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Analysis of industrial wastewater in Aligarh city

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ABSTRACT

The objective of sewage treatment is to produce a disposable effluent without causing harm to the surrounding environment, and also prevent pollution. Industries produce large volumes of wastes that may include a wide variety of chemicals containing most toxic pollutants. Some of the industrial wastes can be treated jointly in municipal wastewater treatment plants, but others must be pretreated at the source. The present paper presents the analysis of the wastewater by finding out the values of various target parameters i.e. pH, alkalinity, hardness, chloride, COD and BOD so that wastewater characteristics of the area can be found out with the purpose of modifying the existing treatment scheme for the wastewater treatment being presently used. The pH of sample collected from Shah Jamal Ward No. 52 was lowest and its value was 6.3 i.e. more acidic than all other samples. The pH of sample collected from Shah Jamal Ward No. 54 was highest and its value was11.5 i.e. more basic than all other samples. Sample collected from Shah Jamal Eidgah Area reported least alkalinity of 180 mg/l as $CaCO_3$. Sample collected from Sarai Rahman reported highest alkalinity of 600 mg/l as $CaCO_3$. The highest total hardness level of 464.5 mg/l as $CaCO_3$ was reported from slaughter house existing on Mathura Rd. area. The lowest total hardness value of 200 mg/l as $CaCO_3$ was reported from Shah Jamal area. The highest values of chloride concentration of 428.3 mg/l were reported from Sarai Rahman area. The lowest chloride concentration of 119.5mg/l was reported from Shah Jamal ward No. 54 area. The least BOD_5 value of 57 mg/l at 20° C was reported at Sarai Rahman area. Highest BOD_5 value of 85.04 mg/l was reported at Shah Jamal Ward No. 64 area. Shah Jamal Ward No. 54 area has reported lowest COD value of 108.8. The highest value of COD was recorded as 158.5 mg/l at Shah Jamal Ward No. 52.

Keywords: Sewage, Wastewater, environment, pollution, analysis, target parameters

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INTRODUCTION

Wastewater is any water which has been adversely affected in quality by anthropogenic influence. It comprises liquid waste discharged by domestic residences, commercial properties, industry, and/or agriculture and can encompass a wide range of potential contaminants and concentrations. In the most common usage, it refers to the municipal wastewater that contains a broad spectrum of contaminants resulting from the mixing of wastewaters from different sources.[1] Wastewater can be broadly classified depending upon the source it is obtained from i.e. Domestic or Municipal Wastewater and Industrial Wastewater. The domestic wastewater is obtained directly from residential buildings. It includes waste water obtained from toilets (human waste), sinks bathing and laundry etc. It might contain intestinal disease organisms.[2] The industrial wastewater discharged directly from different industries such as electroplating, lock manufacturing, small scale industries, die casting, meat production industries etc. This is discharged by manufacturing processes and commercial enterprises.[3] Process wastewater can contain

rinse waters including such things as residual acids, plating metals, and toxic chemicals. The sources of municipal wastewater are human waste, cesspit leakage, septic tank discharge, sewage treatment plant discharge, washing water (personal, clothes, floors, dishes, etc.), also known as grey water or sullage, rainfall collected on roofs, yards, hard-standings, etc. (generally clean with traces of oils and fuel), groundwater infiltrated into sewage, surplus manufactured liquids from domestic sources (drinks, cooking oil, pesticides, lubricating oil, paint, cleaning liquids, etc.), urban rainfall runoff from roads, carparks, roofs, sidewalks, or pavements (contains oils, animal faeces, litter, fuel or rubber residues, metals from vehicle exhausts, etc.), seawater ingress (high volumes of salt and micro-biota), direct ingress of river water (high volumes of micro-biota), direct ingress of manmade liquids (illegal disposal of pesticides, used oils, etc.), highway drainage (oil, de-icing agents, rubber residues), storm drains (almost anything, including cars, shopping trolleys, trees, cattle, etc.), black water (surface water contaminated by sewage). The industrial wastewater contains industrial site drainage (silt, sand, alkali, oil, chemical residues, heavy metals), Industrial cooling waters (biocides, heat, slimes, silt), Industrial process waters, Organic or bio-degradable waste, including waste from abattoirs, creameries, and ice cream manufacture, Organic or non biodegradable/difficult-to-treat waste (pharmaceutical or pesticide manufacturing), extreme pH waste (from acid/alkali manufacturing, metal plating), Toxic waste (metal plating, cyanide production, pesticide manufacturing, etc.), Solids and Emulsions (paper manufacturing, foodstuffs, lubricating and hydraulic oil manufacturing, etc.), agricultural drainage, direct and diffuse.[5]

