Recent Research in Science and Technology 2014, 6(1): 258-262
ISSN: 2076-5061
Available Online: http://recent-science.com/

Assessment of wastewater temperature and its relationship with turbidity

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Abstract
Turbidity consists of suspended material in water, causing cloudy appearance. This cloudy appearance caused by scattering and absorption of light by these particles. The suspended matter may be inorganic or organic. Generally the small size of particles prevents rapid settling of the material. Turbidity can provide food and shelter for pathogens. Solids are present in water in three main forms: suspended particles, colloids and dissolved molecules. Suspended particles, such as sand, vegetable matter and silt range in size from very large particles down to particles with a typical dimension of 10µm. Colloids are very fine particles, typically ranging from 10 nm to 10 µm Dissolved molecules are present as individual molecules or as ions. Most suspended solids smaller than 0.1 mm found in water carry negative electrostatic charges. High turbidity will decrease the amount of sunlight able to penetrate the water, thereby decreasing the photosynthetic rate. When the water is cloudy, sunlight will warm it more efficiently. This occurs because the suspended particles in the water absorb the sunlight, warming the surrounding water. This can lead to other problems associated with increased temperature levels. So in present study researcher tries to assess the waste water temperature of naturally made Nala in Phagwara Tehsil of Punjab and its effect on turbidity.

Keywords: Waste Water, Temperature, Turbidity, Phagwara, Water Quality Index, etc.

INTRODUCTION

The temperature of a body of water influences its overall quality as it can harm aquatic organisms if it is outside the normal range. Temperature should be measured at different locations and a change in temperature determined. Temperature changes could indicate thermal pollution e.g. industrial pollution, runoff from parking lots and rooftops, contributing to increase in overall temperature. Shade is important to the health of the water body as it reduces the warming effect of direct sunlight. Some human activities remove shade trees from the area, allowing more sunlight to reach the water, causing the temperature to rise. Temperature of the air above the water body may affect water temperature depending on the depth of the water. Shallow water bodies are more susceptible to temperature changes than deep water. Factors affecting water temperature are: air temperature, amount of shade, soil erosion increasing turbidity, thermal pollution from human activities, unknown chemical reactions that weren't previously occurring in the water, etc. Effects of water temperature on the water body are as follows: (i) solubility of dissolved oxygen – more gas can be dissolved in cold water than warm, therefore animals requiring a high level of dissolved oxygen will only thrive in cold water, (ii) rate of plant growth – increased water temperature can cause an increase in the photosynthetic rate of aquatic plants and algae, which can lead to increased plant growth and algal blooms, and harm the local ecosystems, metabolic rate of organisms, (iii) resistance in organisms – if water becomes too hot or too cold, organisms become stressed, lowering their resistance to pollutants, diseases and parasites, etc. (http://www.water-research.net/watqualindex/index.htm).

In stagnant waters colloidal and fine dispersions are the two main constituents which induce turbidity whereas in rivers, coarse particles contribute more to turbidity, and include the topsoil washed out from the fields, coarse particles from the mountain areas, domestic waste water, and industrial waste water. They contain clay, silt, and organic and inorganic substances. Organic matter induces the proliferation of microbial groups, which in turn enhances the turbidity. Similarly inorganic constituents like nitrogen and phosphorus induce the algal bloom that spreads out to increase the turbidity. Therefore both the organic and inorganic substances turn the water turbid. Turbidity can be identified even by visual appearance and hence turbid water is not preferred as potable water. Moreover turbid water is always associated with water pollution (Murugesan & Rajakumari, 2005).

REVIEW OF LITERATURE

Altaher and Alghamdi (2011) worked on Enhancement of Quality of Secondary Industrial Wastewater Effluent by Coagulation Process: A Case Study in Yanbu Industrial City, Kingdom of Saudi Arabia. The removal efficiency of turbidity from industrial waste-water was experimentally investigated using coagulation technique. Four different coagulants were tested. The temperature did not have a preannounced effect on the coagulation process.

Morgan (2010) worked on a project to determining the relationship between a water sample's temperature and its turbidity level. The results did not give conclusive evidence of any correlation between temperature of a water sample, and it's turbidity level.

