Chapter -2

Experimental
PHYSICO-CHEMICAL PARAMETERS

TEMPERATURE

Discharges of heated effluents bring about thermal changes in natural waters. Temperature is basically an important factor for its effects on chemical and biological reaction in water. The temperature of river water was recorded at the time of sampling with the help of Celsius’s thermometer and expressed in degree.

pH

pH is a scale of acidity or alkalinity and measure the concentration of hydrogen ions in water. In the laboratory electronic glass electrode Elico pH meter model L_{1-120} used.

ALKALINITY

Alkalinity of water is its capacity to neutralize a strong acid and by the presence of OH^{-} ions capable of combining with hydrogen ions. Alkalinity may be expressed as due to individual bases.
Material

(i) Laboratory Glassware

(ii) Reagents.

Regents

(A) Sulphuric acid (0.02 N):

Diluted 2.8 ml of Concentrated $\text{H}_2\text{SO}_4$ to 1:1 using diluted water.

Diluted 200 ml. of this stock solution (0.01 N) to 1:1 using diluted water to prepare (0.02 N) $\text{H}_2\text{SO}_4$ acid titrant standardized the solution.

(B) Phenolphthalein indicator

Dissolved 1 gm. of Phenolphthalein in 100 ml ethyl alcohol and added 100 ml. of distilled water. Now added NaOH solution, drop by drop until a faint pink colour appeared.

(C) Methyl orange

Dissolved 0.5 gm. of methyl orange in 100 ml. of distilled water.

METHOD

After collection of river water about 50 ml. of sample (river water) taken in a flask and added 2-3 drops of phenolphthalein indicator. Phenolphthalein alkalinity was confirmed due to appearance of pink color and it was due to hydroxide/
carbonate. The $\text{H}_2\text{SO}_4$ (0.002 N) used as titrant, was added in to the solution and solution become colorless (end point), 2-3 drops of methyl orange indicator was added in same flask and continued to titrate against $\text{H}_2\text{SO}_4$. Yellow color of the solution turned in to orange (end point) and calculated with following equation.

\[
\text{Phenolphthalein alkalinity} = \frac{\text{P} \times 1000}{\text{S}}
\]
\[
\text{Total alkalinity as } \text{CaCO}_3 \text{ mg/l} = \frac{\text{S}}{\text{t} \times 1000}
\]

Where $\text{p}$ - volume of titrant used against Phenolphthalein indicator (ml),

$s$ = volume of sample (ml).

$t$ - total volume of titrant used for the two titrations (ml).

**TOTAL SOLIDS**

Total solids of sample were estimated by evaporating a measured volume of the samples in an oven at 105°C in a dry constant weight crucible. Following formula was used to calculate the total solids.

\[
\text{Total solids (mg/l)} = \frac{\text{weight of crucible with empty residue - weight Crucible}}{\text{ml sample}} \times 1000
\]

**ACIDITY**

Potentiometric titration method was used for the determination of the acidity of water. Titrant sodium hydroxide (0.025 N) was used to raise pH of the sample water (100 ml.) up to 8.3 (Phenolphthalein acidity).
Phenolphthalein gives pink color above pH 8.3 below which it remain colorless.

The acidity was calculated using following formula:

\[
\text{Acidity} = \frac{V \times N \times 50,000}{\text{ml sample}} \quad \text{mg L}^{-1} \text{ CaCO}_3
\]

Where V and N are volume and Normality of the titrant respectively

**DISSOLVED OXYGEN (DO)**

DO means oxygen dissolved in water. It is very important parameter of water. The two main source of dissolved oxygen in water (i) diffusion from air (ii) photosynthetic activity within water. Diffusion of oxygen is a physical phenomenon and depends upon solubility of oxygen which is influenced by factors like temperature, water movements and salinity etc.

**Material**

(i) BDD bottles (100-300 ml)

(ii) Reagents

(A) Sodium thiosulphate

In a 250 ml boiled distilled water dissolved 6.205 gms. of sodium thiosulphate and then added a pallet of NaOH as stabilizer.

(B) Mangenous sulphate solution

In a 250 ml boiled distilled water dissolved 100 gm. mangenous sulphate solution and then it was filtered.
(C) Alkaline KI

250 gm KI, 100 gm KOH were dissolved in 250 ml. of boiled distilled water.

(D) Starch Indicator

In a 100 ml. of boiled distilled water dissolved 1 gm. of starch and then added few drops of formaldehyde solution.

METHOD

In BDD bottle, 50 ml. of river water sample was taken and added 1 ml. manganous sulphate (B) and 1 ml. alkaline KI (C) solution precipitate appeared 2 ml. of H₂SO₄ was added and shaked thoroughly to dissolved the precipitate, 20 ml. of sample was taken from whole content in a conical flask and added a few drops of starch indicator (D) titrated against sodium thiosulphate solution(A). Blue green color changed in to colorless (end point).

Calculation

If whole content is used for titration

\[
DO \ (mg/1) = \frac{V_1 \times N \times 8 \times 1000}{V_2 - V_3}
\]

If a fraction of the contents is used for titration

\[
DO \ (mg/1) = \frac{V_1 \times N \times 8 \times 1000}{V_4(V_2 - V_3)}
\]

\(\frac{V_2}{(65)}\)
**BIOCHEMICAL OXYGEN DEMAND (BOD)**

The rate removal (i.e. consumption) of oxygen by microorganisms in aerobic degradation of dissolved organic matter in water is called biochemical oxygen demands. It is used as an index of organic pollution in water, more amount of oxygen required to degrade it biologically hence more the BOD.