Waste Water Characteristics

The selection and design of treatment plants for (industrial and domestic) wastewater is based on the study of the physical, chemical and biological characteristics of wastewater, the quality that is to be maintained in the environment to which the wastewater is to be discharged or quality that is to be maintained for its reuse and standards for its discharge as specified by CPCB.The important and principal physical characteristics of wastewater are its color, solid contents, its odor and temperature and chemical properties include organic compounds, inorganic compounds, pH, alkalinity, dissolved oxygen. [6]

Color

Color is a qualitative characteristic that can be used to assess general condition of Wastewater. Wastewater that is light brown in color is less than 6 h old, while a light-to- medium grey color is characteristic of wastewaters that have undergone some degree of decomposition or that have been in the collection system for some time. If the color is dark grey or black, the wastewater is typically septic, having undergone extensive bacterial decomposition under anaerobic conditions. [7]

Total Solids

The total solids in a wastewater consist of the insoluble or suspended solids and the soluble compounds dissolved in water. Between 40 and 65 % of the solids in an average wastewater are suspended. Settleable solids, expressed as milliliters per liter, are those that can be removed by sedimentation. Usually about 60 % of the suspended solids in a municipal wastewater are settleable.

Odor

The determination of odor has become increasingly important, as the general public has become more concerned with the proper operation of wastewater treatment facilities. The odor of fresh wastewater is usually not offensive, but a variety of odorous compounds are released when wastewater is decomposed biologically under anaerobic conditions. The principal odorous compound is hydrogen sulphide (the smell of rotten eggs). Other compounds, such as indol, skatol, cadaverin and mercaptan, formed under anaerobic conditions or present in the effluents of pulp and paper mills (hydrogen sulphide, mercaptan, dimethylsulphide etc.), may also cause a rather offensive odor. Odor is measured by successive dilutions of the sample with odor-free water until the odor is no longer detectable.

Temperature

Temperature is not a critical issue below 37 °C if waste water is to receive a biological treatment. Most industries waste tends to be on the warmer side. It is possible to operate thermophilic biological wastewater treatment systems up to 65 °C with acclimated microbes. Low temperature operations in northern climates can result in very low temperatures and slow reaction rates for both biological treatment systems and chemical treatment system. Increased viscosity of waste waters at low temperatures makes solid separation more difficult. Efforts are generally made to keep operating temperatures between 10 °C and 30 °C.

Organic Compounds
Organic compounds create most of the pollution problems as a result of their effect on oxygen resources in the environment. The low-molecular weight water soluble organics tend to be biodegraded by bacteria and fungi with utilization of oxygen. Solubility and biodegradability decrease with the complexity of organic molecules. The total COD (Chemical Oxygen Demand) of organic compounds in waste water is measured by dichromate Cod test. A 2-hour reflux with concentrated sulphuric acid and potassium dichromate with silver sulphate and mercuric sulphate catalyst is adequate for complete oxidation of all but a few aromatic organic compounds.

Inorganic Compounds
The inorganic compounds in most industrial wastes are the direct result of inorganic compounds in the carriage water. Soft water sources will have lower inorganic compounds than hard water or salt water sources. In a few instances, industrial processes add inorganic compounds to the waste water. While domestic waste water has a balance industrial processes add inorganic compounds to the waste water. While domestic waste waters have balance in organic compounds and inorganic compounds, many process waste waters from industry are deficient in specific inorganic compounds. Biodegradation of organic compounds requires adequate nitrogen, phosphorus, iron and trace salts. Ammonium salts or nitrate salts can provide the nitrogen, while phosphate supplies the phosphorus. Either ferrous or ferric salts or even normal steel corrosion can supply the needed iron. Other trace elements needed for biodegradation are potassium, calcium magnesium, cobalt, molybdenum, chloride and sulphur. Carriage water or demineralised waste waters or corrosion products can supply the needed trace elements for good metabolism. Occasionally, it is necessary to add specific trace elements or nutrient elements.

pH and Alkalinity
Waste water less than ph less than 6 are corrosive in nature and those having pH more than 9 will cause some of the metal ions to precipitate as carbonates or hydroxides.