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Paaijmans *et al.* (2008) worked on the effect of water turbidity on the near-surface water temperature of larval habitats of the malaria mosquito *Anopheles gambiae* and they found that water temperature is an important determinant in many aquatic biological processes, including the growth and development of malaria mosquito (*Anopheles arabiensis* and *A. gambiae*) immature. Water turbidity affects water temperature, as suspended particles in a water column absorb and scatter sunlight and hence determine the extinction of solar radiation. To get a better understanding of the relationship between water turbidity and water temperature, a series of semi-natural larval habitats (diameter 0.32 m, water depth 0.16 m) with increasing water turbidity was created. Here they show that at midday (1300 hours) the upper water layer (thickness of 10 mm) of the water pool with the highest turbidity was on average 2.8 degrees C warmer than the same layer of the clearest water pool. Suspended soil particles increase the water temperature and furthermore change the temperature dynamics of small water collections during daytime, exposing malaria mosquito larvae, which live in the top water layer, longer to higher temperatures.

Industrial area and importance of the study

Phagwara is the city and a municipal council in Kapurthala district in the state of Punjab. It is located on the national highway between Ludhiana and Jalandhar. The city is 76 miles away from Chandigarh and 220 miles from Delhi. It is a junction with road and rail to other cities e.g. Banga, Hoshiarpur, Goraya. It is in the NRI belt of Doaba region of Punjab (Doaba: the region bounded by two rivers of Punjab--Satluj and Beas). It is a 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 Textile (JCT) Mills, Dairy Industry, Leather Industry etc.

The present study is useful to find out a relationship between temperature and turbidity in the waste water of Phagwara.

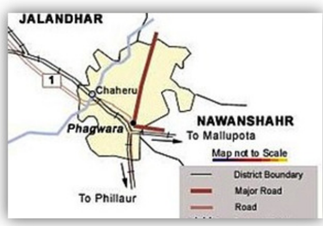


Fig.1: *Phagwara in Punjab.*

Fig.2: Industries of Phagwara

Objectives and hypothesis

Ob1. To determine the Temperature and Turbidity in wastewater of Phagwara.
Ob2. To assess them on the basis of Water Quality Index.
Ob3. To find out the relationship between Temperature and Turbidity in wastewater of Phagwara.
H1. There exist certain correlation between Temperature and Turbidity in wastewater of Phagwara.

METERIALS AND METHODS

To determine the Temperature of the wastewater 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 Turbidity of the wastewater sample.

Material Required: Nephelometer, Colourless and clean glass tubes for sample loading.

Standard Solution: Solution (a) 1 g of hydrazine sulphate is dissolved in 10 ml of distilled water.

Solution (b) 1 g of lexam ethylene tetramine in 10 ml of distilled water.

Transferring 5 ml each from solution (a) and (b) in a 100 ml volumetric flask and leaved it undisturbed for one full day at 25^0C. Make up to 100 for one month from the stock solution is 400. This solution can be used for one month from the stock solution. Pipette out 1 ml and make up to 100 ml using distilled water (40 NTU).

Procedure: Adjusting the nephelometer at 100 using 40 NTU. Then transfer the sample into the nephelometer tube. See to it that the sample did not contain any air bubble during measurement. Read out the value on the scale. If the sample processed an NTU greater than 40, diluted it using distilled water and repeat the procedure as described above (Murugesan & Rajakumari, 2005).

Sampling spots and process

The effluents and sewages from the industries of Phagwara are discharged into a naturally made Ganda Nala, which enters into Phagwara City from Hoshiarpur District that is three kilometer away from Phagwara city and runs twelve kilometers through Phagwara Tehsil and finally meets with the river Kali Baien. Midstream samples were collected in wide mouthed polythene bottles from naturally made Ganda Nala, Phagwara and leveled. They were collected on definite seven sampling stations with more or less similar distance in 15 days interval from January 2009 to December 2011.

