CHAPTER V

PHYSICO - CHEMICAL FACTORS
PHYSICAL FACTORS:

1. Air Temperature:

The air temperature was fairly stable and remained between 23 and 30°C during the rainy season comprising the months of July, August, September and October. With the onset of winter, a sudden drop of 8°C was recorded in the month of November. December and January were the coldest months of the year showing a temperature of only 15°C. With a rise of 4°C, the spring month of February nearly equalized the temperature of November (autumn). Then, the temperature shot up by 10°C in the month of March. Thereafter, the temperature increased rapidly up to May which was also the hottest month of the year with a temperature of 39°C. A sudden drop of 8°C was again noted in June which is the transitional month between summer and rains (Table V-1; Fig. V-1).

Thus, there was a notable difference of 24°C between the hottest and coldest months of the year. Since the pond is situated in an open area, it exhibits more fluctuations in temperature in different seasons.

2. Water Temperature:

A greater degree of stabilization in water
temperature was evident during the study. Owing to that rather less variation was seen in a long span of seven months from April up to October, covering the summer and rainy season. A notable drop of 7.5°C in November coinciding with a fall of 8°C in air temperature in this month, was due to transition from autumn to winter. Like air temperature, water temperature also was the lowest in the months of December and January but it was slightly more than the air temperature. The uptrend appearing in February was more marked in March with a rise of 7°C in this month, which was still higher in April. The water temperature was less than air temperature only in the months of March, April and May. In all other months it was either equal or more than air temperature. The highest water temperature was recorded in August when it was 31.5°C (Table V-1; Fig. V-1).

As compared to air temperature, there was only a difference of 15.5°C between the hottest and coldest months of the year. The water temperature resists quick change which reminds the role of water in environmental stability due to its high specific heat. But essentially the air temperature has a direct influence over water temperature.

3. **Secchi Disc Transparency**

The Secchi disc transparency readings recorded can be arranged in three groups as high,
The moderate Secchi Transparency was noted for eight months i.e. from October upto May, when the variation was less and it remained between 17 - 20 cm. The lowest readings recorded in June and July were probably due to first showers of rains, bringing quantities of silt and rubbish with water from the upland around the pond, which is obvious from high C.O.D. and PV value in these months. The readings of Secchi transparency were the highest in the months of August and September being 24 and 26 cm respectively (Table V-1; Fig V-2). This might be due to raised water level and settling of a high proportion of detritus with passage of time, which also reduced the C.O.D. and PV value in these months - although other factors may also play their part on this parameter. A difference of 16 cm. was seen between the highest and lowest readings of September and June respectively which suggests that this parameter is governed by a number of factors.

4. Water Level (Depth):

The maximum depth in November was 3.5 metre when the permanent reference point was 70 cm. above the water level. The water level was nearly stationary for four months from October upto January and remained between 60 - 70 cm. from the permanent reference point.
The low level of 90 cm. from the permanent reference point was recorded in February which again showed little change up to April and remained between 80 to 90 cm. Then, arrived the summer months of May and June, when the water level was the lowest (depth being 3.2 and 3.25 metre respectively) indicating the heating effect of the season. The increasing water level between June and September was obviously due to rains in these months. The highest water levels of 70 and 58 cm. from the permanent reference point were recorded in August and September respectively; the depth in these months being 3.7 and 3.62 metres. The water level thus fluctuated within 50 cm. during the year of study (Table V-1; Fig. V-2).

5. Apparent Colour:

The apparent colour was always green to light green but it was sometimes masked by a tinge of brown.

CHEMICAL FACTORS:

1. Total alkalinity:

Three groupings can be made out for alkalinity viz. low, moderate and high. From October up to February the alkalinity showed little change and varied between
308 to 374 ppm. This was the period of moderate alkalinity. The highest value of 560 ppm was recorded in March followed by April, July and May (450, 420 & 407 respectively). With the exception of June (330 ppm), this was a period of high alkalinity. The period of low alkalinity remained for two months only in August and September showing a value of 240 ppm. This low value might be due to increased dilution in the rainy season.

The total alkalinity varied between 240 ppm - 560 ppm (Table V-1; Fig. V-3). This suggests that the pond has good reserves of alkalinity and belongs to hard water category. This high alkalinity also provides buffering to resist changes in pH.

2. Phenolphthalein Alkalinity (P Alkalinity):

The P alkalinity measures the hydroxides and one half of the carbonates. The hydroxides were always absent and P alkalinity, therefore, was only due to carbonates in the present case. The P alkalinity was absent in December and January. In all other months it represents half of the carbonates (Table V-1; Fig. V-3).