Dissolved Oxygen
Dissolved Oxygen is present in water which is an essential element for the working of aerobic bacteria in the biological treatment systems. It is important that the waste water have maximum DO level, when these are discharged. Oxygen is a poorly soluble gas in water, having a solubility of 9.1 mg/l at 20°C. DO is minimum when the BOD rates are maximum.

Chlorides, sulphates, pH and alkalinity are determined to assess the suitability of reusing treated wastewater and in controlling the various treatment processes. Trace elements, which include some heavy metals, are not determined routinely, but trace elements may be a factor in the biological treatment of wastewater. All living organisms require varying amounts of some trace elements, such as iron, copper, zinc and cobalt, for proper growth. Heavy metals can also produce toxic effects; therefore, determination of the amounts of heavy metals is especially important where the further use of treated effluent or sludge is to be evaluated. Many of the metals are also classified as priority pollutants

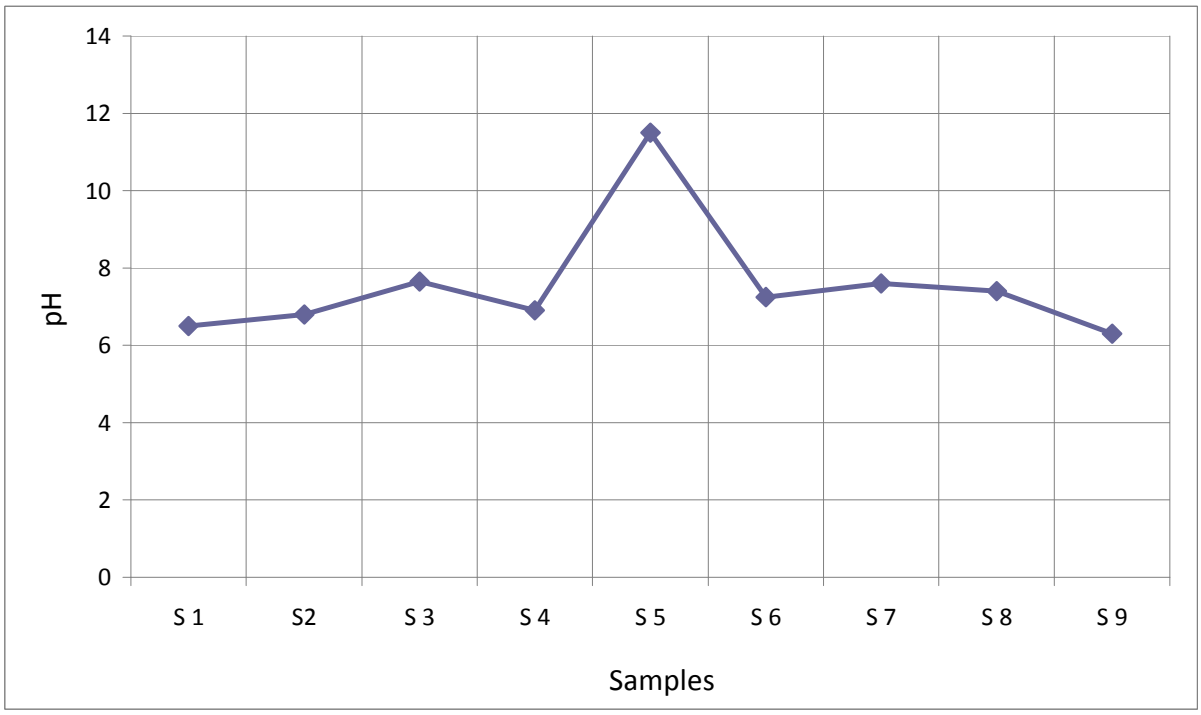
EXPERIMENTAL SECTION

Wastewater samples were collected from different locations in the vicinity of different industries at Aligarh. The collected wastewater samples were analyzed for pH, alkalinity, hardness, chlorides, BOD_5, COD.[8]

