlations among water quality parameters in a specific environmental condition have been shown to useful (Tiwari & Manzoor Ali 1988; Kannan & Rajasekaran 1991; Patnaick[3] et al 1991; Mahajan 2005)[4&5]. When such correlations exist, then specifying a few of the more important ones would suffice to give a rough, but still fairly useful indication of the quality of effluents since the other parameters and their function can be explained and accounted for by using these correlations. This may greatly facilitate the task of rapid monitoring of the status of pollution and may prove to be a boon in India and other developing Asian countries, where laboratory facilities and trained man power are inadequate. The present study has been undertaken with a view to document the water quality parameters of various industry effluents in Tiruchirapalli to characterize and to find the extent of pollution and correlations among water quality parameters.

II. MATERIALS AND METHODS

Samples of raw effluents for analysis were collected from common effluent treatment plants (CETPs) at Tiruchirapalli for a period of 12 months. Samples were collected from 3 different CETPs and mixed in equal volumes and analysed to get an average data on water quality parameters. Standard recommended procedures have been followed for the collection, storage and determination of various physic chemical parameters of samples (Rand et al 1976; APHA (1975)[6&7.] IS: 3025, (1964)[8] WQI values were calculated from the observed water quality parameters as per the procedure reported by Tiwari and Ali (1987)[9]. SPSS . The (Statistics Package for Social Sciences) software is used to carry out the correlation analysis and to compute the correlation co-efficents (r values) for all possible correlations among water quality parameters. The SPSS software is a used to calculate the regression parameters A and B of the straight line Y= AX+B by applying the well known method of least squares (Wonnacott & `wonnacott (1981) [10]; Gupta (1974)[11] to fit the experimental data to the straight line given by the previous equation.

A few important chemical parameters, such as sodium absorption raito (SAR), percent sodium (PS), Kelley's ratio (KR) and magnesium ratio (MR) are determined to assess the general suitability of the industrial effluent for irrigation. These parameters were calculated by using the following relationships (Srinivasa Gowd 1999)[12].

SAR=Na/[(Ca+Mg)/2]$^{0.5}$ ……………………...(1)

PS=100

[(Na+K)/(Ca+Mg+Na+K)]…………………….(2)

KR= Ca+Mg)]………………………………... (3)

MR= 100[Mg/(Ca+Mg)]……………………….(4)

Where , the ionic concentrations are expressed in mili equivalents per litre. The average values of SAR, PS, KR and MR have been caluculated from water quality parameters for the dyeing units effluent.(Table 2)

III. RESULTS AND DISCUSSION

Almost all the water quality parameters are found to be very high and well above the permissilble limit (ICMR 1963; BiS, IS:10500,1983; MWH 1975). The PH values of the water samples collected from the CETP s are noted and fluctuatd form 7.68 to 9 .56. During treatment processes, bleaching liquids, soda ash, caustic soda, sulphuric acid, hydrochloric acid, sodium peroxide, sodium chloride and many other chemicals are used. The samples are slightly alkaline and smell terrible. Most of the PH values are above the permissible limit recommended by ICMR 7.0 - 8.5.

The temperature of the effluent samples ranging between 27.1 and 29.3^{0}C which is the ambient temperature for water sampling. The electrical conductivity of the dyeing effluents is in the range of 8275 and 21140 micromhos which is well above the permissible limit of ICMR – 400 units. The TDS of the samples are also expected to be very high since mostly the ionic substances acids and bases are responsible for the value of EC. In the treatment plants only colour of the effluent is removed but the TDS is slightly increased compared to original effluents due to the addition of lime and ferrous sulphates to remove the colour. Most of the samples are having more than 7500 ppm which is well above the stipulated value of TNCPB (2100ppm). To remove the high TDS in effluent the Tiruchirapalli industries were instructed to install Reverse Osmosis (RO) plants to produce zero effluent.

