STATISTICAL ANALYSIS AMONG THE ECOLOGICAL PARAMETERS OF INDUSTRIAL WASTE WATER OF U.P. INDIA

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Abstract- **In the present investigation the data collected on the physico-chemical characteristics of the industrial waste water have been analyzed for correlation and regression among the various parameters viz., pH, TS, TDS, TSS, COD, BOD, Acidity Hardness, Cl, SO_4,Ca, Mg, Na, K, etc. This industry is located at Amroha Distt. U.P. in India, for these studies a wizard fast digital computer unit was used. Beside the above analysis standard deviation, relative standard deviation and coefficient of variation in all the parameters have also been evaluated, respectively.**

Key words: **Industrial waste, Ecology, Regression, Correlation coefficient.**

Introduction

Industrial waste water is generated from a wide variety of production and processing processes. Depending on the industry, industrial waste water can be composed of various components. Besides organic compounds like oil fat, alcohol and flavorings, other substances such as heavy metals, acid and alkalis also combine with the water. This kind of waste water must be pretreated before discharging it to public sewage treatment plants or nature or reusing it for internal purposes. Insilco Ltd. Sadullapur Gajraula, Amroha (U.P.) waste water is one of the major waste of ecological concern; the plant is situated 65 Kms. west of Moradabad and manufacturing precipitated silica in different grades for rubber and various non-rubber applications. In the present manuscript the quality of industrial waste water is described according to the correlation and regression of it's physico-chemical parameters.[1, 2, 3] Several workers have carried out similar work for water quality parameters.[4, 5, 6]

Material & Methods

All chemicals and reagents for this research work used were of AR grade of CDH, Indian Glycols and Fulka. Industrial waste water samples were collected from Insilco Ltd. Sadullapur Gajraula, Amroha (U.P.) India unit at monthly intervals from July 2009 to Feb 2010. The samples were analyzed for the physico-chemical parameters by following standard methods[7]. Standard deviation, relative standard deviation and coefficient of variation were calculated for various parameters.[8]

Result and Discussion

All results are shown in table (1-4). Table-1 reveals that average, SD (Standard variation), RSD (Relative Standard deviation) and CV (Coefficient of variation) values of the parameters analyzed for industrial waste water exhibit a declining effect. An attempt has also been made to explain the variation by fig. 1 below the table1. Table 2 and 3 demonstrated by correlation coefficient (r) and coefficient of linear regression A and B. The statistical data of the correlation coefficient between each pair of industrial waste water parameters have been presented in Table-2 and in fig.2 as well. To carry out these extensive numerical calculations a brief details are mentioned below the tables.

Table-1Average values of ecological parameters analyzed for Industrial waste water

Parameters	No. of Sample	Average Value	±SD	RSD	CV%
pH	8	4.5	0.330	0.0733	7.333
TSS mg/l	8	2330	518.31	0.222	22.24
TDS mg/l	8	61410	3415.12	0.0556	5.561
TS mg/l	8	63740	3524.21	0.552	5.529
COD mg/l	8	74013	3120.14	0.0421	4.215
BOD mg/l	8	1265	401.2	0.079	7.984
Acidity mg/l	8	10241	311.12	0.030	3.037
Cl mg/l	8	6450	713.12	0.110	11.056
SO_4 mg/l	8	4123	429.1	0.104	10.407
Hardness mg/l	8	7678	739.63	0.096	9.633
Na mg/l	8	301	37.03	0.123	12.302
K mg/l	8	11603	992.28	0.085	8.551
Ca mg/l	8	1590	401.03	0.252	2.552
Mg mg/l	8	1024	315.25	0.307	3.078

TSS- Total suspended solids; TDS- Total dissolved solids, TS- Total solids COD- chemical oxygen demand, BOD - Biological Oxygen demand.