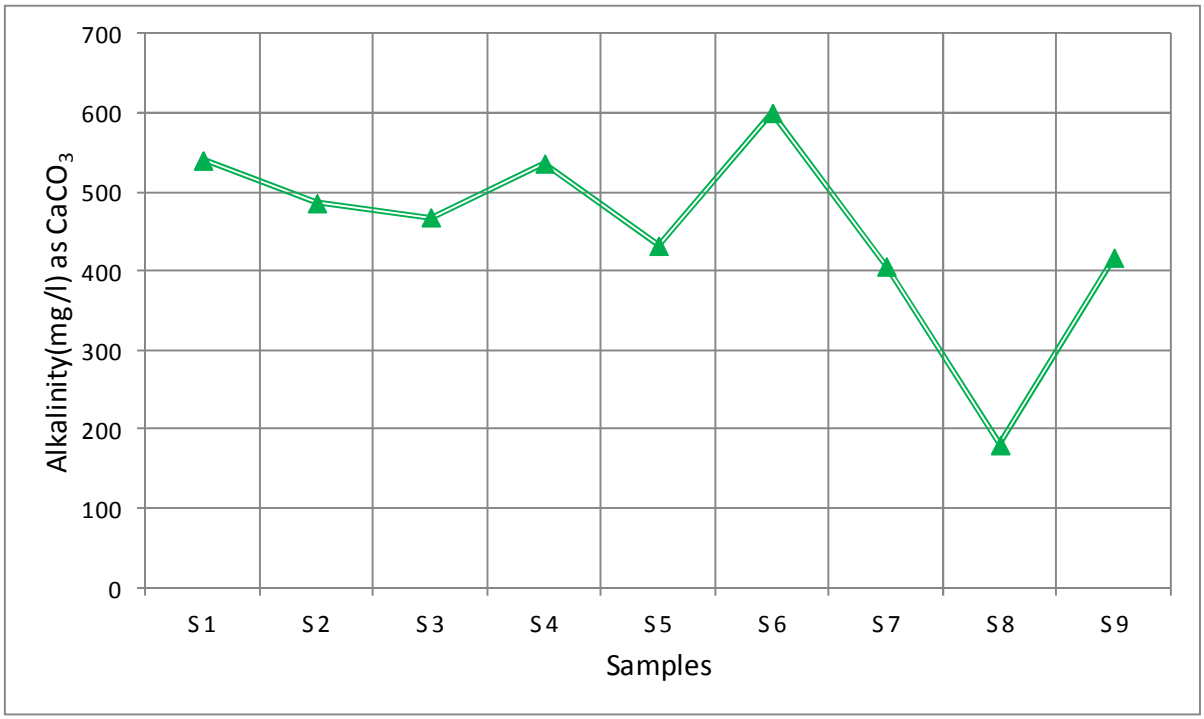
Locations from where wastewater was collected and the type of industries in that area:

Sample	Location	Industries
S 1	Industrial Estate/NSIC	Dye Casting/Lock/Electroplating
S 2	Industrial Estate/Numaish Ground	Electroplating/ Dye Casting
S 3	Shahjamal - 64	Lock/ Handles/Electroplating
S 4	Gaunda Road, Lal Masjid	Electroplting/Lock
S 5	Shahjamal - 52	Electroplting/Lock
S 6	Sarai Rehman	Lock/Cottage/Electroplating
S 7	Slaughter House	Meat Production
S 8	Shahjamal Eidgah	Electroplating/ Dye Casting/Lock
S 9	Shahjamal	Electroplating/ Dye Casting/Lock