Table 1 Physico-chemical characteristics of industry effluents

Period	Temp (^{0}C)	pH	EC	TSS	TDS	TH	TEH	PEH	Ca	Mg	Na
Sep 2014	27.2	8.62	11050	34	6742	475	296	179	206	269	2060
Oct 2014	27.8	8.38	12780	70	7865	528	340	188	220	308	2090
Oct 2014	26.9	7.68	8275	63	4858	336	215	121	146	109	1760
Oct 2014	26.4	7.81	10600	72	6272	490	284	206	210	280	1920
Dec 2014	26.2	7.98	11310	114	6470	542	310	232	227	315	2190
Dec 2014	26.7	8.07	8540	55	4724	325	205	120	175	150	1520
Jan 2015	26.3	8.89	10920	110	6130	428	235	193	188	240	1630
Jan 2015	26.8	8.32	8925	206	4950	460	240	220	210	250	1480
Feb 2015	27.6	8.12	9965	96	5758	670	390	280	305	365	1570
Mar 2015	28.2	8.61	10670	140	6168	800	470	33	365	435	1870
Apr 2015	287	9.06	12640	198	7002	870	560	310	415	455	2040
May 2015	28.9	9.56	11680	60	6560	820	470	350	380	440	1840
Jun 2015	27.8	8.65	15740	115	8970	570	326	244	265	305	2360
Jul 2015	27.8	8.02	14500	90	8556	610	320	290	288	322	2270
Jul 2015	28.8	8.17	15070	110	8332	680	355	325	335	345	2340
Sep 2015	27.6	8.05	14630	268	8350	730	390	340	345	385	1520
Oct 2015	26.8	8.35	12940	80	7870	690	396	294	317	373	1980
Nov 2015	26.3	9.35	11370	245	6340	700	396	304	330	370	1860
Jan 2016	25.2	8.12	10520	160	6470	545	260	285	230	315	1690

Feb 2016	26.3	7.85	12260	110	6725	690	400	190	317	373	2030
Mar 2016	28.3	8.45	14290	270	7860	760	470	190	320	440	2205
Apr 2016	28.7	9.03	19760	337	12350	950	550	400	370	580	2690
May 2016	28.6	9.5	21140	260	13300	850	560	290	386	463	3510
May 2016	26.9	9	17020	170	9800	660	400	260	350	310	2562

Uniyt : Except pH and EC all other values are in mg/l . EC in micromhos/cm.

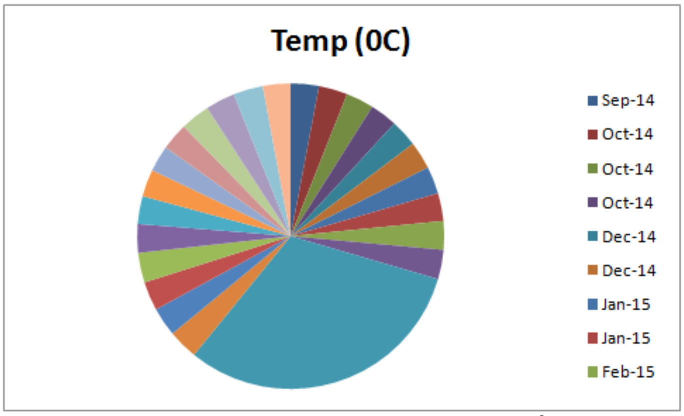

Fig:1 Comparison of Period and Temp (^{0}C)

