LITERATURE REVIEW

Heavy Pollution from natural and anthropogenic sources of the riverine system is very alarming. Natural sources contribute when the river flows through different substratum and leaching out a number of elements whereas anthropogenic sources contribute to domestic and industrial discharges and agricultural practices. The purity of riverine system in terms of "clean water" is always at a stake due to the entry of above mentioned toxicity producing sources. These pollutants cannot be removed by "Self Purification Capacity" or by means of biological processes. In fact they accumulate in the system and enter the food chain getting into the flora and fauna of the aquatic environment through bioaccumulation and biomagnification processes.

During last few decades the pollution load in the Indian rivers and their treatment methods have drawn the attention of many workers however there is much scope left for such studies. A brief account of publication in the field is worth mentioning.

Chauhan (1991) investigated the effect of distillery effluent on the river Wainganga, before and after closure of the factory. He reported that the distillery effluent added high concentration of organic matter to the river which was responsible for remarkable decrease in DO and pH, increase in BOD, COD and TSS. He also reported that after a flow for about 3 Km., BOD was reduced by 36% indicating self purification capacity of the river within 30%
reduction in TSS and COD which also had a high value. The physico-
chemical parameters of the effluent from distillery indicate that the maximum
value of TSS was 30,644 mg/l, DO nil, Total alkalinity was 4180 ppm, chloride
218 mg/l and NH₃ 3330 mg/l, BOD 21,910 mg/l and COD 91,225 mg/l.
However, when the distillery was closed the values of physico-chemical
parameters decreased to a great extent, showing TSS 465 mg/l. DO 8.23
mg/l, total alkalinity 212 mg/l, BOD 10.9 mg/l, chloride 20 mg/l, and COD 58
mg/l. This reduction, in their opinion was on account of self purification
capacity of the river. He also reported that, during the operation of distillery,
fishes were never found from two of the sampling stations. However, a few
mollusks, a few species of zooplankton, a few phytoplanktons and a few
rotifers were present at these stations.

Panda (1991) investigated the water quality of Brahmani river and
reported the 23 physico-chemical characteristics of its water. He observed,
that the river water was not much polluted except near the industrial area. In
the most polluted site, the DO was 4.2 mg/l, TDS 1107 mg/l. Total Hardness
113.5 mg/l, chloride 318 mg/l and TDS 127.3 mg/l.

Gill and Sahota (1993) carried out studies on phytoplankton and
physico-chemical parameters of River Sutlaj. The analysis revealed that the
Sutlaj water is very rich in nutrients as evidenced by high concentration of
phosphates and nitrates. The river water is rich in bicarbonates, carbonates
and moderate conductivity. Phytoplankton occurrence seems to be associated
with increased levels of phosphates, sulphates, iron and calcium. Chlorides
have a negative correlation with the occurrence of phytoplanktons. Out of the
phytoplanktons, diatoms were the most dominant. Among the higher plants, Potomogeton type of weeds were observed at a site where the nitrogen was comparatively high in concentration.

Singh, Yadav and Joshi (1993) carried out studies on assessment of BOD load in river Yamuna in respect of potable water at Agra and found that with the increase in organic pollution load and decrease in the water quality of Yamuna at Agra city, the high BOD affect the DO of the water which creates problem for survival of aquatic life. The pH is also high which increases alkalinity of water. This may be due to discharge of various municipal sewage and industrial effluents from Mathura and Agra city.

Boruah, Kotoky and Bhattacharya (1995) analysed the physico-chemical parameter of river Jhanji for three different seasons. The results revealed that DO, BOD and COD were within the acceptable limits. However, the high value of DO in monsoon period was probably due to high flow rate of the river. The turbidity was found to be too high in the monsoon season, obviously due to high values of TSS present in the system.

Kataria and Jain (1995) carried out the physico-chemical analysis of river Ajnar. They revealed that the conductivity ranged from 740 to 1206 \( \mu \) mhos/cm, chloride 22.6-48.0mg/l, DO 3.6-5.4mg/l, BOD 3.2-12.6mg/l, COD 24.4-48.8mg/l, fluoride 12.8-48.0mg/l, sodium 2.0-12.0mg/l and potassium 1200-2380 mg/l of the river water. They concluded that the higher values of these parameters were due to confluence of domestic sewage and industrial effluents.
Kaul, Nandi and Biswas (1995) carried out studies on scale-up relationship for pitch blade surface aerator for wastewater treatment. This investigation is concerned with model studies on pitch blade surface aerator. To design a surface aerator for a given wastewater treatment facility, it is necessary to develop scale up equations for oxygenation capacity and net power consumption. Scale up relationship for pitch blade surface aerator has been developed based on model studies, which will be of immense use to the practicing engineers.