**Material** (i) BOD incubator, (ii) BOD bottles and (iii) reagents

**Regents** All reagents used in determine to DO.

**Method**

BOD is calculated by measuring oxygen concentration In water sample and incubation in dark at 20 C for 5 days.

\[
\text{BOD (mg/l)} = \frac{\text{DO (initial) - DO (5 days incubation)}}{\text{Decimal fraction of dilution}}
\]

Where

- **DO** = Dissolved oxygen
- **N** = Normality of titrant (0.25)
- **V_j** = Volume of titrant (ml.)
- **V_2** = Volume of sampling bottle after placing the stopper (ml.)
- **V_3** = Volume of mangenous sulphate +KI solution added (ml.)
- **V_4** = Volume of fraction of the contents used for titration (ml.)

- **DO initial** = dissolved oxygen of first sample.
DO 5 days incubation = dissolved oxygen of the sample after 5 days incubation in dark.

CHEMICAL OXYGEN DEMAND (COD)

Chemical oxygen demand is the measure of oxygen required in oxidizing the organic compounds present in water.

MATERIAL

(i) COD reflux unit (ii) Hot water bath (iii) Reagents

(A) **KI solution** (0.25 N): Dissolved of 12.259 gm. of the potassium dichromate (dry- AR) in distilled water to prepare 1:1 of solution.

(B) **Silver sulphate**: Dry, powdered

(C) **Murcuric sulphate**: Drv powdered

(D) **Sulphuric acid**: concentrated

(E) **Ferroin indicator solution**: Dissolved 0.695 gm. of ferrous sulphate and 1.485 gm. of 1.10 phenothroline in distilled water to make 100 ml. of indicator solution.

(F) **Ferrous ammonium sulphate**: Dissolved 98gm ferrous ammonium sulphate in distilled water and added 20 ml of $H_2SO_4$ acid, cooled and diluted to 1:1 by further adding distilled water.
METHOD

Taken 20 ml. of river water sample in a flask of reflux unit and added 10 ml. of $K_2Cr_2O_7$ solution A, a pinch of regents B and C and 30 ml. $H_2SO_4$ (D). Now flask was heated on a water bath after attaching the Lie beg condenser for at least two hours, to reflux the content. Flask was cooled and its contents were diluted about 150 ml. by adding distilled water, 2-3 drops Ferroin indicator was added titrated against Ferrous ammonium sulphate solution (E). Blue green color of solution was changed in to redish-blue. Distilled water was used as blank. The COD was calculated as

$$\text{COD (mg/l)} = \frac{(B - A) \times N \times 1000 \times 8}{V}$$

Where

$A$ = Volume of titrant used against sample (ml.).

$B$ = Volume of titrant used against blank (ml.)

$N$ = Normality of titrant (0.25).

$V$ = Volume of sample (ml.)

CHLORIDE($Cl^-$)

Inland natural waters, in general, have low chloride concentration, often less than bicarbonates, and sulphates. High concentration of chloride in natural fresh water is considered to be an indicator of pollution, industrial effluents may increase the chloride contents in natural water. Chloride content above 250 mg/l

(68)
makes a water safety in taste, however a level up to 1000 mg/1 is safe human consumption.

Material

(i) Laboratory glassware and (ii) reagents

(A) Silver nitrate solution (0.02 N) : Dissolved 3.397 gm of nitrate in one liter distilled water.

(B) Potassium chromate indicator : Dissolved 10 gm. of potassium chromate in about 20 ml. of distilled water and added a few drops of (0.02 N) AgNO₃ solution (reagents A) to produce a red precipitate filter and diluted the filtrate to 1:1 with distilled water.

Method

In a flask taken 10 ml. of water and added 5-6 drops of potassium chromate indicator (B) The color of sample becomes yellow. Titrated against AgNO₃ solution (A), yellow color of sample was changed in to the brick redish color (end point).

Calculation

\[
\text{Chloride (mg/1)} = \frac{V \times N \times 35.457 \times 1000}{S}
\]

(69)
Where

\[ V = \text{Volume of titrate (ml.)} \]
\[ N = \text{Normality of titrant (0.02)} \]
\[ S = \text{Volume of sample (ml.)} \]

**PHOSPHATE (PO}_4^{3-} \)**

**Material**

(i) Filter paper (whatman No. 50)  (ii) other reagents

**Reagents**

(A) Ammonium molybdate solution

Added 62 ml. of \( \text{H}_2\text{SO}_4 \) acid (concentrated) slowly to 80 ml. of distilled water and let cooled. Dissolved separately 5 gm. of ammonium molydate in 35 ml. of distilled water and mixed it with \( \text{H}_2\text{SO}_4 \). Now added distilled water to make the solution 200 ml.

(B) Stannous chloride solution

Dissolved 0.5 gm. of \( \text{SnCl}_2 \) in 2 ml. of Cone. HC1 and diluted to 20 ml. with distilled water.

(C) Standard phosphate solution

Dissolved 4.388 gm. of dried anhydrous potassium hydrogen phosphate in
distilled water to make the volume 1:1. Took 10 ml of this soln. and added distilled water to make 1:1 of stock soln. containing mg/1. Standard Phosphate solution of various strength was prepared by diluting the stock solution with distilled water.

**Method**

In a flask 4 ml ammonium molybdate and 10 drops of Sncl$_2$ were added to 50 ml of distilled water and make up to 100 ml. Blue colored appearance represents the presence of PO$_4$$^{3-}$ The final calculation was made with the help of standard graphs, prepared from known concentration of phosphate in solution.

Organic phosphorous (mg/1) = TP - IP

Where

TP = Total Phosphorous (mg/1)

IP = Inorganic Phosphorous (mg/1)

**Sulphate**

Domestic sewage and industrial effluents may add to sulphate content of water. Sulphate salts are mostly soluble in water and impart hardness.