Table 1 (Continued) Physico-chemical characteristics of industry effluents

Period	K	COD	BOD	Cl	SO_4-	Fe	CU	Cr	Zn	WQIS
Sep 2014	32	145	69	3739	492	0.15	0.056	0.84	0.18	2838
Oct 2014	42	210	105	3960	580	0.27	0.043	0.26	0.192	2943
Oct 2014	44	114	52	2658	370	022	0	0	0	2484
Oct 2014	57	160	73	3210	530	0.12	0	0	0.128	2784
Dec 2014	58	190	87	3731	585	0.16	0	0	0	3136
Dec 2014	38	72	156	2505	329	0,09	0.029	0.84	0	2155
Jan 2015	32	370	115	2900	520	0.34	0.019	0.64	0	2296
Jan 2015	28	159	77	2430	513	0.17	0.23	0	0.44	2084
Feb 2015	37	175	79	2855	890	0.24	0.126	0.26	0.22	2283
Mar 2015	42	200	87	3298	635	0.26	0.093	0.52	0.19	2698
Apr 2015	38	175	60	3626	745	0.15	0.33	0.179	0.18	2908
May 2015	32	190	105	3549	770	0.13	0.28	0	0.14	2623
Jun 2015	46	245	70	4690	380	0.09	0.13	0.35	0	3312
Jul 2015	38	195	83	4070	760	0.19	0.13	0.632	0.629	3162
Jul2015	41	230	118	3840	865	0.22	0.05	0.245	0.377	3272
Sep 2015	25	170	69	2699	768	0.18	0.08	0.38	0.14	2187
Oct 2015	34	140	60	3960	685	0.34	0	0.18	0	2793
Nov 2015	32	205	78	3458	535	0.4	0	0	0.34	2625
Jan 2016	26	250	96	3045	245	0.24	0.14	0.29	0	2355
Feb 2016	45	135	105	3458	620	0.17	BDL	0.31	0.13	2898
Mar 2016	38	275	160	4300	600	0.24	0.165	BDL	0.51	3107
Apr 2016	55	175	78	4385	1030	0.34	0	0	0	3801
May 2016	63	250	140	6115	1100	0.4	0.24	0	0.46	4893
May 2016	45	210	90	4200	690	0.26	0.26	0	0.34	3568

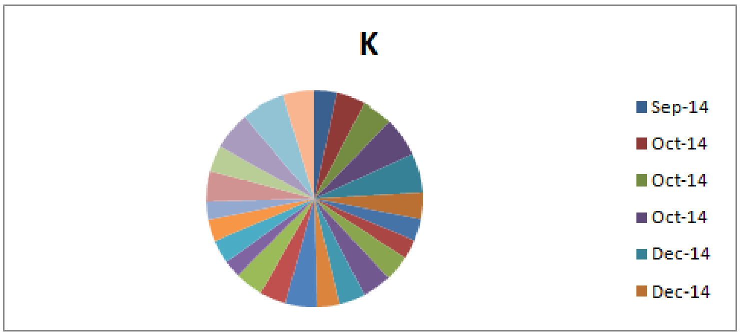

Fig: 2 Comparison of Period and k

The samples of dyeing unit effluents are noted to fall in the category of "hard type" according to Sawyer's classification (Sawyer 2003)[13]. The total hardness (TH) of waste water samples collected from CETPs are higher amount of carbonate hardness or temporary hardness(THE) range of 205 to 560ppm. The non- carbonate hardness or permanent hardness (PEH) of these effluent samples are 120 -400 ppm which is lesser than that of carbonate hardness. These water samples can be softened by boiling method. Water treatment processes other than boiling will be more effective in the removal of total hardness of these water samples.

Table 2 values of SAR, PS, KR and MR of industrial effluent

Parameter/ratio	industrial effluent
SAR	116.33
PS	75.18
KR	3.38
MR	54.46
Na^+	88.77
Ca^{2+}	14.35
Mg^{2+}	28.37
K^+	1.03

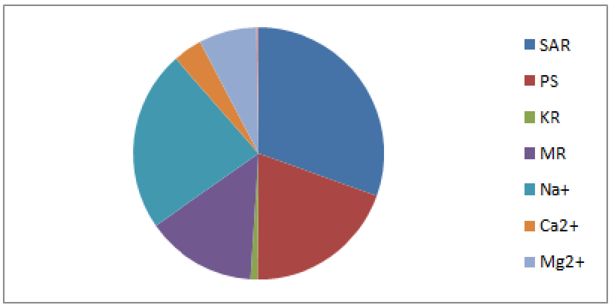

Fig: 3 Comparison of Parameter/ratio and industrial effluent

The various cations analysed sodium content is very high and well above the toxic level. Sodium represents nearly 80% of the total cations estimated (Range 1480-3510 ppm), calcium (146-415), Magnesium (150-580ppm) and potassium (25 – 63ppm) iron, copper, chromium and zinc are 0.09-0 .40, 0.02-0.33, 0.18-0.84 & 0.13-0.63ppm respectively. Among the anions analysed the chloride (Range 2430- 6115ppm) and sulphates 245-1100ppm) are very high and above the tolerance level. The effluent samples are having high salinity which is hazardous to human health (Bockns 1977). The water quality index ranges from 2084-4893 indicateshighlypolluted.