Kaul, Nandy and Biswas (1995) undertook a study on mixing parameters for radial type surface aerators for wastewater treatment. In this investigation radial type surface aerator was selected (vertical type). A circular plate with several blades fixed at the periphery of the aerator was fabricated. Based on the studies of oxygenation capacity and oxygenation efficiency the optimum size of the blade was determined. The mathematical expressions for pumping capacity, mixing time, dispersion number and net power consumption have been developed by model studies on surface aerators. These equations can be used for scale up purpose.

Krishnamurthy and Bharati (1995) evaluated the water pollution load in the river Kali (Karnataka State). The water samples were analysed to assess the physico-chemical properties at different stations. At the site near mining areas the value of Fe was not high. The waste water discharged from pulp and paper mill was dark brown in colour and the value of DO was always below 2.58 mg/l. The phosphate, fluoride, COD and hardness were recorded high indicating pollution load in the water. The occurrence of algal species in
abundance indicates the presence of natural pH, high DO and low values of dissolved organic matter. They reported that the diatoms were dominant with the members of Cyanophyceae and Chlorophyceae.

Meikap and Roy (1995) carried out the physico-chemical analysis and reported the typical composition of waste water from municipality as well as a few industries. They also projected the relative advantages of various modern bioreactors working on immobilization technique. Further, a comparative picture with respect to various modern bioreactors has been presented and the uniqueness of the fluidized and semifluidized bed bioreactors in the treatment of wastewater has been emphasized.

Mishra & Roy (1995) described biofluidization as a novel technique for the treatment of waste water. In this technique, application of the principle of fluidization to various bioconversion processes in general and the management of solid and liquid effluents in particular has been highlighted. The salient features of an aerobic fluidized bed reactor for the treatment of waste water have been detailed and its priority over the operation of the activated sludge homogeneous reactor has been established. Here, the use of anaerobic technique for the effective and economic treatment of organic waste with high oxygen demand has been emphasized and the use of a fluidized bed for the purpose has been recommended. In addition to this, some general design guidelines for aerobic and anaerobic biofluidizers have been presented.
Om Kumar (1995) carried out studies on Song river of eastern Doon Valley and water samples were analysed for various physico-chemical parameters. The results were found to be within permissible limits for almost all the parameters pH (8.0 to 8.3) conductivity (0.125 to 0.850 μmhos/cm), chloride (4.5 to 16 mg/l), potassium (0.99 mg/l to 2.80 mg/l), sodium (2.06 – 7.25 mg/l), calcium (12.4 to 20.2 mg/l), total iron (0.10 – 0.2 mg/l), total alkalinity (135 – 227.5 mg/l). He concluded that the river is not grossly polluted.

Pandey, Jha et.al. (1995) conducted biological studies on Kosi river and investigated the phytoplankton population. They reported the maximum density 37.3% of Cholorophyceae during May, April and December 40.07% of Mixophyceae in March and April, 15.1% of Bacillariophyceae in May and August and 7.47% of Euglenophyceae during November and December. They also reported that when the population density of phytoplanktons was maximum, the pH was found to be low.

Reddy & Reddy (1995) carried out studies on hydro-geochemistry of Musi river and ground water of Hyderabad city. The water samples were analysed for pH, Electrical Conductivity, alkalinity, NO₃⁻, SO₄²⁻, Na⁺, Cl⁻, K⁺, Mg²⁺, Ca, Zn²⁺ and Fe²⁺. The results revealed that high values of EC and alkalinity in the polluted river water and ground water reflect the higher abundances of dissolved solids. The pollution with respect to SO₄, Cl and NO₃ and others is attributed to the large scale discharge of municipal waste, sewerage water and other waste material into the river water.
Shakya and Ojha (1995) carried out studies on water pollution and macro invertebrates in Bagmati river. They found the river water unpolluted at upstream, polluted to extremely polluted after Gokarna confluence towards downstream area. They observed that Microinvertebrates were having random distribution in unpolluted sites and contagious distribution at polluted sites of the river. The conductivity ranged from 32 to 360 μ mhos/cm, turbidity 4.83 to 410.83 NTU, alkalinity 26.69 to 103.33 mg/l. Total hardness 7.3 to 143.40mg/l, DO 2.47 to 8.58mg/l, BOD 0.48 to 34.85 mg/l and COD 3.87 to 113.12 mg/l.