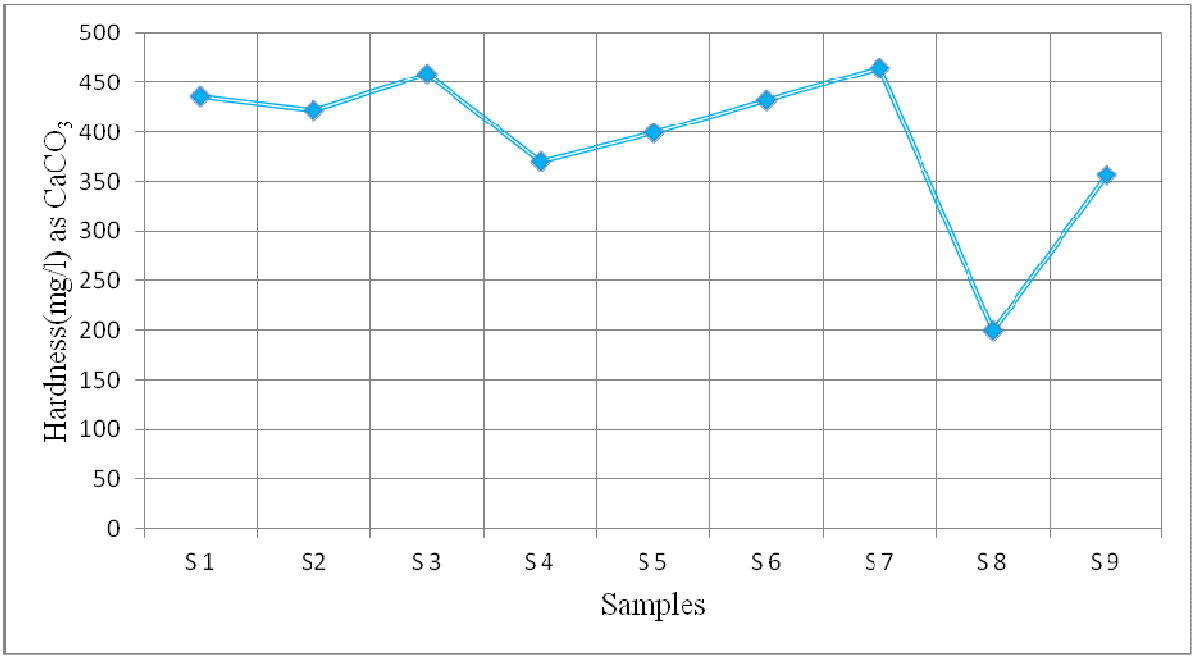
Graph 1: Graphical Representation of Observed Values of pH



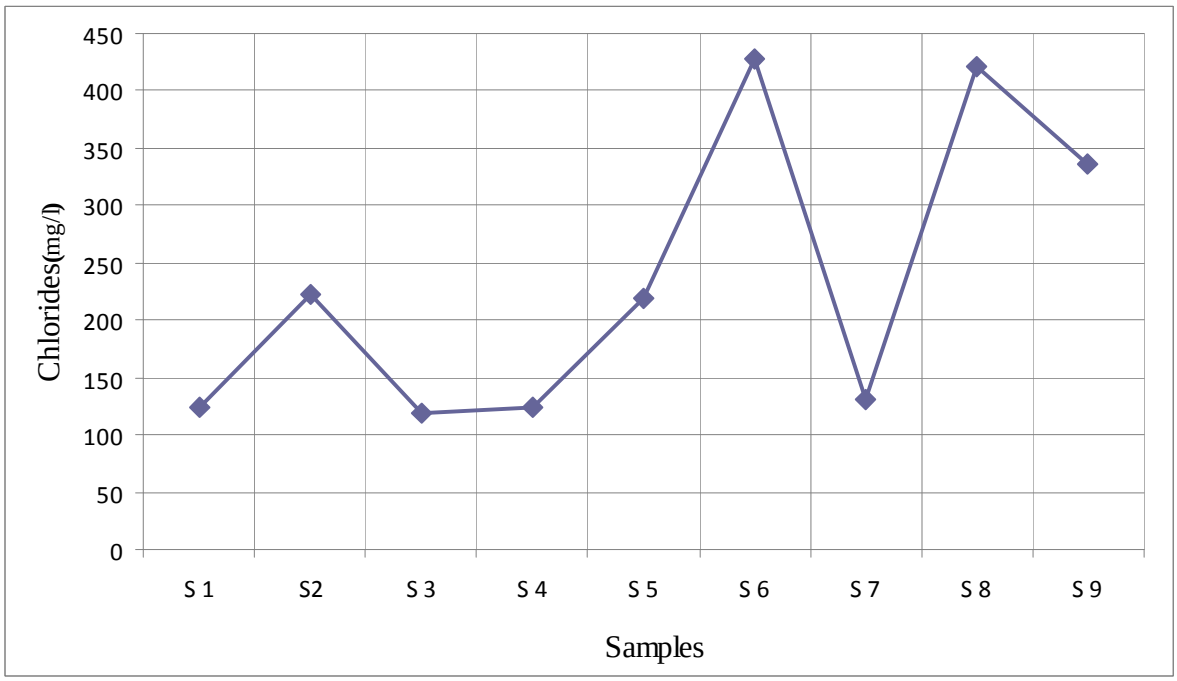
Graph 2: Graphical Representation of Observed Values of Alkaliniy