Table 3 Statistical values of water quality parameters of industrial effluents

Name of the parameter	Minimum	Maximum	Range	Std Deviation	Mean	Median
Temperature (^{0}C)	25.20	28.90	3.70	1.01	27.37	27.40
pH	7.68	9.56	1.88	0.54	8.49	8.37
Electrical conducti vity (Micromhos)	8275.00	21140.00	12865.00	3275.41	12774.79	11970.00
Total suspended	34.00	337.00	303.00	83.06	143.04	112.00

solids (mg/l)						
Total dissolved solids(mg/l)	4724.00	13300.00	8576.00	2112.04	7434.25	6733.50
Total hardness (mg/l)	325.00	950.00	625.00	166.74	632.46	665.00
Temporary hardness (mg/l)	205.00	560.00	355.00	106.11	368.25	372.50
Permanent hardness(mg/l)	120.00	400.00	280.00	72.75	255.88	270.00
Calcium(mg/l)	146.00	415.00	269.00	76.60	287.50	311.00
Magnesium(mg/l)	150.00	580.00	430.00	95.60	344.92	333.50
Sodium(mg/l)	1480.00	3510.00	2030.00	452.89	2041.13	2005.00
Potassium(mg/l)	25.00	63.00	38.00	10.12	40.33	38.00
Chemical oxygen demand (mg/l)	72.00	370.00	298.00	59.90	193.33	190.00
Biological oxygen demand (mg/l)	52.00	160.00	108.00	28.91	92.17	85.00
Chloride (mg/l)	2430.00	6115.00	3685.00	819.80	3611.71	3587.50
Sulphate (mg/l)	245.00	1100	855.00	210.27	634.88	610.00
Total iron (mg/l)	0.09	0.40	0.31	0.09	0.22	0.22
Copper (mg/l)	0.02	0.33	0.31	0.10	0.14	0.13
chromium(mg/l)	0.18	0.84	0.66	0.23	0.42	0.33
Zinc (mg/l)	0.13	0.63	0.50	0.15	0.30	0.25
Water Quality Index	2084.00	4893.00	2809.00	620.92	2883.54	2815.50

Table 4 Correlation Matrix of effluents

Parameter	T	PH	EC	TSS	TDS	TH	TEH	PEH	Ca	Mg	Na	K	COD	BOD	Cl	SO_4	Fe	Cu	Cr	Zn	WQI
T	1.00	0.438	0.531	0.257	0.497	0.646	0.689	0.482	0.636	0.616	0.451	0.196	0.081	0.145	0.476	0.688	0.022	0.317	0.198	0.068	0.461
PH		1.00	0.469	0.397	0.460	0.566	0.616	0.472	0.579	0.522	0.437	0.033	0.392	0.140	0.503	0.401	0.439	0.607	0.036	0.020	0.431
EC			1.00	0.576	0.987	0.652	0.658	0.517	0.622	0.638	0.870	0.470	0.331	0.176	0.850	0.691	0.396	0.296	0.410	0.386	0.870
TSS				1.00	0.552	0.618	0.582	0.501	0.540	0.644	0.348	0.089	0.274	0.105	0.306	0.433	0.468	0.425	0.416	0.316	0354
TDS					1.00	0.621	0.635	0.505	0.567	0.627	0.883	0.498	0.297	0.142	0.857	0.685	0.442	0.269	0.403	0.373	0.881
TH						1.00	0.964	0.819	0.960	0.974	0.489	0.178	0.174	0.016	0.529	0.764	0.357	0.606	0.657	0.108	0.510
TEH							1.00	0.676	0.926	0.939	0.569	0.291	0.132	0.069	0.605	0.759	0.360	0.621	0.589	0.127	0.591
PEH								1.00	0.801	0.787	0.270	0.030	0.184	0.230	0.291	0.657	0.318	0.419	0.557	0.076	0.284
Ca									1.00	0.872	0.453	0.103	0133	0.025	0.489	0.741	0.292	0.636	0.604	0.095	0.471
Mg										1.00	0.488	0.227	0.196	0.007	0.529	0.737	0.389	0.549	0.683	0.115	0.510
Na											1.00	0.713	0.255	0.226	0.949	0.577	0.367	0.320	0.212	0.430	0.999
K												1.00	0.026	0.120	0.586	0.358	0.091	0.196	0.139	0.194	0.730
COD													1.00	0.315	0.341	0.100	0.419	0.057	0115	0.556	0.246
BOD														1.00	0.235	0.060	0.093	0.192	0.387	0.400	0.221
Cl															1.00	0.521	0.358	0.307	0.273	0.419	0.946
SO_4																1.00	0.403	0.344	0.394	0.163	0.595
Fe																	1.00	0.033	0.293	0.321	0.362
Cu																		1.00	0.508	0.093	0.331
Cr																			1.00	0.255	0.256
Zn																				1.00	0.412
WQI																					1.00