**Material**

(i) Spectrophotometer

(ii) Fimeter Paper (What man No 1)

(iii) Reagents.
(A) NaCl-HCl Solution

Dissolved 240 gm of sodium chloride in distilled water. Added 20 ml. of
HCl it and dilute with more of distilled water to make the volume 1:1.

(B) Glycerol-ethanol solution

Added 50 ml. of glycerol to 100 ml. of ethyl alcohol and shake well.

(C) Barium chloride: Dry crystals

(D) Standard sulphate solution

Dissolved 0.1479gm of anhydrous sodium sulphate in distilled water to
make the volume 1:1, the soln. contains 100 mg sulphate/1.

Method

First of all filtered the sample and took 50 ml of filtrate in a flask. Now
added 10ml of NaCl - HCl soln. (reagent A), 100ml.of glycerol -ethanol soln.
(reagent B), and 0.15 gm. of barium chloride (reagent C). Stir the sample with the
help of a magnetic stirrer for about an hour. Measure the absorbance (S) against a
distilled water blank at 420 nm using spectrophotometer. Process the standard
solution of different strength (reagent D) in similar way and record the absorbance
from each.
NITRATE (NO₃⁻)

Nitrogen forms a major constituent (80%) of atmosphere but in water small amounts occur in forms of NH₃, nitrite and nitrate.

\[
\begin{align*}
\text{Nitrification} & \\
\text{Ammonia} & \xrightarrow{\text{Nitrite}} \text{Nitrate} \\
\text{Denitrification} &
\end{align*}
\]

Nitrate is the highest oxidized form of nitrogen in water by biological oxidation. Domestic sewage, agricultural runoff are chief sources of nitrogenous organic matter. Metabolic wastes of aquatic community and dead organisms add to the nitrogenous organic matter.

Phenol disulphonic acid method

Material

Reagents

(A) Phenol disulphonic acid

Dissolved 25gm. of white phenol in 150 ml. of H₂SO₄ (cone). Heat for about 2 hours on a water bath, cool, and keep the solution in a dark bottle.

(B) KOH Solution (12 N)

Dissolved 336.5 gm. of KOH in distilled water to make the volume 500 ml.

(C) Standard nitrate solution

Dissolved 0.722 gm. of anhydrous potassium nitrate in distilled water to prepare 1:1 of the stock solution.

(73)
Method

Took 25 ml. of sample in porcelain disc and evaporate it to dryness on a hot water bath. Added 0.5 ml. of phenol disulphonic acid (reagent A), to the residue and dissolved the latter with the help of a glass spatula. Added 5 ml. of distilled and 1.5 ml. of KOH solution (reagent B), Stir for thorough mixing. Took the supernatant of yellow color and read it’s absorbance (S) on spectrophotometer at 410 nm. used process same for standard nitrate solution (reagent C).

IRON (Fe)

All natural water contain iron which is both in oxidized (Ferric) and reduce (ferrous) forms. Most of the iron occurs in ferrous state in ground water which I quickly oxidized to ferric state (Ferric hydroxide) under aerobic condition, CO₂ is released during the oxidation of Ferrous bicarbonate to ferric hydroxide.

Material

(i) Spectrophotometer (ii) reagents

(A) Hydrochloric acid: Concentrated 12 N.

(B) Hydroxylamine hydrochloride solution:

Dissolved 10 gm. of hydroxylamine hydrochloride in distilled water to make 100 ml of solution.
(C) **Ammonium acetate buffer solution**

Dissolved 100 gm. of ammonium acetate was dissolved in 60 ml. of distilled water and added 280 ml glacial acetic acid.

(D) **Phenanthroline solution**

Dissolve 50 mg. of 1.10-phenanthroline monohydrate in 50 ml. of distilled water by shaking and heated up to 80°C at a water bath.

(E) **Standard Iron solution**

20 ml. of cone. H₂SO₄ was diluted in 50 ml. distilled water and then 1,404 gm. ferrous ammonium sulphate was dissolved 0.1 gm. KMnO₄ was added slowly till a faint pink color appears and then diluted to one liter.

**Method**

Took 50 ml. of sample of water in a conical flask and added 2 ml. cone. HCl and 1 ml. of hydroxylamine hydrochloride solution. The contents were boiled for half of the volume and then cooled. 10ml. of ammonium acetate solution and 2 ml. phenanthroline added one by one orange red color appeared. Then after 10 minutes the contents were dissolved in distilled water and 100 ml. volume was made. The reading of absorbance of the above solution was observed from spectrophotometer at 510 nm. Process the standard iron solution of the different concentration in similar manner and record absorbance for each.
ZINC (Zn)

In water sample the determination of concentration of zinc used method Zincon method.

Regents

(A) Stock zinc solution

(1ml = 100 mg Zn). Dissolved 100 mg of Zn in 1 ml of HCL (1 + 1) and diluted into 1 liter distilled water.

(B) Standard Zinc Solution:

(1 ml = 10 mg Zn ) Stock solution of zinc was diluted 10 times (10 - 100 ml)

(C) Sodium as carbonate

Fine granular powder

(D) Potassium cyanide solution

In distilled water 1.0 gm KCN dissolved and prepare 100 ml of solution.

(E) Buffer solution

In one liter of distilled water 40 gm of NaOH was dissolved and prepare IN NaOH , 213 ml of 1 N NaOH diluted to 600 ml and then added 37.8 gm KCN and 31.0g H$_3$BO$_3$ and made the volume to 1 liter.