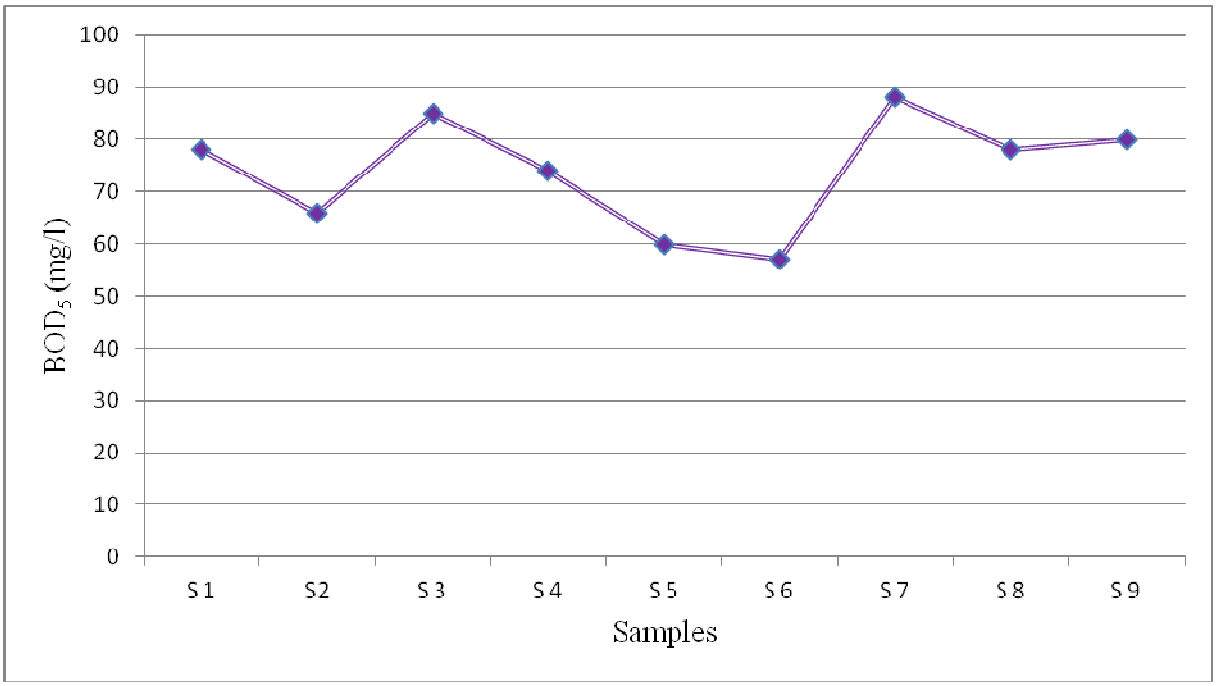
Graph 3: Graphical Representation of Observed Values of Hardness