Parameter	Fe	Cu	Cr	Zn	WQI
T	0.022	0.317	0.198	0.068	0.461
PH	0.439	0.607	0.036	0.020	0.431
EC	0.396	0.296	0.410	0.386	0.870
TSS	0.468	0.425	0.416	0.316	0354
TDS	0.442	0.269	0.403	0.373	0.881
TH	0.357	0.606	0.657	0.108	0.510
TEH	0.360	0.621	0.589	0.127	0.591
PEH	0.318	0.419	0.557	0.076	0.284
Ca	0.292	0.636	0.604	0.095	0.471
Mg	0.389	0.549	0.683	0.115	0.510
Na	0.367	0.320	0.212	0.430	0.999
K	0.091	0.196	0.139	0.194	0.730
COD	0.419	0.057	0115	0.556	0.246
BOD	0.093	0.192	0.387	0.400	0.221
Cl	0.358	0.307	0.273	0.419	0.946
SO_4	0.403	0.344	0.394	0.163	0.595
Fe	1.00	0.033	0.293	0.321	0.362
Cu		1.00	0.508	0.093	0.331
Cr			1.00	0.255	0.256
Zn				1.00	0.412
WQI					1.00

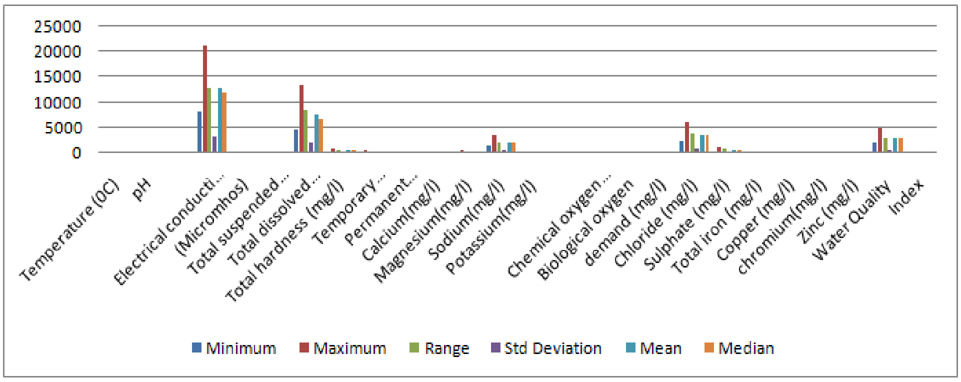

Fig: 4 Statistical values of water quality parameters of industrial effluents

Table 5 Observed and calculated values of WQI

WQI 1.3690 Na+89.2341 (r=0.998)