(F) Zincon reagent

In 100 ml methanol dissolved 130 gm zincon powder and stirrer for 1 night

(G) Chloral Hydrate Solution

10 gm chloral hydrate was dissolved in 100 ml of distilled water.
Concentrated HCl

Sodium Hydroxide 6N

In one liter of distilled water dissolved 240 gm NaOH to prepare 6N - NaOH.

Method

In a conical flask 50 ml of water sample taken and 1 ml of cone. HCl was added then filtered and adjusted the pH to 7 with 6N NaOH, 10 ml filtered sample was taken in conical flask and added 0.5 gm sodium as carbonate 1.0 ml KCN solution, 5.0 ml buffer solution, 3.0 ml Zincon Reagent and mixed, at last 3.0 ml of chloral hydrate solution was added and color was measured at 620 nm. in spectrophotometer exactly after five minutes.

The concentration of Zinc calculated as -

\[ Zn(mg/l) = \frac{\mu g Zn}{ml \ of \ sample} \]

Copper

Analysis of copper is done by the use of atomic absorption spectrometer and chemical analysis by Bathocuproine methods.

Reagents

(A) Hydrochloric acid

(B) Hydroxylamine Hydrochloride Solution

Dissolved 50 gm of NH₂OH.HCl in 450 ml distilled water.
(C) Sodium citrate solution
Dissolved 300 gm of Na$_3$C$_6$H$_5$O$_7$. 2H$_2$O was dissolved in litter distilled water.

(D) Disodium bathocuproine disulphonate solution
Dissolved 1.0 gm disodium bathocuproine disulphonate in 1 liter of distilled water.

(E) Stock solution of copper
Took 20 mg of polished copper wire in a 250 ml. conical flask 10 ml water and 5 ml concentration HNO$_3$ were added in a conical flask. After some time, it was warmed gently for the complete dissolution of the copper and boiled to oxides the Nitrogen. It was then cooled and then added 50 ml of distilled water transferred in one litter volumetric flask and diluted up to mark with distilled water.

(F) Standard copper solution
Dissolved 250 ml of stock copper solution in one litter of distilled water.

Method
Water sample (50ml) taken in 250 of flask and added 1 ml (1 + 1) HCl, 5 ml NH$_2$OH • HCl solution, 5 ml sodium citrate solution and 5 ml disodium bathocuproine disulphonate solution. After that the solution was measured at 484 (78)
nm on a spectrophotometer.

The concentration of copper was estimated by

\[ \text{Cu (mg/l) = } \frac{\mu \text{g Cu (in 66 ml final volume)}}{\text{ml sample}} \]

Cadmium (Cd II)

Direct - Air - Acetylene Flame method was used for the determination of Cd (II) concentration in water sample as adopted in APHA (1995), The experiments was conducted using cadmium chloride solution prepared from commercially available laboratory grade chemical. Cadmium concentration in feed and is permeate streams were measured using atomic absorption spectrometer model G.B.C. 904 AA using cadmium hollow cathode lamp and measuring the absorption at 229 nm in air - acetylene flame following the normal procedure.

Apparatus

a) **Atomic absorption spectrometer**

This is consisting of a light source emitting the line spectrum of an element (electrode discharge lamp), a means of isolating an absorption line (mono chromator) and a photoelectric detector with its associated electronic amplifying.

b) **Burner**

The most common type of burner is introduces the spray into a
condensing chamber for removal chamber for removal of large droplets.

c) Lamps

Use a hollow-cathode lamp for element being measured.

d) Vent

Place a vent about 15-30 cm above the burner to remove fumes and vapour from the flame.

Reagents

a) Air

b) Acetylene: Use standard commercial grade.

c) HCl: 1%, 10%, 20%, and concentration

d) PINO.3 (2%)

e) H₂O₂(30%)

f) Calcium solution:

Dissolve 630 mg CaCO₃ in 50 ml of 1+5 HCl

g) Aqua regia: 3 vol. cone. HCl + 1 vol. HNO₃

h) Cadmium chloride: Standard commercial grade

i) Standard metal solutions:

Cd Dissolve 0.100gm in 4 ml cone. HNO₃. Added 8.0 ml cone. HNO₃ and dilute to 1000 ml with water.
Procedure

First of all prepare the sample. The measured metal were obtained by filter at time of collection using preconditioned plastic filtering device with vacuum pressure, the filtering device by rinsing with 50 ml deionized water. Instrument operated as suggested by manufacturer. Install a hallow - cathode lamp used and let instrument warm up until energy source stabilizes generally about 10-20 min. Re adjust current as necessary until optimum energy gain is obtained. Install suitable burner head and adjust burner head position. Turn on air and adjust How rate and ignite flame. Let flame stabilizes for a few minutes. Aspirate a standard solution and adjust for obtain maximum sensitivity. Adjust burner both vertically and horizontally to obtain maximum response, select at least three concentration of each standard metal solution. Aspirate blank and zero the instrument. Then aspirate each standard in turn into flame and record absorbance.

Analysis of sample

Aspirating water containing 1.5 ml concentration HNO₃/1. Aspirate blank and zero instrument. Aspirate sample and determine its absorbance.