Fig.: 3 *Ganda Nala of Phagwara*

Organization and interpretation of data

The data obtained from analyzed samples are tabulated and interpreted with the Water Quality Index (http://www.water-research.net/watqualindex/index.htm).

Table 1. Water Quality Index Legend

Range	90-100	70-90	50-70	25-50	0-25
Quality	Excellent	Good	Medium	Bad	Very bad

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 2.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

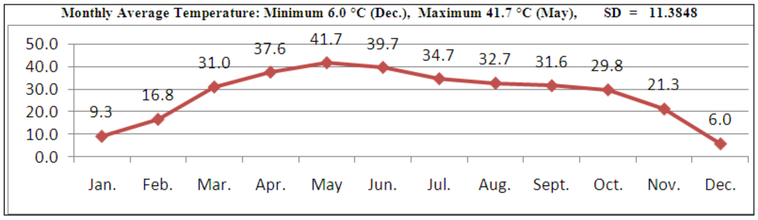


Fig.4: Average Monthly Temperature (°C)

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.

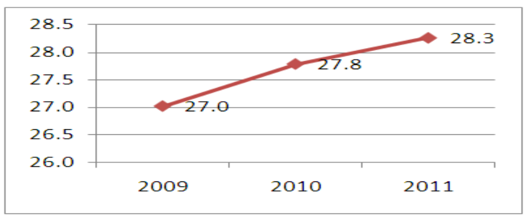


Fig.5: Average Yearly Temperature

Table 3. ***Values of Turbidity (NTU)***

SN	Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Avg.
1	2009	37.33	38.10	39.20	40.80	39.50	43.10	43.20	43.30	42.10	39.00	38.50	37.22	40.11
2	2010	40.10	40.20	40.10	41.40	41.20	42.30	42.50	42.80	41.80	41.20	40.30	40.50	41.20
3	2011	41.20	41.80	41.50	41.90	42.20	42.50	42.30	42.90	43.24	42.50	42.00	40.00	42.00
Average		39.54	40.03	40.27	41.37	40.97	42.63	42.67	43.00	42.38	40.90	40.27	39.24	41.10
Monthly Average Turbidity: Minimum 39.24 NTU (Dec.), Maximum 43.00 NTU (Aug.), SD = 1.300332														

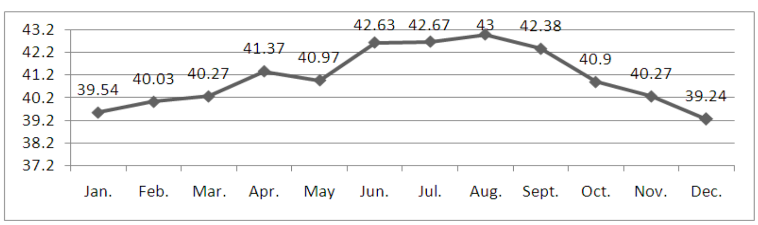


Fig 6. ***Average Monthly Turbidity (NTU) content***

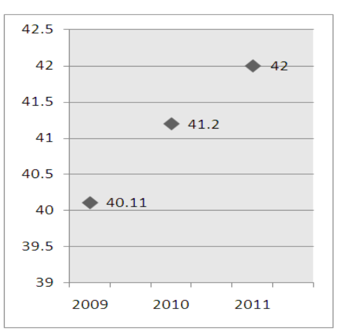
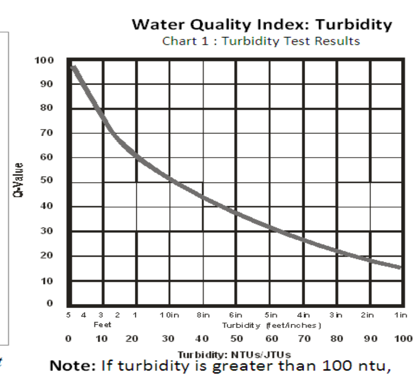


Fig 7. ***Average Yearly Turbidity (NTU) content***



From the above data & graphical representation of turbidity content in wastewater of Phagwara indicates that it is in increasing order from 2009 to 2011. The minimum average turbidity was noted in the month of December 39.24 NTU and maximum in the month of August 43.00 NTU. The average turbidity in 3 years was noted 41.10. The Q-Value of turbidity lies between 39 to 43 NTU, which indicates the bad quality in terms of turbidity.