S.NO	Sodium Obs	WQI Cal	WQI
1	2060	2838	2909.4
2	2090	2943	2950.5
3	1760	2484	2498.7
4	1920	2784	2717.7
5	2190	3136	3087.4
6	1520	2155	2170.1
7	1630	2296	2320.7
8	1480	2984	2115.4
9	1570	2283	2238.6
10	1870	2698	2649.3
11	2040	2908	2882.0
12	1840	2623	2608.2
13	2360	3312	3320.1
14	2270	3162	3196.9
15	2340	3272	3092.7
16	1520	2187	2170.1
17	1980	2793	2799.9
18	1860	2625	2633.6
19	1690	2355	2402.9
20	2030	2898	2868.3
21	2205	3107	3107.9
22	2690	3801	3771.9
23	3510	4893	4894.4
24	2562	3568	3596.6

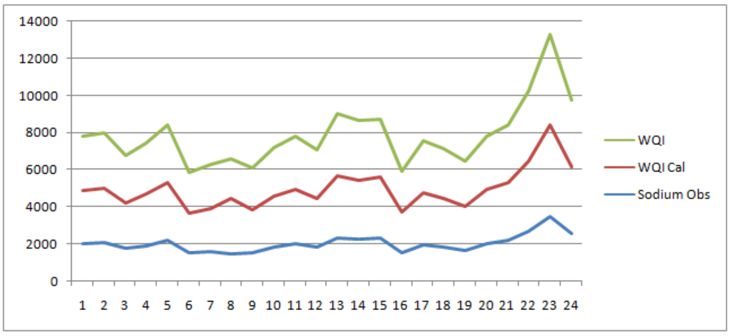

Fig: 5 Observed and calculated values of WQI

Kelley (1951) first pointed out the importance of considering the concentration of sodium in assessing the suitability of water for irrigation. According to him, excess sodium in irrigation waters reacts with soil to reduce its permeability as a result of clogging of particles. According to the U.S Salinity Laboratory[14], the SAR predicts reasonably well the degree to which irrigation water tends to enter cation exchange reactions in soil.

High values for SAR imply a hazard of sodium replacing adsorbed calcium and magnesium, a situation ultimately damaging soil structure. Therefore, the SAR is used for adjudicating the irrigation waters. Irrigation waters are classified by Richards (1954)[15] based on SAR is between o and 10, the water is excellent and it is good if the value is 10 to 18 ; the quality is fair if the SAR ranges from 18 to 28, while it is poor beyond 28. Based on the above classification, the value of SAR of industrial effluents is 116.33 indicates that the effluent is unsuitable for irrigation. Percent sodium (PS) values less than 50 are suitable for irrigation (Wilcox 1948) and therefore here again the effluent has more than 75 percent sodium. Excess level of sodium in water is indicated by having the value of KR values of the dyeing effluent sample are 3.38 which again confirm that the effluent is not suitable for irrigation. Calcium and magnesium maintain a state of equilibrium, generally in most of the waters. In equilibrium with more magnesium being present in waters, it will adversely affect the soil quality converting it to alkaline. This, in turn, affects the crop yields. MR values must be 50% for a water sample for irrigation. Since the value of MR of dyeing effluent is 54.46, it is not suitable for irrigation. But, when the effluents are properly treated, probably they will be more suitable for irrigation.

The application of SAR, PS, KR and MR to assess the suitability of water for irrigation has been mostly tested with fresh water system, however this has also been extended to the industrial effluents as reported by Venkateswara Rao et al (1996)[16]. Dyeing industrial effluents are highly polluted and it exceeds all the four values (SAR, PS, KR & MR) it is not at all suitable for irrigation purposes. The minimum, maximum , range, standard deviation (s.d) , mean and median values of the water quality parameters are given in Table 3. The mean values of the water quality data also confirm the polluted nature of these effluents and indicate a heavy load of pollutants which are present well above the toxic level (De 1987)[17]; Kudesia 1990). Hence, these effluents from dyeing industries are not at all suitable for any use for human activities without any further waste water treatment. The effluents exceed the tolerance limits proposed by ISI for industrial effluents that can be discharged into inland surface water (IS: 2490, 1974)[18] into public sewers (IS 3360, 1974) onland for irrigation (IS: 3307, 1965). This fact also reveals that the dyeing industry effluents are to be necessarily treated before discharge (Zero discharge as prescribed by Chennai High Court)

Correlation among water quality parameters: The correlation co-efficients (r values) for all the possible correlation among water quality parameters are presented in the form of a correlation matrix in Table 4. The range of correlation coefficient values (r values) is found to be -0.683 to 0.999. For the statistically significant correlations alone (r >0.7).

