Recent Research in Science and Technology 2014, 6(1): 171-175
ISSN: 2076-5061
Available Online: http://recent-science.com/

Effect of temperature on electrical conductivity in industrial effluents

Harashit Kumar Mandal

Research Scholar, Environment and Microbial Biotechnology, Jodhpur National University, Narnadi, Jhanwar Road, Bornada, Jodhpur (Rajasthan), India.

Abstract
This study is to know the effect of temperature on electrical conductivity in industrial effluents and sewages of Phagwara Tehsil of Punjab. Water contamination is a major global problem which requires ongoing evaluation and revision of water resources policy at level (Ugbune 2011). It has been suggested that it is the leading worldwide cause of deaths and disease (Pink 2006). Temperature increase was recently considered as a serious water pollutant. Increase in temperature can have adverse affect on the physical properties of water, such as density, viscosity, vapor pressure, surface tension, gas solubility and gas diffusion etc. Electrical conductivity (EC) is a measure of the ability of water sample to conduct electricity and is also related to the concentration of ionized substance in water. Temperature also has an important effect on conductivity. This is because as temperature increase, conductivity also increases owing to a decrease in viscosity that is caused by increase in temperature. The objective of this study is to know the level & effect of temperature on electrical conductivity in industrial effluents.

Keywords: Temperature, Electrical Conductivity, Industrial Effluents & Sewages, Biochemical, Ionized

INTRODUCTION

Discharge of heated water from the thermal water plants is the major source of thermal pollution. Except for a very high temperature they do not have noticeable chemical contaminants. However the impact they cause on the ecology of the receiving stream is beyond imagination. Some of the harmful effects of thermal pollutants are dramatic drop in dissolved oxygen content, change in the physicochemical properties of water, enhancement of toxicity of hazardous substances etc. (Murugesan & Rajakumari, 2005).

Solids found in streams come in two forms, suspended and dissolved. Suspended solids (turbidity) include silt, stirred up bottom sediment, decaying plant matter, or sewage treatment effluent. Dissolved solids in freshwater samples include sodium, magnesium, calcium, iron and aluminum. The presence of these dissolved solids affects the water's ability to pass an electrical current. Conductivity is the measurement of the water's ability to pass an electrical current (*www.tetonscience.org/data/.../Turbidity%20and%20Conductivity.pdf*). The conductivity of all solutions changes as the solution's temperature changes. An increase in a solution's temperature will cause a decrease in its viscosity and an increase in the mobility of the ions in solution. An increase in temperature may also cause an increase in the number of ions in solution due to dissociation of molecules. As the conductivity of a solution is dependent on these factors then an increase in the solution's temperature will lead to an increase in its conductivity (Barron & Ashton, 2013). If conductivity levels are high, especially due to dissolved salts, many forms of aquatic life are affected. The salts act to dehydrate the skin of animals. High concentrations of dissolved solids can add a laxative effect to water or cause the water to have an unpleasant mineral taste. It is also possible for dissolved ions to affect the pH of a body of water, which in turn may influence the health of aquatic species (www.tetonscience.org/data/../Turbidity%20and%20Conductivity.pdf

REVIEW OF LITERATURE

Barron & Ashton (2013), Technical Services Department, Reagecon Diagnostics Ltd, Shannon Free Zone, County Clare, Ireland, authors on the effect of temperature on conductivity measurement and they describe that measurement temperature has a significant influence on conductivity readings; but appropriate temperature compensation is a powerful tool to allow meaningful comparison of readings taken at different temperatures. The analyst must ensure that the type of temperature compensation utilized is appropriate for both the type of sample being analyzed and the required test accuracy. This is an essential factor for determining the suitability of a conductivity instrument for measurement applications. A conductivity measurement taken with the sample at the reference temperature will always be more accurate than a temperature compensated reading taken away from the reference temperature – this point is essential for critical applications requiring high accuracy of measurements.

Emagbetere & Molua (2012), assessed on levels of temperature and electrical conductivity of ground water in Sapele local government area of delta state, Nigeria and found that the temperature increase was recently considered as a serious water pollutant. The known sources that modestly increase the temperature of groundwater are municipal wastes, industrial effluents and biochemical activities. Electrical conductivity which is the ability of water to conduct electricity is also related to the concentration of ionized substance in water. The ions that have major influence on

*Corresponding Author

Akash Sharma
SRM University, Chennai, Tamilnadu, India.

email: harashit@gmail.com

the conductivity of groundwater are H^+, Na^+, Mg^{2+}, Ca^{2+}, $Cl^-SO_4^{2-}$. Samples of borehole water were collected around Sapele L.G.A and were analytically assessed to ascertain the physicochemical characteristics. Results obtained shows that temperature range between 14ºC – 30ºC and electrical conductivity range of 23.00 – 400.00 us/cm and were found to be within the world health organization (WHO) desirable and maximum levels.