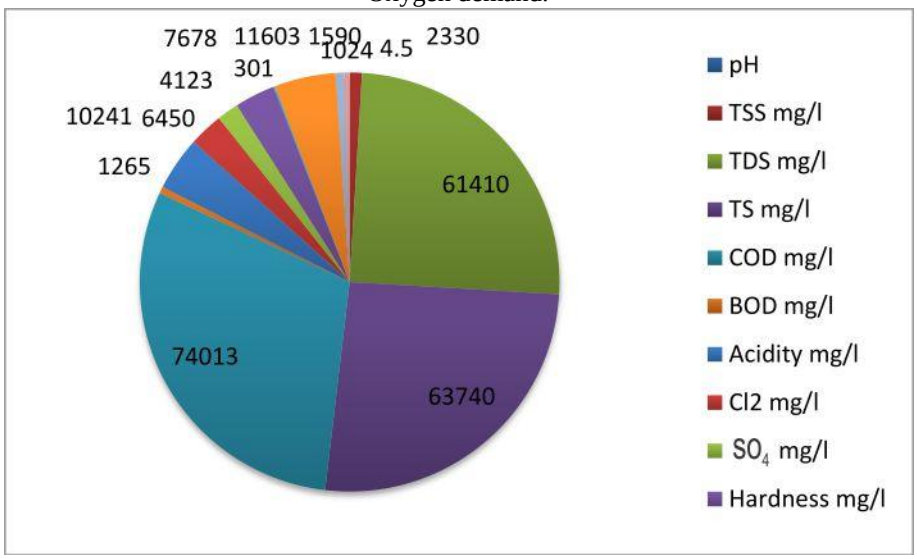

Fig.-1 Diagram showing average value variation (Industrial waste water)

Table-2 Correlation coefficients values for industrial waste water at different ecological parameters

Parameter	pH	TSS	TDS	TS	COD	BOD	Acidity	Cl	SO_4	Hardness	Na	K	Ca	Mg
pH	1.00	0.27	0.27	0.13	-0.54	-0.51	-0.98	-0.45	0.02	0.34	0.05	0.41	-0.16	0.31
TSS		1.00	0.98	0.73	0.24	0.25	-0.33	-0.66	0.48	-0.57	0.03	-0.47	-067	-0.14
TDS			1.00	0.70	0.27	0.28	-0.34	-0.64	0.51	0.53	-0.26	0.42	-0.73	-0.16
TS				1.00	0.02	-0.02	-0.18	0.65	-0.02	0.75	-0.78	-0.72	0.11	0.03
COD					1.00	0.23	0.52	0.06	0.58	-0.15	0.16	-0.31	-0.51	-0.16
BOD						1.00	0.32	0.47	0.01	-0.30	-0.04	-0.38	-0.19	-0.29
Acidity							1.00	0.37	0.10	0.31	0.62	0.33	0.40	-0.20
Cl								1.00	0.11	0.14	0.35	0.18	-0.84	0.05
SO_4									1.00	0.13	0.65	0.41	0.05	0.41
Hardness										1.00	0.55	0.75	-0.24	-0.28
Na											1.00	0.59	0.02	0.18
K												1.00	0.12	0.15
Ca													1.00	0.12
Mg														1.00