Table 6 Observed and calculated values of Total dissolved solids

TDS= 0.6366 EC-697.62 (r=0.987)

S.NO	Electrical conductivity	TDS Obs	TDS Cal
1	11050	6742	6336.3
2	12780	7865	7437.6
3	8275	4858	4569.9
4	10600	6272	6049.9
5	11310	6470	6501.8
6	8540	4724	4738.6
7	10920	6130	6253.6
8	8925	4950	4983.6
9	9965	5758	5645.7
10	10670	6168	6094.4
11	12640	7002	7348.4
12	11680	6560	6737.4
13	15740	8970	9321.8
14	14500	8556	8532.4
15	15070	8332	8895.3
16	14630	8350	8615.2
17	12940	7870	7539.4
18	11370	6340	6540.0
19	10520	6470	5998.9
20	12260	6725	7106.6
21	14290	7860	8398.8
22	19760	12350	11880.7
23	21140	13300	12759.2
24	17020	9800	10136.6

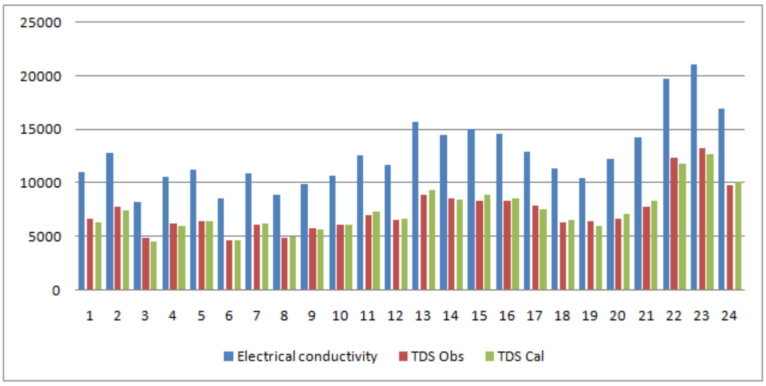

Fig: 6 Observed and calculated values of Total dissolved solids

The linear regression analysis Y= A+BX was carried out by calculating the slope (A) and intercept (B) and X and Y are water quality parameters. The range f correlation co-efficient values is found -0.683 to 0.999. A very high positive correlation (r= 0.999) exists between sodium and WQI and between chloride and WQI (r= 0.946) since dyeing industry effluent has very high sodium and chloride ions, the other statistically significant correlations noticed are between EC and TDS (r= 0.987, TH & Mg (r= 0.974) EC &Na (r=0.870), PEH & Ca (r= 0.801)

EC = 6.294Na- 72.486 (r=0.870,
ψ= 0.515……………………………………………………..… (1)

PEH = 0.761Ca+37.188 (r=0.801,
ψ = 0.626)………………………………………………….... (2)

TDS= 0.637EC- 697.620 (r=0.987,
ψ = 0.165)…………………………………………………..... (3)

TH = 1.699 Mg +46.318 (r= 0.974,
ψ= 0.236)…………………………………………………….. (4)

WQI = 1.360Na +89.234 (r= 0.998, ψ =0.057)……………… (5)

Table 7 Observed and calculated values of total hardness
TH=1.6994Mg+46.3182 (r=0.974)