Graph 4: Graphical Representation of Observed Values of Chlorides



Graph 5: Graphical Representation of Observed Values of BOD_5



Graph 6: Graphical Representation of Observed Values of COD

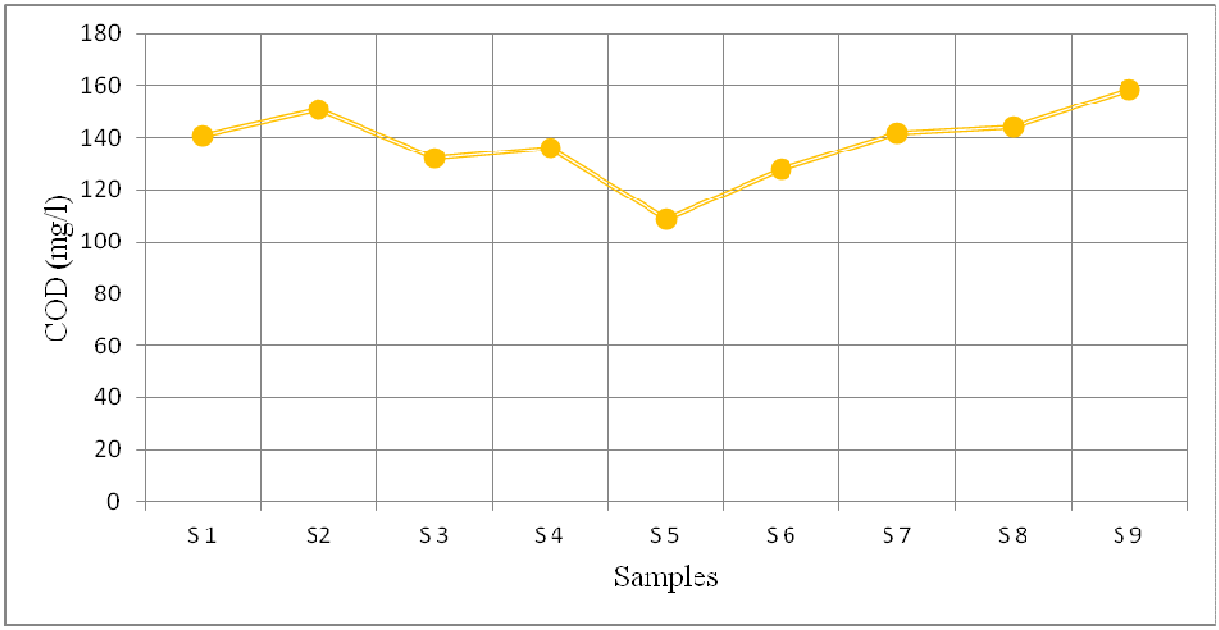
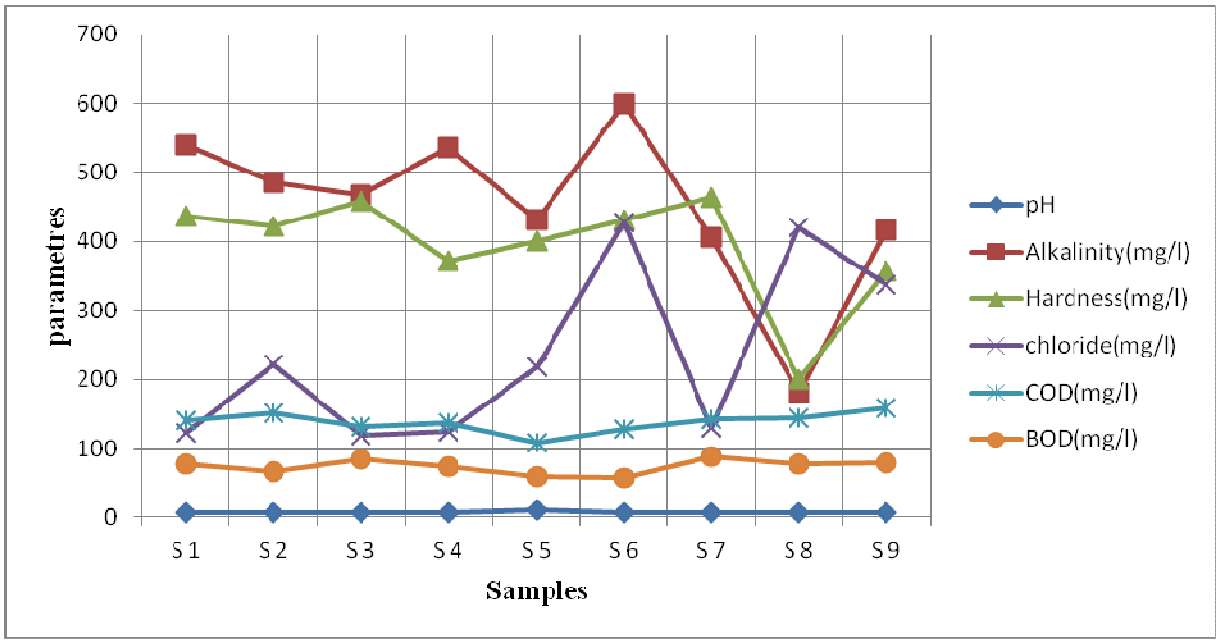


Table 1: Observed Values of different parameters

Parameter / Sample	pH	Alkalinity (mg/l) as $CaCO_3$	Hardness (mg/l) as $CaCO_3$	Chloride (mg/l)	COD (mg/l)	BOD_5 (mg/l)
S 1	6.5	540	436	123.37	140.8	78
S 2	6.8	486	422	222.22	150.6	66
S 3	7.65	468	458.2	119.52	132.12	85.04
S 4	6.9	536	371	124.2	136.2	74
S 5	11.5	432	400	218.37	108.8	60
S 6	7.25	600	432	428.326	128	57
S 7	7.6	406	464.5	130.326	141.6	88
S 8	7.4	180	200	421.146	144	78
S 9	6.3	417	357	336.7	158.5	80