Calculations

Calculate concentration of metal ion in micro milligrams/liter.
Sodium (Na) and Potassium (K)

Sodium and Potassium were estimated using Systronics type 121 flame photometer with specific filter. Known volume (100 ml) of water samples were evaporated to dryness on steam bath in porcelain crucibles. The crucible were transferred to muffle furnace at the temperature of 450 °C for over night. Ash was dissolved in cone. HCl and warm distilled water diluted sample were filtered, filtrate was neutralized with NH₄OH and made upto the volume with double distilled water. Know concentration of sodium and potassium were prepared from NaCl and KC1 respectively for galvanometer adjustment and transmission of unknown solution was recorded and the concentration were calculated by the formula given in systronic type 121 manual.

\[
C = C_2 + \frac{(C_1 - C_2)}{(a_1 - a_2)} (a - a_2)
\]

where,

\[
C = \text{concentration of unknown solution.}
\]

\[
C_1 = \text{maximum concentration in ppm of NaCl and KC1 solution.}
\]

\[
C_2 = \text{minimum concentration in ppm of NaCl and KC1 solution.}
\]

\[
a = \text{transmission reading of unknown soln.}
\]

\[
a_1 = \text{transmission reading of maximum concentration of NaCl and KC1 soln.}
\]

\[
a_2 = \text{transmission reading of minimum concentration of NaCl and KC1 soln.}
\]

(82)
Adsorbents and their characterization

1. Activated Coconut Jute Carbon

Activated coconut jute carbon was prepared the same method as for activated bagasse carbon and this bagasse carbon prepared by treating four parts of raw bagasse with 3 parts of concentrated \( \text{H}_2\text{SO}_4 \) acid and kept in an air oven maintained at 150 - 160 °C for a period of 24 hours. The carbonized materials was dried at 105 - 110 °C for 24 hours.

The dried material was subjected to thermal activation at 800 - 850 °C for a period of 15 minutes. The material was ground and the particle size range of 150 - 400 microns was used through the studies.

To study the adsorption capacities of these adsorbents batch experiments were carried out. Synthetic wastes of Cr (VI) concentration ranging between 2.5 to 50 mg/1 (100 ml) were taken separately in conical flasks. Suitable doses of 0.1 to 10 gm of adsorbent were added. The system was equilibrated by shaking thoroughly on an electric shaker. The suspension was then filtered using whatman no. 41 filter paper and the filtrate analyzed spectrophotometrically at 540 nm complexing with diphenyl carbazide for residual Cr (VI) concentration in the solution. In order to find out total Cr, about 10 ml of the solution was taken in a conical flask and diluted to 100 ml using double distilled water. The solution was boiled and it about 5-6 drops of 0.1 N \( \text{KMnO}_4 \) was added to oxidize to Cr (III) to Cr(VI). To this about 4-5 drops of 0.5 % sodium azide was added to remove excess of \( \text{KMnO}_4 \). The
analysis of this part gave the total unadsorbed Cr. The amount of Cr reduced was very little (< 1 %) as compared to the amount of or adsorbed under present experimental conditions. The effects of pH (0.5 - 8.0) and temperature (10 - 40 °C) variations were also studied. Initial pH values of the suspensions were adjusted by adding HCl acid.

2. Fly ash

The physicochemical nature of adsorbent can have profound effects on both rate and capacity for adsorption.

Fly ash a waste product in a huge amount by combustion of pulverized coal. Fly ash was obtained from the electrostatic precipitation of thermal power plant Obra (Sonbhadra, U. P.) and used, without pretreatment after sieving through 55 μm sieve. It is extracted from flue gases by electrostatic (Deoros) P. J. lawps News letter, 25, 04 (1988) reveals that national thermal power plants in India will discharge 10 millions tonnes of fly ash per year.

Its disposal creates a serious problem in our country, Recently fly ash has been employed as an adsorbent in water and waste water treatment by several workers. Pandey et. al. (1979), Gupta et. al. (1984), Pandey et. al. (1985), Singh et. al. (1987), Yadav et. al. (1988), Khare et. al. (1988), Gupta et. al. (1988), Gupta et. al. (1989) Fly ash, consists of Oxides of Aluminium, Ca, Silicon etc. These oxides are amphoteric in nature. In addition, bottom ash, fly ash and other (84)
carbonaceous ashes also contain 2 - 15 % un burnt carbon which is similar in behavior to activated carbon and which may attach organic functional groups containing oxygen. Mall I. D. (1992), Haribabu E.; and Upadhyay S. N. (1993) on contact with an aqueous medium, these oxides form surface hydroxyl compounds. The charged interface thus formed interacts with charged aqueous pollutant species of the wastewater. The following mechanism was proposed for the adsorbents having these metallic oxides: Ahmed M. N. and Ram R. N. (1992), K.K. Pandey et. al.( 1988).

\[
S + H^+ + A \rightarrow S < H \quad A \\
S + OH^- + A^+ \rightarrow S < OH \quad A
\]

Where S and A^+ (or A^-) denote adsorbent and adsorbate respectively

<table>
<thead>
<tr>
<th>Chemical % Composition</th>
<th>Fly ash</th>
</tr>
</thead>
<tbody>
<tr>
<td>SiO₂</td>
<td>61.25</td>
</tr>
<tr>
<td>Al₂O₃</td>
<td>29.78</td>
</tr>
<tr>
<td>Fe₂O₃</td>
<td>3.28</td>
</tr>
<tr>
<td>CaO</td>
<td>3.01</td>
</tr>
<tr>
<td>MgO</td>
<td>0.54</td>
</tr>
<tr>
<td>Other</td>
<td>0.16,</td>
</tr>
</tbody>
</table>

Table-2.1

Characteristics of fly ash

(85)
In the case of fly ash the nature of the original feed coal and method of combustion, combustion temperature and ash collection methods are likely to affect the adsorption capacity. Ganguli and Thods (1973) reposted that the acid (0.025 N HNO₃) and alkali (0.25 N NaOH) treated fly ash showed reduced adsorption capacity for phosphate where as treatment with 0.25 HCl increase it. Increasing carbon content in the fly ash improves its adsorption capacity. (Johnson et. al 1965; Satpathy et. al. 1984). Adsorption capacity of fly ash was improved by entrapping it. (Taguchi 1988 ; Taguchi and Owda 1989). In a cement matrix and adding NH₄ Cl, KC1, MgCl₂, Na₂SO₄, citric acid and Ca Cl₂, Johnson et.al (1965) reported that the mild oxidation of coals rendered them in effective as adsorbent.