3. Carbonates:

The carbonates were present throughout the
year except in December and January. This corresponds with a pH of 8.5 to 10 recorded for ten months. The lowest pH of 8.2 was recorded in the months of December and January when the carbonates were absent. From February up to November the amount of carbonates remained fluctuating between 28 and 120 ppm, recorded in the months of July and October respectively (Table V-1; Fig. V-1).

As percentage of total alkalinity they contributed from zero % in December and January up to 35.3% in October and 27.6% in August. In all other months the percentage was low and varied between 6.6 to 20%.

4. Bicarbonates:

Notwithstanding the presence of carbonates in all the months except December and January, the bicarbonates were always in the main cause of alkalinity. The quantity was fairly high throughout the year providing a buffer of carbon dioxide and reached from 188 ppm in August up to 460 ppm in March (Table V-1; Fig. V-1). During the winter season comprising December January and February, the amount was moderate and showed little change. The highest readings were recorded in March and April. The amount was 341, 264 and 392 ppm in the months of May, June and July respectively. The
lowest amounts 163 and 200 ppm in August and September respectively were followed by an up trend which continued upto December and January, the months when the alkalinity was exclusively due to bicarbonates. The bicarbonates in general showed a good interrelation with total alkalinity except in the months of February, March and October when this trend was less marked because of the increasing amount of carbonates.

5. pH:

The pH remained on the alkaline side throughout the study and varied between 8.2 to 10. The lowest pH of 8.2 was recorded in the months of December and January. In all other months it was between 8.5 to 10 (Table V-1; Fig. V-5). This high pH suggests that the pond basin is rich in bases and the water mass must be of hard type.

6. Filterable Solids:

The filterable solids remained high throughout the study. Two groups can be made out for this parameter viz. moderate and high. Only two months of rainy season viz. August and September fall in the first group when the amount of filterable solids was within 400 to 500 mg/l. In all other months i.e. from October to July it was on the higher side and ranged from 600 to 800 mg/l. In this category too, only in three months the
amount was below 700 mark (Table V-1; Fig. V-5).

7. Chemical Oxygen Demand Value (C.O.D.) :

The C.O.D. value varied throughout the year, but in general falls into three categories viz. moderate, high and very high. The moderate category was found during the period of four months i.e. from November to February when the value remained between 54 to 68 mg/l. The second category of high C.O.D. value remained for three months i.e. from March to May when it varied between 76 to 88 mg/l. The highest values recorded in June and July were 131.25 and 170.25 mg/l respectively. In August and September the value was moderate due to dilution but an increase was noted in October. The generally high C.O.D. value suggests that the water contained good amount of organic matter (Table V-1; Fig. V-6).

8. Permanganate Value (PV Value) :

The PV value is another index of measuring organic pollution in water bodies; from the graphs it is clear that the C.O.D. and PV value revealed nearly the same trend which suggests their nearly parallel relationship as indicators of organic pollution. These methods actually measure a proportion of the ultimate oxygen demand (U.O.D.) of the system, thus giving information on the oxygen budget. The magnitude of the
results as expected was PV less than C.O.D. Lowest PV value of 9.2 observed in February and the highest 27.2 ppm in July (Table V-1; Fig. V-6).

9. Dissolved Oxygen (D.O.) :

The value of dissolved oxygen varied from 5 to 18 mg/l at 9 A.M. at this pond (Table V-1; Fig. V-7). The highest dissolved oxygen value at 9 A.M. was measured in the month of March and May. The lowest value of 5 mg/l was measured in July when the sky was not clear the C.O.D. and PV values were the highest. It is notable that the highest values of C.O.D. and PV coincide with the lowest value of oxygen in the month of June and July. This reflects the increasing oxygen demand with the increasing putrescible matter. The graph of the dissolved oxygen at 9 A.M. in general shows its inverse relationship with C.O.D. and PV.

10. Percentage Saturation of Oxygen :

The saturation values at the time of measurement were below 100% in the months of November, December and January (winter). From February to May (spring and summer) it was above 100% and the highest values suggestive of very high photosynthetic rate were 236 and 219 in May and March respectively. The saturation values were again below 100% in June and July due to increased oxygen demand for putrescible organic
matter. The saturation values in August, September and October again reached above 100% when the percentage of organic matter was reduced due to raised water level. A perusal of the data shows that out of 5 months showing a saturation below 100%; in three months (December, January and June) it was near saturation i.e. above 90% and in the remaining two months (November and July) the saturation was markedly low. Here too, the sky was partly cloudy in July and the water was loaded with organic matter (Table V-1; Fig. V-7).