Smith (2013), worked on temperature correction in conductivity measurements and described that electrical conductivity has been widely used in freshwater research but usual methods employed by limnologists for converting measurements to conductance at a given temperature have not given uniformly accurate results. The temperature coefficient used to adjust conductivity of natural waters to a given temperature varies depending on the kinds and concentrations of electrolytes, the temperature at the time of measurement, and the temperature to which measurements are being adjusted. The temperature coefficient was found to differ for various lake and stream waters, and showed seasonal changes. High precision can be obtained only by determining temperature coefficients for each water studied. Mean temperature coefficients are given for various temperature ranges that may be used where less precision is required.

Location & importance of the study

Phagwara is main industrial centre in the Kapurthala district of Punjab because of its good location on the national highway. This city has many different types of industries like, Guru Nanak Autos (GNA), Wahid Sandhar sugar mill, Jagjit Cotton Textiles (JCT) Mills, Dairy Industry, Leather Industry etc. which release numerous industrial effluents and sewages. These effluents are drawn into the Ganda Nala which affects the surrounding area of agricultural land, ground water, surface water and later on the river Kali baien of Kapurthala District. The present study is helpful to find out a correlation between temperature and electrical conductivity in industrial effluents of Phagwara.

Fig 1. Phagwara in Punjab.

Fig 2. Sampling Location (Naturally made Ganda Nala)

Objectives & hypothesis

Ob1. To determine the Temperature and Electrical Conductivity in Industrial Effluents of Phagwara.

Ob2. To assess them on the basis of Water Quality Index.

Ob3. To find out the Correlation Effect of Temperature and Electrical Conductivity in Industrial Effluents of Phagwara.

H1. There exist certain correlation between Temperature and Electrical Conductivity in Industrial Effluents of Phagwara.

MATERIALS AND METHODS

To determine the Temperature of the effluent sample.

Material Required: Laboratory glassware & Thermometer etc.

Procedure: Transferring 50 ml of the sample in a beaker wiped and cleaned the thermometer with blotting paper and immersed into the beaker. Stir the sample well before noting down the temperature. Allowing sufficient time to achieved a constant temperature. Noted down the temperature, took the thermometer outside the beaker, wiped it cleaned and recapped it for further use.

To measure the Electrical Conductivity of the effluent sample.

Material Required: Conductivity meter, Conductivity cell, Thermometer, Thermostat etc.

Procedure: Reading the temperature of the sample and adjusted the temperature knob of the conductivity meter accordingly. Shifting the selector switch to 1000 and adjusting to CAC mark, taking the sample in a beaker with thermostat to set real temperature and immersed the conductivity cell in it. After connecting the cell terminals to the sockets, noted for the deflection in dial. In the case of negligible deflection, shifting the selector switch to X 100 and repeat the step described above. Record the deflection at this level. Shifting the selector switch to X 10 and performed the steps described above. Disconnecting the cell terminals, wash with distilled water and put off the instrument.

Calculation

Electrical Conductivity =
Deflection value in the dial×Value of the selector switch
(Murugesan & Rajakumari, 2005).

Sampling

Samples were collected from definite sampling stations in 15 days interval from Jan. 2009 to Dec. 2011 from naturally made Ganda Nala in wide mouthed polythene bottles from midstream of naturally made Ganda Nala of Phagwara. For temperature it was measured on the spot. But in case of conductivity measurement it was necessary to thermostat samples, so that same temperature was used for the calibration and measurement *(www.tcd.ie/Biochemistry/courses/js_conductivity.pdf).*

Tabulation and graphical representation of data

The data obtained from analyzed samples are tabulated and interpreted with using the appropriate statistical tools and techniques.

Table 1. Values of Temperature (°C)

SN	Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Avg.
1	2009	9.0	15.2	30.4	36.5	41.2	39.2	34.3	32.3	31.1	29.5	19.5	6.0	**27.0**
2	2010	9.2	17.3	30.8	37.4	41.6	39.8	34.9	32.9	31.8	29.9	21.8	6.0	**27.8**
3	2011	9.8	17.9	31.9	38.8	42.3	40.0	34.8	32.9	31.9	30.0	22.7	6.1	**28.3**
Average		**9.3**	**16.8**	**31.0**	**37.6**	**41.7**	**39.7**	**34.7**	**32.7**	**31.6**	**29.8**	**21.3**	**6.0**	**27.7**
Monthly Average Temperature: Minimum 6.0 °C (Dec.), Maximum 41.7 °C (May), SD = 11.3848														