Study Site : (Water Pollution)

In modern civilization a large number new cities and towns have arisen and the existing towns have grown, as a result of which sewer system. Municipal sewer disposal by dilution in which the waste is dumped in to an available body of water
such as river or lake.

Domestic sewage is the waste water from kitchens bathrooms, Lavatories and laboratories etc. sewage also results from the disposal of water in factories and trade premises and also from the we of water in dwellings hospitals and schools. In addition to the mineral and organic matter already in water despondence to the community, the domestic sewer also contains such as human excrement as urine, faces, soapy wastes, food wastes, paper dirt, dirty water. Sewage also contains living organisms in solutions notably the bacteria, Viruses and protozoa. So the greater the concentration of the sewage, the more pronounced will the order of turbidity. The strength or weakness of sewage depends, on-

(a) Per capita water consumption

(b) The amount of industrial waste - the composition, character and appearance of sewage is pro founded.

The main source of pollution of the river Gomati at Jaunpur city are domestic sewage disposal of dead bodies and industrial effluent. Pollutants through agriculture run off also play an important role during the rainy seasons. A number of a large basic and small industries are situated around the river and also in the city of Jaunpur. Most of the effluent of the sources mixed with about 70 MLD cu/meter from these sources in Jaunpur, sewage generated by 1, 36, 289 in habitant of Jaunpur through miner and major nallas 14 drains in to the river Gomai Various aspects of sewage and industrial effluents such as biophysicochemical properties and its impact on
aquatic flora and Fauna - bio assay experiments etc. have been worked out by different investigators. However there is lack of paucity data on the physicochemical properties of sewage entering in to the river Gomati at Jaunpur city.

Therefore in order to fill up the gap of knowledge and sewage and provide physicochemical character sticks of sewage quality sample have been collected from four major sewage discharge site.

1. **S₁**

   S₁ site is situated near Bajarng Ghat 400 mt west from Shahi Bridge. This Ghat was named of a famous temple of Bajarng Balli. Here a city drawn open Carrying (3.15 MLD) sewage waste from the area of Tadatala.

2. **S₂**

   S₂ nearly 600 mt from S₁ site in the area of Kaseri Bajar where well known “Hanuman Mandir” adjacent to area nearly a drain open site river caring (2.25 MLD) sewage waste from different area.

3. **S₃**

   S₃ site is located 5.5 Km. from S₁ (Bajarng Ghat) when drain caring (4.175 MLD) sewage water from different municipal area. It is also a open drain which is located in near at Pachahatia.

4. **S₄**

   Site S₄ (near Ram Ghat) is selected out of the City and 1.0 Km east from site S₃ (near Suraj Ghat) where a drain open into the river with (2.76 MLD) capacity
caring from different area of Pachahati and Railway Station.

Analysis for pH, temperature, acidity, alkalinity, DO, BOD, COD, Chloride, NO₃⁻ N, PO₄³⁻ P, Na, K, Fe, Cd, Zn, Cu.

**Material and methods**

Detailed experiments methods are described in character II and data are obtained were statistically analysed and tested for significant by the following methods.

(1) **Correlation.**

(2) **Analysis of Variance (ANOVA)**

The water samples were taken selected sampling station as stated in chapter-1. The observations were carried out in the second week of each month from 2008 to 2009 (July to June) for different parameters viz temp., pH, total solid, temperature, acidity, alkalinity, DO, BOD, COD, Cl⁻, NO₃⁻ N, PO₄³⁻ P, Na, K, Fe, Cd, Zn & Cu.

(1) **Correlation**

Correlation is suggesting for the strength of linear relationship between two independent variable. The correlation coefficient is represented by 'r' and its limit is varying from +1 and the degree correlation value is suggesting that.

(I) \( r = 1 \), Perfect positive correlation increases in one variables is accompanied by the increase in the other.

(II) If, \( r = 0 \) No correlation

(89)
(III) If, $r = -1$, it is suggesting for the perfect negative correlation increase in one of variables is associated by decrease, in other (as table) correlation matrix was calculated with respect to different sampling stations (i.e. among the sites.)

(2) Analysis of Variance (ANOVA)

The results were statistically analyzed by using methods of analysis of Variance (ANOVA). The basic purpose of ANOVA is to test the homogeneity of several means. Thus the total variation present in a set of observable quantities may be partitioned into a number of components associated with the nature of the classification of the data. The analysis of variance of each parameter is presented in table 3.9 to 3.25. The degree of freedom have been calculated as 2, 9, in each of the case and the tabulated value of the variance ratio ($F$) in 4.26 at 5% level of significance and 8.02 at 1% level of significance. The calculated value of temperature and Cu lesser than tabulated value. All the analyzed parameters are significant either 1% or 5% level except temp, and Cu, 'F' value is the variance ratio keeping greater variance as the value of 'F' obtained for seasonal are given in ANOVA table 3.9 to 3.25 squares are correlation sectors are calculated to obtain the corrected sum the squire.