S.No	Magnesium	Total hardness Obs	Total hardness Cal
1	269	475	503.4
2	308	528	569.7
3	190	336	369.2
4	280	490	522.1
5	315	542	581.6
6	150	325	301.2
7	240	428	454.2
8	250	460	471.2
9	365	670	666.5
10	435	800	785.5
11	455	870	819.5
12	440	820	794.0
13	305	570	564.6
14	322	610	593.5
15	345	680	632.6
16	385	730	700.6
17	373	690	680.2
18	370	700	675.1
19	315	545	581.6
20	373	690	680.2
21	440	760	794
22	580	950	1031.9
23	463	850	833.12
24	310	660	573.1s

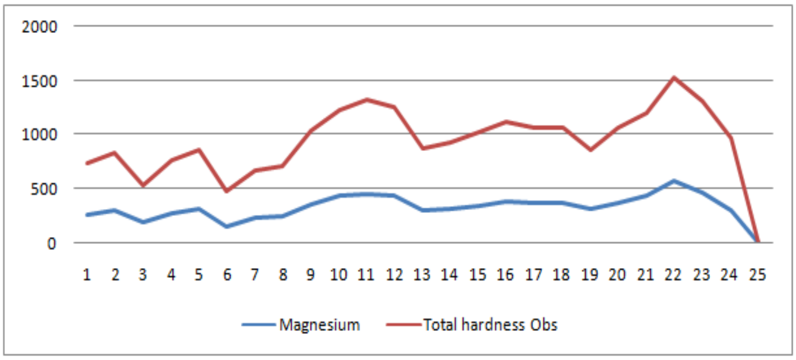

Fig: 7 Total hardness Obs vs. Magnesium

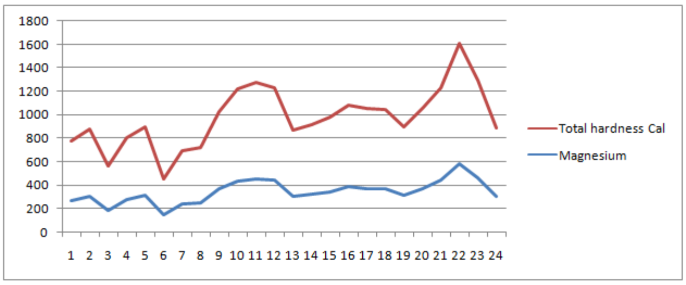

Fig: 8 Total hardness Cal vs Magnesium

These equations 1 to 5 are characteristics of the dyeing unit effluents of Tiruchirapalli. These equations reveal that there exists linear relationship between the above pairs (X and Y) of water quality parameters. A typical linear relationship between TDS and EC (3) and WQI and NA (5) are shown in Figs.1 and 2 reveal that the experimentally observed quantities of TDS and WQI and calculated values of TDS and WQI are linearly related to each other. The correlation equations 1 to 5 are used to calculate the estimated or predicted values of water quality parameter (Y) by substituting the observed values (X) of any other physic-chemical parameter. For example, in equation 3 the experimentally observed values of TDS were substituted to compute the corresponding predicted values of TDS. The calculated values of TDS, WQI and Total hardness are given Tables 5, 6 and 7.

IV. CONCLUSIONS

By making use of these correlations, it is also possible to predict the other water quality parameters (fairly to the expected value) taking into account of all these correlations which can be used to predict and simulate water quality parameters. One need not have to experimentally estimate all the parameters all the time. Instead, it is enough if few of them were estimated. The remaining parameters can be obtained by the judicial application of these correlations. This process will save time, manpower and also it will be economical. The significance of such correlations can be understood from the fact that the overall water quality in terms of WQI itself can be predicted within a few minutes merely from the experimental values of Na (Sodium) alone, while the usual laboratory estimation requires at least three days.

From this study it is clear that there exist statistical correlations which are highly useful in predicting and simulating the water quality parameters. It is concluded that such an analysis for wastewater from various industries will certainly simplify the task of rapid monitoring and control of water pollution.The waste water from industries certainly uncontaminated and unfit for consumption and other purposes. From the graphical comparison it clearly indicates that all most all the parameters are in increasing trend for the respective parameters obtained , which indicates that water quality in the study area are further deteriorated which requires immediate attention to overcome the problem.

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