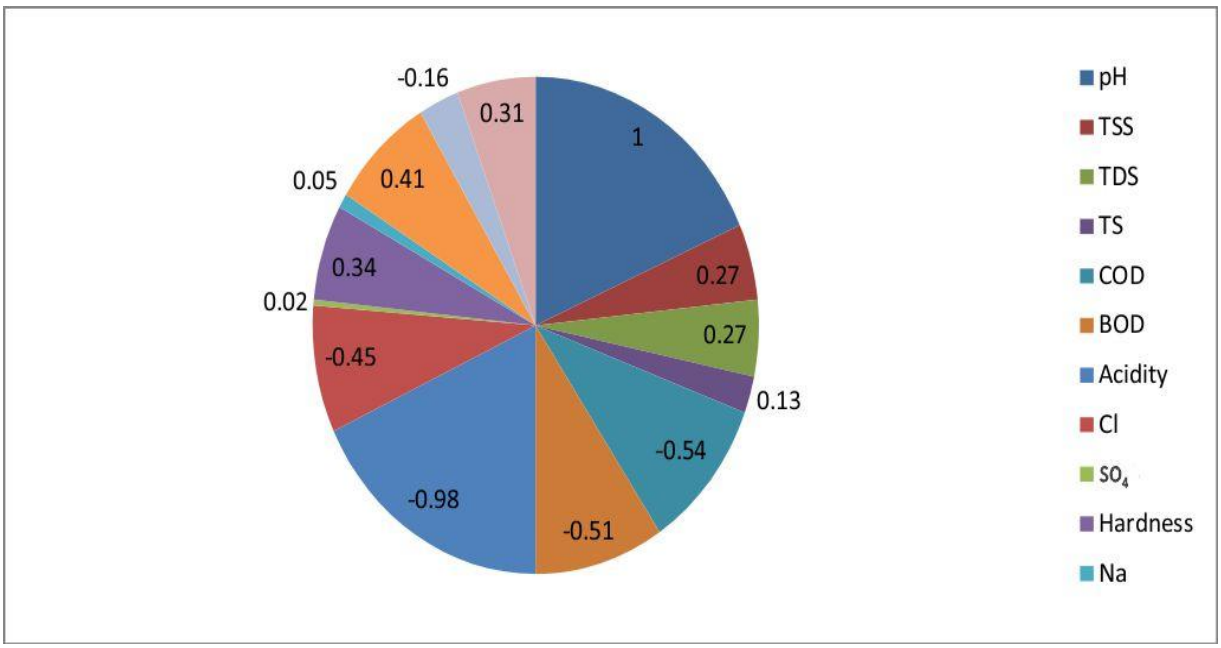

Fig. 2 Statistical diagram of some ecological parameters.

Table-3 Least square fitting for linear relations $y = Ax + B \quad (r \geq \pm 0.60 - \pm 0.99)$ between ecological parameters for industrial waste water.

X		Y	r	A	B
1.	pH	Acidity	-0.99	-1121.71	15512.04
2.	TSS	Cl	-0.76	-1.053	8254.94
	TSS	Hardness	-0.79	-1.120	10039.33
	TSS	Ca	-0.79	-0.728	3293.08
	TSS	Mg	-0.72	-0.414	1863.89
3.	TDS	TSS	0.72	-0.086	3030.51
	TDS	Cl	-0.64	-0.23	13375.86
	TDS	Na	-0.73	-6.653	612.92
4.	TS	TSS	0.99	1.042	-4923
	TS	TSS	0.99	0.079	-3916.07
	TS	Cl	0.77	-0.134	14320.70
	TS	Na	-0.66	-6.554	412146.29
5.	Cl	Ca	0.62	0.358	-150.49
6.	SO_4	Na	-0.84	-0.069	484.34
7.	Hardness	Ca	0.65	0.406	-1401.14
8.	Hardness	Mg	0.91	0.355	-1743.51
	Ca	Mg	0.75	0.468	156.162