Degree of freedom is also calculated
Where,

\[ u = \text{No. of frequency classes due to the seasons variation,} \]

\[ v = \text{No. of frequency classes due to site variation.} \]

\[ df = \text{degree of freedom} \]

\[ A = \text{Sum of secure} \]

\[ B = \text{mean square of sums in columns.} \]

\[ D = \text{Average square of grand total.} \]

Thus on the basis of data analysis it may be calculated that the river pollution is significantly caused by municipal and industrial factors.
<table>
<thead>
<tr>
<th>S. No</th>
<th>Degree of correlation</th>
<th>Positive</th>
<th>Negative</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Perfect correlation</td>
<td>+1</td>
<td>-1</td>
</tr>
<tr>
<td>2.</td>
<td>Very high degree of</td>
<td>More than +.90</td>
<td>Less than -.90</td>
</tr>
<tr>
<td></td>
<td>correlation</td>
<td>(+.75 to +.90)</td>
<td>(-.75 to -.90)</td>
</tr>
<tr>
<td>3.</td>
<td>Sufficient high degree</td>
<td>More than +.75</td>
<td>Less than -7.5</td>
</tr>
<tr>
<td></td>
<td>of correlation</td>
<td>(+.75 to +.90)</td>
<td>(-.75 to -.90)</td>
</tr>
<tr>
<td>4.</td>
<td>Moderate degree of</td>
<td>More than +.60</td>
<td>Less than -60</td>
</tr>
<tr>
<td></td>
<td>correlation</td>
<td>(+60 to +.75)</td>
<td>(-.60 to -.75)</td>
</tr>
<tr>
<td>5.</td>
<td>Only the possibility</td>
<td>More than +.30</td>
<td>Less than -30</td>
</tr>
<tr>
<td></td>
<td>of correlation</td>
<td>(+.30 to +.60)</td>
<td>(-.30 to -.60)</td>
</tr>
<tr>
<td>6.</td>
<td>Possibility of on</td>
<td>More than +.30</td>
<td>Less than -30</td>
</tr>
<tr>
<td></td>
<td>correlation</td>
<td>(+.30 to +.60)</td>
<td>(-.30 to -.60)</td>
</tr>
<tr>
<td>7.</td>
<td>Absence of</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>correlation</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(92)
Fig. 2.3 Sampling Points in Gomati River at Jaunpur
STUDY SITE (Air pollutions):

Scattered industries are located in Jaunpur district, the district Jaunpur located between 24° to 26° N latitude. The occurrence of wide variety of industries in varying shape and size are unevenly distributed in rural areas surrounded with agroecosystems. The study was conducted for 3 consecutive years around three industrial setups namely.

I. SATHARIA (SIC)

II. METAL INDUSTRIES NEVADA (MIN)

III. UMBA CEMENT & CHEMICAL FACTORY, RAMPUR topology of the (UCCI) alluvial soil region is even with slightly up and down terranes. The Satharia is situated about 48 km. south west from Jaunpur city on Allahabad road. The industrial complex of Satharia is distributed on both the sides of road and occupied about 6 km². The entire industrial complex is surrounded by agricultural lands based on rain fed practices. Thus the cultivation of gram (*Cicer arietinum*) and pigeonpea (*Cajans Cajan*) is very common, very frequently these crops receive heavy load of gaseous emissions coming out from (Chimneys) in the industrial complex.

1. A metal industry (THE ABHINAV STEEL) based on coal combustion, is situated in the eastern north part of the complex. Chemical Industry is located in the western back portion of ABHINAV STEEL, and is
based on rice bran for its heat energy derivation. The gaseous emissions usually flow to eastern agrolands due to westerly common wind direction prevail during winter season. The crop plots receive heavy load of gaseous emissions from these two industries.

2. The second metal plating industry is situated about 22 kms south east from Jaunpur city on NH.54 i.e. Lucknow to Varanasi road. The Industrial Complex is distributed on the both the sides of the road. The metal industries based on coal buming for its heat energy derivation. The crop lands distributed in the eastern region of industrial complex on a big landscape. The agroecosystem is without any irrigation facility is and totally based on rain fed water. In Ravi season the cropping of Gram and Arhar is practiced in these agrofields due to scarcity of irrigation facilities. Very often these crops receive the heavy load of gaseous emissions from this industry.

3. The third, The study area was selected around the UMBA CEMENT FACTORY at Sidhwan near Rampur 35Km. south from Jaunpur city on Mirzapur road. The factory is situated at 24°30 N latitude and 82°E longitude with an elevation of approximately 200m above the mean sea level (M.S.L.) and distance of about 40 km. east of varanasi, the rock in the area are of the Dharwar period comprising mainly shale, sand stone, lime stone, quartizite, hamatite, schist and delerites ores. The soil is sandy loam in texture and slightly brown in colour.
The climate is typically tropical semiarid and the year being clearly divided into (i) Rainy, (ii) Winter and (iii) Summer seasons (Dudgeon 1920). The rainy season extending from late June to early October, is characterised by heavy rain fall derived from monsoon wind originated from the bay of Bangal. The winter season being with a gradual decline in temperature and extended from November to February. It is characterised by moderate days and cool nights presence of morning dew on vegetation and with scanty rain fall. The summer season being by dessicating wind with a few occasional showers. The high temperature, wind causes the spread and acceleration in dispersal of cement dust particles. In the year 2009 there was a total precipitation of 1150 mm including 1250 mm in rainy season 4.2 mm in winter season and 42.4 nun in bright sun summer season, the relative humidity ranged between 50.8% to 83% and average temperature ranges from 23.0 to 38.7°C in rainy season 9.2 to 30.°C in winter season and 12.6 to 42.7°C in summer season.