11. Nitrate:

This nutrient was not in short supply because the lowest amounts recorded in the months of February, March and April were 0.95, 0.7 and 1 mg/l. The highest amount of 1.8 and 1.6 mg/l was recorded in July and August respectively. In all other months there was rather little variation in the amount of this nutrient and it remained between 1.2 and 1.4 mg/l. (Table V-1; Fig. V-8).

12. Phosphate:

The phosphate was present throughout the year in appreciable quantities. It was however more in winter and spring (0.2 to 0.25 mg/l) and less during summer and rains (0.1 to 0.175 mg/l) (Table V-1; V-8). The greater amount of phosphate in winter and spring might be due to low photosynthetic rate and therefore less consumption.
Fig. v-1. MONTHLY VARIATION IN PHYSICAL FACTORS AT POND No.1 & No. 2
Fig. v-2. MONTHLY VARIATION IN PHYSICAL FACTORS AT POND No. 1 & No. 2
Fig. v-3. MONTHLY VARIATION IN CHEMICAL FACTORS AT POND No. 1 & No. 2
Fig. v-4. MONTHLY VARIATION IN CHEMICAL FACTORS AT POND No.1 & No. 2
Fig. v-5. MONTHLY VARIATION IN CHEMICAL FACTORS AT POND No. 1 & No. 2
Fig. v-6. MONTHLY VARIATION IN CHEMICAL FACTORS AT POND No. 1 & No. 2
Fig. v-7. MONTHLY VARIATION IN CHEMICAL FACTORS AT POND No. 1 & No. 2
Fig. v-8 MONTHLY VARIATION IN CHEMICAL FACTORS AT POND No. 1 & No. 2
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### CHEMICAL FACTORS

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( - ) Denotes absence
PHYSICAL FACTORS:

1. Air Temperature:

Air temperature was fairly stable in the months of June, July and August and varied between 30 - 31°C. A gradual monthly decline of 2°C was noted from September up to November when the temperature was 25°C. Thereafter, with a decline of 4°C approached the coldest months of December and January when the temperature was 21°C. A gradual rise in temperature was noted from the spring month of February to April. Then, there was a notable rise of 9°C in the month of May which was the hottest month with a temperature of 37°C. This was followed by a sudden drop of 7°C in June (Table V-2; Fig. V-1).

As compared to 24°C in pond no. 1, there was only a difference of 10°C between the hottest and coldest months at this pond. This might be due to daily fluctuations in the weather conditions.

2. Water Temperature:

The water temperature remained stabilized for five months from May up to September and varied between
30 - 32°C. A gradual decline of 3°C each was noted in October and November. December and January were the coldest months with a temperature of 19 and 18.5°C respectively. An increase of 5.5°C was recorded in February and the temperature of February and March was equal to that of November. A rise of 3°C each was noted in April and May showing a temperature of 27 and 30°C respectively. The temperature in April was equal to that of October and of May to that of June and September. The highest water temperature of 32 and 31°C was recorded in July and August respectively (Table V-2; Fig. V-1).

The water temperature was more than air temperature only in 3 months i.e. July, September and February. During winter and summer (November to May) it was less than air temperature. For the remaining three months i.e. June, August and October it was equal to air temperature. A notable difference between the water temperature of the two ponds was that, being smaller in size the temperature of this pond was normally more than the first pond and also less than the air temperature in winter (i.e. November to February) showing more cooling at night. In March & April it was less than the first pond but it was due to the reduced air temperature at the time of measurement. There was a difference of 13.5°C between the highest and lowest temperature. From May up to October there was a great similarity in the range of water temperature in the
2 ponds.

3. Secchi Disc Transparency:

It was minimum in June and July. The increased visibility of August, September and October was due to raised water level which is obvious from the highest visibility of September coinciding with the highest water level. The visibility of 15 cm in November was due to rather calm and bright weather. The decline in visibility during winter (December to February) was due to reduced water level and low intensity of light during these months. The visibility again increased in March and April when the water level increased due to an inflow of water from the adjoining canal. The visibility again decreased in May due to decreased water level and turbulence (Table V-2; Fig. V-2).

It is notable that the highest and lowest transparency readings were recorded in the same months in both the ponds and possibly due to similar reasons. As compared to 16 cm in the first pond, there was only a difference of 7 cm between the highest and lowest readings. The transparency readings were overall less then the first pond.

4. Water Level (Depth):

The maximum depth in November was 1.32 metre
when the permanent reference point was 39 cm. above the water level. The level was maximum in August, September and October due to rains. Then, it continued to recede reaching the lowest in February. The 2nd rise in water level was seen in March and April which was due to an inflow of water from the adjoining canal. A sudden drop in water level in May was due to heating effect of the month. The first showers of June and July slightly improved the water level in these months. There was a difference of 62 cm. between the highest and lowest level from the permanent reference point (Table V-2; Fig. V-2). The water level showed greater fluctuation in this pond possibly because it is smaller in area and also connected with the adjoining canal through a culvert.