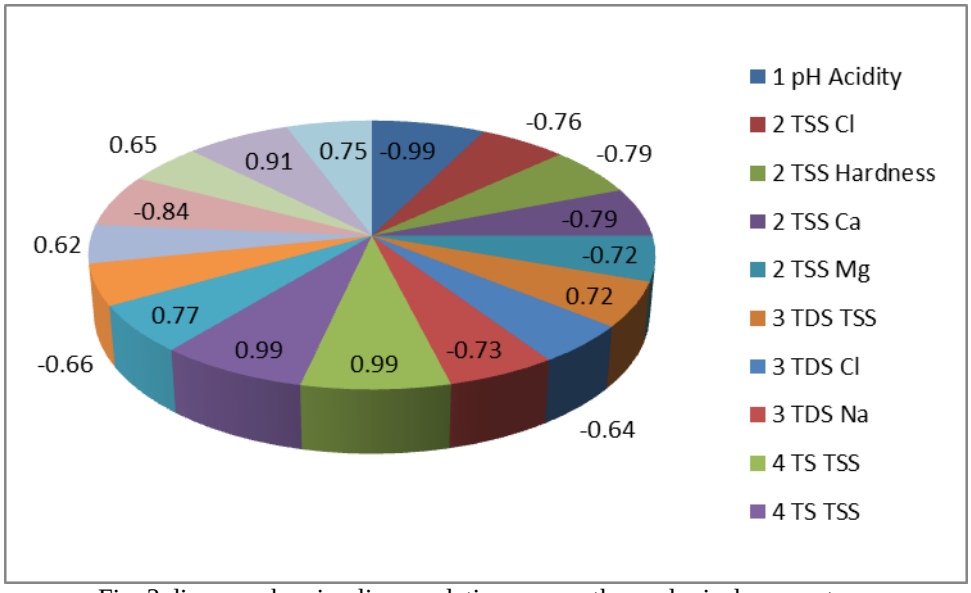

Fig. 3 diagram showing linear relation among the ecological parameters.

Correlation and regression are techniques used to analyze the relationship between two quantitative variables, while correlation measures the strength of a linear relationship between two variables, regression measures how these variables affect each other using an equation. X & Y are the two variable, r-Correlation coefficient has been calculated between each pair of 14 industrial waste water parameters by using the experimental data A & B are the constant

$$r = \frac{\sum xy}{(\sum X^2)(\sum Y^2)} \qquad x = X - \overline{X}$$

$$y = Y - \overline{Y}$$

For higher value of r between X & Y there linear relation will be

$$Y = Ax + B$$

On the basis of above A & B can be calculated

$$Y - \overline{Y} = r\frac{6Y}{6X}(X - \overline{X})$$

Where $\overline{X} = \frac{\sum X}{n}, \qquad \overline{Y} = \frac{\sum Y}{n}$

6Y- Standard deviation of Y

6X- Standard deviation of X
n= no. of observation
All data were run on the digital computer in the dept. of chemistry Hindu College, Moradabad. In the present work most of the observation of pH values was found to be (+ve) between TSS, TDS, TS, Hardness, K, Ca, and Mg etc., whereas most (-ve) values of TSS was observed against the parameters COD, BOD, Acidity, Cl, SO_4, hardness, Na, Ca and Mg etc. The values of R in positive correlation lie between +0.01 to +0.99 and in case of negative correlation -0.02 to -0.99. The high (+ve) correlation value (0.99) was observed in between pH and acidity. The low (+ve) correlation value (0.01) was observed in between BOD and Cl whereas negative (-0.02) value was observed in between TSS and COD, TS & Cl, Na & K, respectively [8]. The value of r in the case of positive correlation nearer to +1 or in the case of negative correlation nearer -1 show that the greater probability of a definite linear relationship exists between the variable of parameters (e.g. X & Y). The values of r that tend towards zero indicate that the pair of parameters are not linearly related[9].
The values of linear relation have been shown in table 3 and also discussed in diagram in fig. 3. Again to save space we have presented the results only for those parameters which have $r \geq \pm 0.60$ to ± 0.99, although we have calculated the value of A & B for each possible pair of 14 parameters[10]. When A & B have been determined the linear relation of the type given equation (y=Ax+B) can be used to predict the value of industrial waste water quality parameters Y, when the values of the parameter X is measured experimentally. With the help of the above linear equation we have predicted the values of TSS and Cl from the experimentally measured values of TDS. The results of the predicted and observed values of TSS and Cl are being given in table 4.
The above findings show that many such positive and negative correlations do exist among these parameters. The very high positive value of r^2 shows that the variation of Y is influenced by changes of X. The high positive values of coefficient of determination (r^2=0.98) of a pair pH and acidity reveals that 98% variations in acidity values are influenced by pH changes. However the possibility of resting 2% can be attributed to other causes. So our task is not only important for environmental scientists but also to the engineer's working on industrial management and research in this area.