RESULTS AND DISCUSSION

Table 4. Average data of Temperature and Turbidity

2009-2011	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.
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
Turbidity	39.54	40.03	40.27	41.37	40.97	42.63	42.67	43.00	42.38	40.90	40.27	39.24

Table 5. ***Statistical Data of Temperature and Turbidity***

Variable	Mean	Standard Deviation (δ)	Correlation coefficient (r)
Temperature (°C)	27.7	11.3848	0.596754
Turbidity (NTU)	41.10	1.300332	

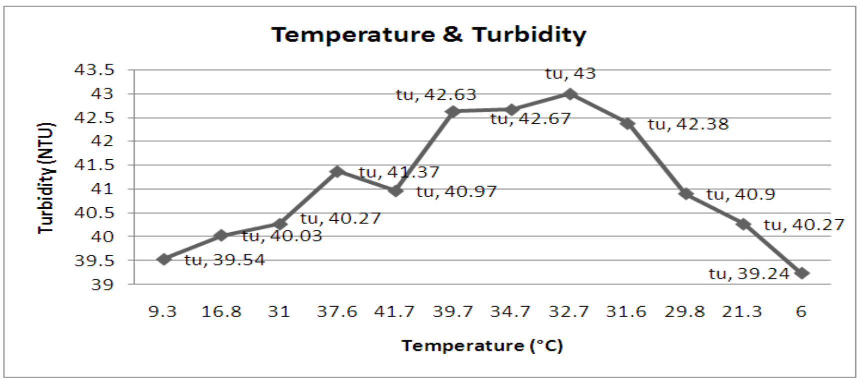


Fig.7: Correlation between Temperature and Electrical Conductivity

The curve of Figure 7 shows that Turbidity increases with the temperature. The shape of the curve also shows that turbidity is increasing in order from winter to summer season as temperature follows the similar pattern. The position of curves also shows that turbidity is at highest point in the month of August is due to storm water and at lowest point in the month of December is due to low temperature and absence of storm water. The form of the curve shows that both the temperature and turbidity are somehow interrelated. The considerable differences in the position of the curve indicate that a shift in temperature can result from seasonal changes in chemical characteristics. These samples were collected from naturally made Ganda Nala as it enters into the Phagwara city from Hoshiarpur district and run 12 kilometer along it, in which there is some introduction of industrial and domestic wastes.

The Standard Deviation in case of temperature is 11.3848 and for turbidity it is 1.300332 which is very high in both cases and show high variations. The correlation coefficient is 0.596754 which indicates moderate correlation, substantial but low relationship. Thus the research hypothesis is partially rejected and alternate hypothesis is adopted i.e. there exists a moderate, substantial, low & definite significant positive relationship between temperature and turbidity in waste water 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 work is needed not only to gain better understanding of the behavior of correlation coefficients, but also to provide greater meaning to the use of turbidity measurements in the description of aquatic conditions of Phagwara.

CONCLUSIONS

Results of this study indicate that the temperature can determine the rate of biochemical reactions in the aquatic environment or whether they can occur at all. If, however, water is known to be polluted or to have other unusable chemical characteristics, reasonable precision can be assured only by determining the temperature range within which turbidity measurements are made. The results obtained from the study area also show that the levels of temperatures are not within the recommended range provided by WHO as 25°C. It is also observed, in the course of the study, that turbidity is moderately high, i.e. greater than 10 or 15 NTU (Nephelometric Turbidity Units). This indicates that the waste water in the study area is more useful for only in agricultural purposes and not fit for other domestic or industrial purposes.

RECOMMENDATION

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

I. The wastewater point sources across the industrial area should be analyzed at regular intervals, so as to ascertain the quality of water.

II. Indiscriminate disposal of municipal waste in the Local

Government Area should be stopped and a proper coagulation process should be adopted for the turbidity removal from waste water.

III. Extensive research should be carried out in that area.

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