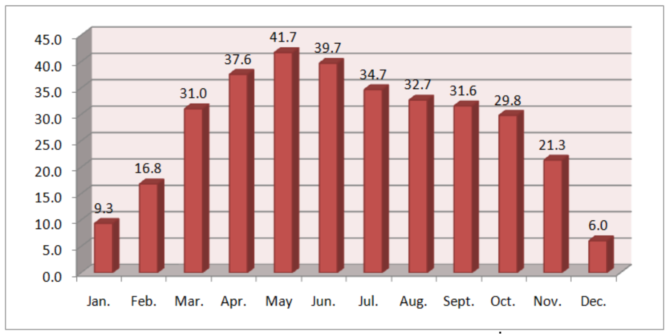

Fig 3. Average Monthly Temperature (°C)

Temperature was recorded by using a mercury thermometer, immediately after collecting the samples from Ganda Nala. The temperature varied from 6°C to 42.3°C. In monthly average temperature, the highest temperature 41.7°C was recorded in the month of May and lowest was in the month of December 6°C. The results also indicate that the temperature is increasing in order from 2009 to 2011 and the average temperature of three years is 27.7°C.

Table 2. Values of Electrical Conductivity (ms/cm)

SN	Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Avg.
1	2009	0.885	0.886	0.897	0.911	0.913	0.908	0.905	0.899	0.888	0.894	0.884	0.896	**0.897**
2	2010	0.917	0.916	0.919	0.932	0.937	0.931	0.931	0.920	0.918	0.911	0.909	0.915	**0.921**
3	2011	0.973	0.999	1.076	1.109	1.187	1.141	1.096	1.084	1.063	1.025	1.018	0.957	**1.061**
Average		**0.925**	**0.934**	**0.964**	**0.984**	**1.012**	**0.993**	**0.977**	**0.968**	**0.956**	**0.943**	**0.937**	**0.923**	**0.960**
Monthly Average Electrical Conductivity: Minimum 0.923 ms/cm (Dec.), Maximum 1.012 ms/cm (May), SD = 0.0830.														

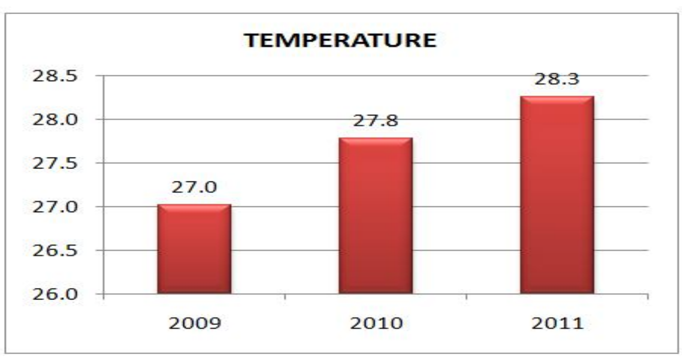

Fig 4. Average Yearly Temperature (°C)

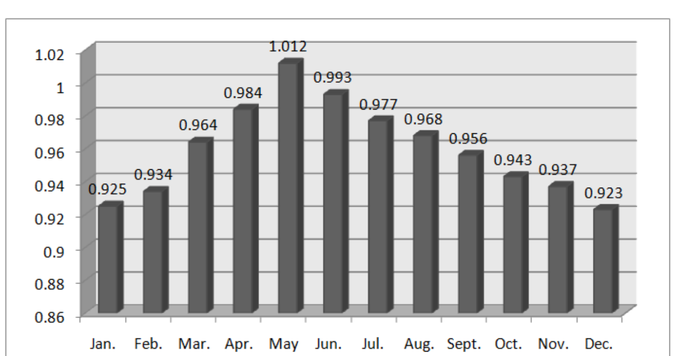

Fig 5. Average Monthly Electrical Conductivity (ms/cm)

Electrical Conductivity was recorded by using conductivity meter, after collecting the samples from Ganda Nala with setting the real temperature in a thermostat. The Electrical Conductivity varied from 0.884 *ms/cm* to 1.187 *ms/cm*. In case of monthly average Electrical Conductivity, the highest conductivity was recorded as 1.012 *ms/cm* in the month of May and lowest was recorded as 0.923 *ms/cm* in the month of December. The results also indicate that the EC is in increasing order from 2009 to 2011 and the average EC in three years is 0.960 *ms/cm*.