Table- 4 Predicted and Observed values of TSS & Chloride as function of TDS

TDS mg/l	TSS mg/l		Cl mg/l	
	P	O	P	O
53724	1750	1925	5630	6610
56424	2008	2483	6181	6100
55531	1943	1412	6283	6438
58301	2140	2283	5993	6283
59991	2320	2542	5743	4435
64801	2718	2743	6172	5502
61498	2438	24479	5573	5872
58900	2224	2115	5892	6036

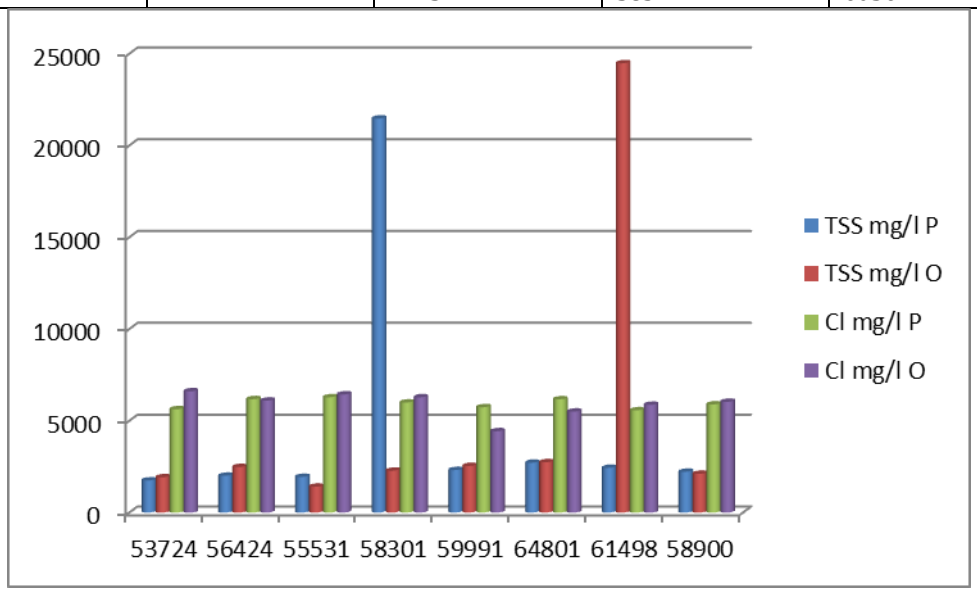

Fig. 4 bar diagram showing experimentally measured value of some parameter of waste water.

This study will provide a baseline data and help to delineate the physico-chemical characteristics of industrial waste water and correlation between them.

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REFERENCES:

1. S.N. Vaishnav and V. S. Shrivastava, Assessment of pollution status of industrial waste water, correlation and regression study. Ind. J. Environ. Protection, 27(6):554-558, 2007.
2. A. Bhatnagar and P. Devi, Application and regression and analysis in assessing lentic water quality; a case study at Brahma Sarovar Kurukshetra, India, Int. J. Environ, Sci. 3(2):813-820,2012.
3. S. Jena and K. C. Pradhan, Linear regression and correlation analysis of water qualities of Daya canal Bhubaneshwar Odisha, Poll. Res. 34(3): 127-133, 2015.
4. J.G. Mulla., M. Farooqui and A. Zaheer, A correlation and regression equation among water quality parameters, Int. J. Chemical Sci., 5(2): 943-952,2007.
5. K. Vijay Kumar et. al., correlation and regression model for physico-chemical quality of groundwater in the south India city of Gulbarga, AJEST, 6(9): 353-364, 2012.
6. N.S. Bhandari and K. Nayal, Correlation study on physico-chemical parameters and quality assessment of Kosi-river water, Uttarakhand, E-Journal of chemistry, 5(2): 342-346,2008.
7. I.A. Vogel, A text book of quantitative inorganic analysis, ELBS and Longmans & Green London,1961.
8. G.W. Snedecor and W.G. Cocharan, Statistical methods, Oxford and IBM, New Delhi, 2000.
9. B.Tripathi, R. Pandey et.al., Studies on the physico-chemical parameters and correlation coefficient of the river Ganga at Holy place Shringverpur Allahabad. IOSR, J. Environmental Sci. Toxi. & Food Tech., 8(10): 29-36,2014.
10. Neeha Agarwal et al., linear regression and correlation analysis of water quality parameters. A case study of river Kosi at Distt. Rampur (U.P.), India, IJIRSET, 2(1, 2): 172-787, 2013.