5. Apparent colour:

It was always green to light green due to a rich crop of algae.

CHEMICAL FACTORS:

1. Total Alkalinity:

Total Alkalinity was moderate from April to September and varied between 193 ppm - 294 ppm during this period. It reached still higher values in October and December and was 360 and 330 ppm respectively. In
the month of November it was however 226 ppm. The highest alkalinity readings were recorded in January, February and March when it was 440, 429 and 400 ppm. respectively. The alkalinity in this pond was generally less than the first pond except in the months of January, February and October when it was more than the pond no. 1. The alkalinity in both the ponds was low in August and September. The alkalinity at this pond thus varied from 198 ppm. up to 440 ppm. (Table V-2; Fig. V-3).

2. Phenolphthalein alkalinity (P alkalinity):

The P alkalinity was present only in January, February, March and July. In all other months it was absent. It was due to the presence of carbonates because hydroxides were absent (Table V-2; Fig. V-3).

3. Carbonates:

The carbonates were present only in January, February, March and July. In the present case, since phenolphthalein alkalinity was always less than half of total alkalinity, hence,

\[ \text{carbonates} = 2P \]

The maximum amount of carbonates was present in February when it was 167.2 mg/l (Table V-2; Fig. V-4).

4. Bi carbonate:

Except January, February, March & July
bicarbonates were alone the cause of alkalinity in all the months (Table V-2; Fig. V-4). When combined with carbonates, they were still the major cause of alkalinity except in February when the carbonates increased upto 30%. This also increased the pH upto 9.5 in this month.

5. **pH**

The pH always remained on the alkaline side and varied in the range of 8 to 9.5 (Table V-2; Fig. V-5). The high pH range (between 8.2 - 9.3) was recorded only in four months when the carbonates were present. The highest pH of 9.5 was recorded in February when the carbonates were maximum. As compared to the first pond, the pH was always less in this pond except in January.

6. **Filterable Solids**

The filterable solids varied between 320 and 930 ppm. (Table V-2; Fig. V-5). They registered an increase from November upto February. The value was the highest in February when the water level was the lowest and the abrupt fall in filterable solids in March might be due to sudden rise in water level as a result of an inflow of water from the canal. From March upto September the filterable solids were less in amount as compared to previous months. October again showed a higher value due to decrease in water level.

7. **C.O.D.**
The C.O.D. was high during winter i.e. December to February. In summer (March to May) its value was low. The value again increased in June when there was mixing of putrescible organic matter due to first showers of rains. During rains July to September the C.O.D. was not so high. In October and November it was 96 and 50.96 ppm. respectively (Table V-2; Fig. V-6). Thus, no definite trend can be made out for this parameter but high C.O.D. value indicates organic pollution.

8. P.V value:

Although it is not possible to make out a definite pattern in P.V value, it is notable that whenever the C.O.D. was high the P.V was also high and a low C.O.D. value was associated with low P.V value. The highest P.V value was 17.6 mg/l recorded in June and the lowest was 12 mg/l recorded in March (Table V-2; Fig. V-6).

9. Dissolved Oxygen:

The dissolved oxygen was 7.5, 10 and 9 ppm. during November, December and January respectively. In February and April it was 6 ppm. but in March it was 8 ppm. The water was super-saturated with Oxygen in May. From June up to October the quantity of Oxygen between 2.4 to 5 ppm. (Table V-2; Fig. V-7).

10. Saturation Percentage of Oxygen:

The saturation values at the time of measurement...
were above 100% only in two months i.e. December and May. In November, January and March the water was nearly saturated (i.e. saturation was above 90%) with Oxygen. In all other months the saturation value varied between 32 to 75% (Table V-2; Fig. V-7).

The lowest value of 32% was recorded in September. As compared to this pond the lowest saturation value in the pond No. 1 65% recorded in the month of July and the highest saturation value recorded in the pond No. 1 (236%) in May was much higher than the value (12%) in this month recorded for this pond.

11. Nitrate:

The nitrate varied between 0.3 to 2 mg/l during the study. From November up to March, the quantity was less and remained between 0.3 to 0.8 mg/l while from April up to October it was more and varied between 1 to 2 mg/l. This shows that the quantity was less during the winter and spring and more during summer and rainy season (Table V-2; Fig. V-3).

12. Phosphate:

The phosphate mg/l was maximum during March to June (0.25 to 0.3 mg/l). In all other months it was between 0.15 to 0.2 except in February when it was only 0.1 mg/l (Table V-2; Fig. V-3).