Graph 7: Comparative Representation of different parameters

BOD_5 to COD Ratio

Sample	BOD_5 : COD ratio	Degree of Biodegradability
S 1	0.55	High
S 2	0.433	Low
S 3	0.64	High
S 4	0.54	High
S 5	0.55	High
S 6	0.44	Low
S 7	0.62	High
S 8	0.54	High
S 9	0.50	Average

RESULTS AND DISCUSSION

The Wastewater Samples were collected from different locations existing in the various zones of Aligarh city including Industrial Estate, Shah Jamal, Gonda Road, Slaughter House and Eidgah etc.The maximum pH of 11.5 was reported in Shah Jamal Ward No. 54 and the least pH of 6.3 was reported from Shah Jamal Ward No. 52. The low pH of this place and high pH in Shah Jamal Ward No. 54 may be due to the various raw materials used and processing techniques adopted in the different industries existing in different areas. In the rest of the places pH varied between these two extreme values of 6.3 and 11.5 respectively. The least alkalinity was reported in Shah Jamal Eidgah area and it was 180 mg/l as $CaCO_3$. The possible reasons can be release of certain acidic compounds

in the domestic and industrial wastewater from this area. The highest alkalinity value of 600 mg/l as $CaCO_3$ was reported from Sarai Rahman area. It could be because of the release of certain alkalis from cottage industries existing in this area. At most of the places the alkali levels were in the range of 400-500 mg/l, which is in the permissible limits according to Central Pollution Control Board criteria. The highest total hardness level of 464.5 mg/l as $CaCO_3$ was reported from slaughter house existing on Mathura Rd. area. This may be due to high total hardness levels in the ground water of this area because most of the water used in residential buildings and industries in this area is taken from the ground water source. Again the lowest total hardness value was reported from Shah Jamal area. At most of the places the total hardness levels ranged between 350 to 450 mg/l as $CaCO_3$, these are accepted values for municipal wastewater. The highest values of chloride concentration of 428.3 mg/l were reported from Sarai Rahman area. This can be due to the presence of Sodium Chloride (NaCl) in domestic wastewater and various other chloride salts being used in cottage industries existing in this area. The lowest chloride concentration of 119.5mg/l was reported from Shah Jamal ward No. 54 area. The Chloride value at most of the places was much below the permissible values of 1000 mg/l in municipal wastewater prescribed by CPCB. The least BOD_5 value of 57 mg/l at 20° C was reported at Sarai Rahman area and the highest BOD_5 value of 85.04 mg/l was reported at Shah Jamal Ward No. 64 area. This is because of the low level of micro-organisms present in the wastewater. The BOD_5 values at all other places were found to be within these extreme values which are much below the permissible values of effluent discharge as recommended by CPCB. Similarly, Shah Jamal Ward No. 54 area has reported lowest COD value of 108.8 which indicates lower amount of organic compounds in wastewater collected from this area. The highest value of COD was recorded as 158.5 mg/l at Shah Jamal Ward No. 52. All other locations reported COD values between these limits, and are below the standards for discharge of effluent as per CPCB.

CONCLUSION

- The pH of sample collected from Shah Jamal Ward No. 52 was lowest and its value was 6.3 i.e. more acidic than all other samples.
- The pH of sample collected from Shah Jamal Ward No. 54 was highest and its value was11.5 i.e. more basic than all other samples.
- Sample collected from Shah Jamal Eidgah Area reported least alkalinity of 180 mg/l as $CaCO_3$.
- Sample collected from Sarai Rahman reported highest alkalinity of 600 mg/l as $CaCO_3$.
- The highest total hardness level of 464.5 mg/l as $CaCO_3$ was reported from slaughter house existing on Mathura Rd. area
- The lowest total hardness value of 200 mg/l as $CaCO_3$ was reported from Shah Jamal area.
- The highest values of chloride concentration of 428.3 mg/l were reported from Sarai Rahman area.
- The lowest chloride concentration of 119.5mg/l was reported from Shah Jamal ward No. 54 area.
- The least BOD_5 value of 57 mg/l at 20° C was reported at Sarai Rahman area.
- Highest BOD_5 value of 85.04 mg/l was reported at Shah Jamal Ward No. 64 area.
- Shah Jamal Ward No. 54 area has reported lowest COD value of 108.8
- The highest value of COD was recorded as 158.5 mg/l at Shah Jamal Ward No. 52.

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