RESULTS AND DISCUSSION

Table 3. Average data of Temperature and Electrical Conductivity

Temp	9.3	16.8	31.0	37.6	41.7	39.7	34.7	32.7	31.6	29.8	21.3	6.0
EC	0.925	0.934	0.964	0.984	1.012	0.993	0.977	0.968	0.956	0.943	0.937	0.923

Table 4. Statistical Data of Temperature and Electrical Conductivity

Variable	Mean	Standard Deviation (δ)	Correlation coefficient (r)
Temperature (°C)	27.7	11.3848	0.3415782
EC (*ms/cm*)	0.960	0.0830	

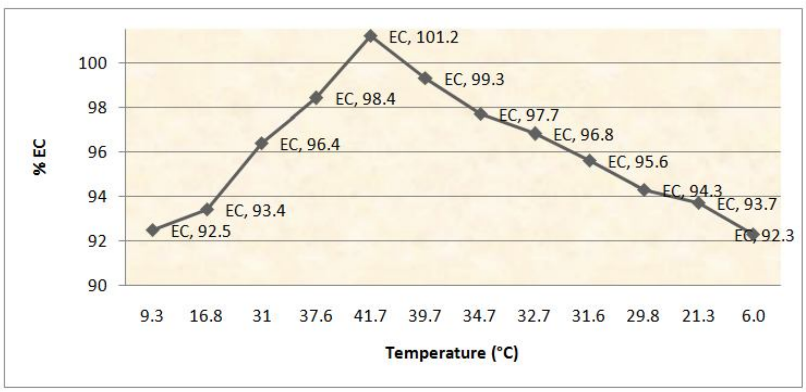

Fig 7. Correlation between Temperature and Electrical Conductivity

The curve of Figure 7 shows that Electrical Conductivity also increase when the Temperature increase. The shape and position of curve also show that Electrical Conductivity is increasing in order from winter to summer session. The form of the curve show that both the Temperature and Electrical Conductivity are at highest point in the month of May and at lowest point in the month of December. The considerable difference in the position of the curve indicates that a shift in temperature can result from seasonal changes in chemical characteristics. These samples were taken from the naturally made Ganda Nala as it enters into the Phagwara Tehsil from Hoshiarpur and run 12 km along it, in which there is some introduction of industrial and domestic wastes. The Standard Deviation (SD) in case of Temperature is 11.3848 and for Electrical Conductivity 0.0830 which are very high in both cases and show high variation. The correlation coefficient (r) is 0.3415782 which indicates low correlation, definite but small relationship. Thus the research hypothesis is partially rejected and an alternate hypothesis is adopted i.e. there exists a low significant positive correlation between Temperature and Electrical Conductivity in industrial effluents of Phagwara. Again explanation for the correlation coefficient of various months might be found in detailed study of differences in chemical content. Certainly more research in needed not only to gain better understanding of the behavior of correlation coefficients, but also to provide greater meaning to the use of conductivity measurements in the description of aquatic conditions.

CONCLUSIONS

Temperature is an important parameter controlling many of the physical (viscosity and surface tension), chemical and biological process taking place in water. Increase of temperature leads to: (i) decrease in the dissolve oxygen (DO) content, which is very essential for survival of the aquatic system, (ii) reduction in crop growth and (iii) deleterious effects on aquatic organisms. Pure water is a poor conductor of electricity. Presence of salts increases conductivity. The value depends on the concentration and degree of dissociation of electrolytes. The migration velocity of the ions in the electric field and temperature affects the conductivity. Stream is supporting a good mix of fisheries range between 50-500 µs/cm. But the present data show very high conductivity from that range which indicates that water is not suitable for fishes or certain macro-invertebrates and need reclamation. However, the results provide general information on electrical conductivity and show very low significant correlation with temperature, but do not provide any information on the nature of the ions.

RECOMMENDATIONS

On the basis of the finding and conclusion reached in this study, the following are therefore recommended.

1. The wastewater point sources across the industrial area

should be analyzed at regular intervals, so as to ascertain the quality of water.

2. Indiscriminate disposal of municipal waste in the Local Government Area should be stopped.
3. Extensive research should be carried out in that area.

REFERENCES

[1] A G Murugesan and C Rajakumari (2005), Environmental Science and Biotechnology, Theory and Techniques, MJP Pub. Chennai, pp. 65, 129-130.

[2] D H Pink (2006), Investing in Tomorrow Liquid Gold “yahoo”.

[3] John J. Barron & Colin Ashton (2013), The Effect of Temperature on Conductivity Measurement, A Practical Guide to Accurate Conductivity Measurement (www.reagecon.com).

[4] S H Smith, Temperature Correction In Conductivity Measurements, http://aslo.org/lo/toc/vol_7/issue_3/0330.pdf, Retrieved on 01.01.2014.

[5] U Ugbune (2011), Book of proceedings, Chemical Society of Nigeria 2011 National Conference. http://www.tetonscience.org/data/contentfiles/File/downloads/pdf/TLC/streamteambackground/Turbidity%20and%20Conductivity.pdf.

[6] www.tcd.ie/Biochemistry/courses/js_conductivity.pdf