CLIMATIC CONDITIONS

Jaunpur is situated in tropical semiarid region of India with three distinct seasons (Ray Chaudhary 1963). The dry- dessicating summer (March to june) wet rainy seasons (July to October) and cool winter (November to February) seasons. Rain fall is principally by monsoon winds originating from Bay of Bengal in the east Mild scattered showers are sporadically received in winter also. The climate with two major components is i.e. Precipitation and temperature constitutes, the
temporal interactions resulting differences and variation in the climate of a region. 

A positive balance between the precipitation inputs and losses results in humid climates.

The rain fall during study period was 1270 mm from July 2008 to 2010 (Metro-logical Section Vikas Bhavan Jatmpur 2010). The climatic condition of upper Gangetic plain is described by (Dudgeon 1920; Misra 1958-59) and of India.in (Ambasht & Ambasht 1998) in to three zones.

(i) Summer (March-June) (ii) Rainy (July-October) (iii) Winter (Nov-Feb). The second fortnight of October and February constitute the transitional periods respectively between rainy/winter and winter/summer seasons.

Temperature

The average temperature ranges from 9.0°C-21.75°C and from 20-20°C to 45.95°C in the month of December 2010 and in January 2009 respectively minimum and maximum. The average maximum temperature of June is 45.95°C and minimum temperature is about 9°C in January.

Rainfall

In India rainy season starts (monsoon turns) from the last week of June (22-26 th June) and continue up to the end of October. This season is characterised by frequent showers and heavy down pours were comparatively lower in this session July and August were the rainfall wettest month, maximum monthly rainfall is about 350-50 cm in August and minimum is about 90,24, in July 2008 to 2010.
Nearly 90% precipitation is obtained high and average temperatures varies 45-95-20-20°C. The total annual rainfall in Jaunpur was recorded 1270 mm from July 2008 to June 2010. (Table.2.2).

Thus warm and wet rainy season suited for the improved fertility better suited for crop growth in the agro ecosystem.

The precipitation is the chief source of soil moisture available to plant and animal from soil comes as result of rainfall. There occur on interchain of water between the earth surface and the atmosphere forming the water. In the fact water during rainfall is directly of little or no use to organism.
Table 2.2

Monthly average value of atmospheric temperature, rainfall and relative humidity of Jaunpur. Data of Temperature, & Rainfall, was collected from VIKAS BHAWAN JAUNPUR.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>July 08</td>
<td>39.65</td>
<td>28.28</td>
<td>194.8</td>
<td>84.28</td>
<td>95.2</td>
<td>86.1</td>
</tr>
<tr>
<td>Aug.</td>
<td>34.25</td>
<td>27.2</td>
<td>350.6</td>
<td>90.24</td>
<td>88.2</td>
<td>88.5</td>
</tr>
<tr>
<td>Sep.</td>
<td>32.33</td>
<td>25.2</td>
<td>95.05</td>
<td>45.00</td>
<td>92.74</td>
<td>95.00</td>
</tr>
<tr>
<td>-Oct.</td>
<td>31.05</td>
<td>20.32</td>
<td>30.00</td>
<td>10.20</td>
<td>84.24</td>
<td>70.00</td>
</tr>
<tr>
<td>Nov.</td>
<td>27.06</td>
<td>15.38</td>
<td>0</td>
<td>0</td>
<td>93.24</td>
<td>65.2</td>
</tr>
<tr>
<td>Dec.</td>
<td>23.2</td>
<td>10.21</td>
<td>0</td>
<td>0</td>
<td>87.24</td>
<td>55.20</td>
</tr>
<tr>
<td>Jan. 09</td>
<td>21.75</td>
<td>9.00</td>
<td>8.20</td>
<td>0</td>
<td>75.2</td>
<td>65.2</td>
</tr>
<tr>
<td>Feb.</td>
<td>22.34</td>
<td>9.45</td>
<td>3.6</td>
<td>0</td>
<td>-70.24</td>
<td>45.26</td>
</tr>
<tr>
<td>Mar.</td>
<td>28.54</td>
<td>13.36</td>
<td>12.24</td>
<td>6.60</td>
<td>40.00</td>
<td>34.50</td>
</tr>
<tr>
<td>Apr.</td>
<td>34.25</td>
<td>18.36</td>
<td>10.22</td>
<td>4.20</td>
<td>33.20</td>
<td>10.38</td>
</tr>
<tr>
<td>May</td>
<td>40.05</td>
<td>25.60</td>
<td>28.24</td>
<td>20.20</td>
<td>32.36</td>
<td>7.29</td>
</tr>
<tr>
<td>June</td>
<td>44.86</td>
<td>21.19</td>
<td>283.20</td>
<td>29.88</td>
<td>30.2</td>
<td>12.00</td>
</tr>
</tbody>
</table>
Monthly average value of atmospheric temperature Rainfall, Relative Humidity of Jaunpur

Fig. 2.2
Monthly average value of atmospheric temperature, rainfall, and relative humidity of Jaunpur.
Wind rose diagram for MIN Jalalpur area during summer, raing winter season in year 2008.
Fig. 2.5

Wind rose diagram for MIN Jalalpur area during summer, rainy, winter season in year 2009
Wind rose diagram for MIN Jalalpur area during summer, rainy, winter season in year 2010
Fig. 2.7 Wind rose diagram for VCCI Jalalpur area during summer, rainy, winter season in year 2008
Wind rose diagram for VCCI Jalalpur area during summer, rainy, winter season in year 2009
Wind rose diagram for VCCI Jalalpur area during summer, rainy, winter season in year 2010.
Wind rose diagram for SIC area during summer, rainy, winter season in year 2008.
Fig. 2.11

Wind rose diagram for SIC area during summer, rainy, winter season in year 2009
Wind rose diagram for SIC area during summer, rainy, winter season in year 2010