Shivasubramani and Mahadevan (1995) analysed the important bacterial and physico-chemical parameters of the river Suruliyar. The results revealed that the BOD ranged from 1.82 mg/l to 8.2 mg/l, COD 1.72 to 38.6 mg/l, chloride 14.02 to 48.0 mg/l, phosphorous 0.02 to 0.23mg/l, Nitrate 0.01 to 0.37mg/l conductivity 80.02 to 350.9 μ mhos/cm, total hardness 7.12 to 220.1 mg/l and alkalinity 25.7 to 60.7 mg/l. They concluded that the high value of hardness and chloride indicate the high sewage contamination in the river water.

Telang (1996) carried out studies on waste water treatment systems. The main objective of any waste water treatment system is the removal of organic impurities from water. The author gave a comprehensive account of rotating biological contactor, biofilter, ventilation, air distribution, dissolved air flotation, basis of flotation and design procedure of the units. She reported the removal efficiencies of BOD 20-70%, COD 10-60%, TSS 50-85% and oil 70 to 95% by these units.
Jain, Bhatia and Seth (1998) during their studies on the effect of waste water disposals on the water quality of the river Kali revealed that the effluents coming from variety of industries is usually blackish in colour and has pungent and irritating smell. Due to the presence of various chemicals and other alkaline mixtures, a soapy and fibrous froth is continuously generated. In the surrounding area the soil appears blackish. The physico-chemical analysis of this waste water indicated a complete absence of DO throughout the year. The BOD and COD values were found to be very high, 639 mg/l and 853 mg/l respectively indicating high degree of organic contamination in these waters.

It was also observed, that in the distillery waste biological action starts obnoxious conditions, resulting in septic condition and produce H₂S gas with the result, the effluent appears black in colour. The conductivity was maximum and the pH was alkaline. They reported that the distillery waste may clog the gills of fishes and hamper the normal gaseous exchange.

Shukla (1998) conducted studies on the role of macrophytes in increasing the carrying capacity of industrial effluent impregnated water related with Betwa river. The author investigated the physico-chemical characteristics of the Betwa river and various study sites. She reported that at the point of confluence of Mandideep Nallah and the river Betwa during summer the chloride ranged between 489.94 to 14772.00 mg/l, DO 0.00 to 2.80 mg/l, BOD 2.55 to 258.00 mg/l, COD 389 to 798 mg/l, total hardness 270.00 to 1711.00 mg/l, Ca Hardness 198.00 to 1506.00 mg/l, Mg hardness 72.00 to 333.00 mg/l. The experiments under simulated conditions were also
conducted in which the metal concentration in various macrophytes and the metal concentration in their respective growing medium were studied.

The removal efficiency of different parameters by different macrophytes were recorded e.g. Hydrilla could remove TSS upto 86.76% and Potamogeton 65%. Vallisneria removed Nitrate upto 77.23% and Potamogeton 14.49%. Under these experimental conditions BOD was removed upto 82.13% by Bergia but Vallisneria removed only 67.59%. The COD was removed upto 80.16% by Bergia and 46.40% by Vallisneria.

Dwivedi, Tiwari and Bhargava (2000) conducted studies on toxic metals in the river Ganga at Varanasi. The metals such as Mn, Fe, Pb, Cr, Cd, etc were analysed so as to determine the limits of toxicity in the river water. They found high coliform counts, beyond 20,000/100 ml at most of the down stream sampling stations which is hazardous for use as Public Water Supply, fish culture and recreational uses. Water Quality Index values at different sites reveal that there is general progressive decline in the water quality along the down stream and it is due to the discharge of sewage and bathing activities at different ghats along the river.

Willie Gujer (2000) carried out detailed studies on the dynamics of self-purification. He discovered that self purification processes in shallow stream are caused by the biofilm attached to the stream gravel. Biofilm growth is affected by various environmental factors such as sub-strata and oxygen concentrations, temperature, pH, height, water velocity and surface area available for the colonization. Changes of the environmental conditions lead to
significant changes of the bacterial population in the river and thus of the in-stream self purification capacity. The complex ecological machinery which performs water purification in aquatic system includes at least four types of functional biofilters, consisting of aquatic bacteria, algae, plants and invertebrates.

Bhave and Borse (2001) analysed various physico-chemical parameters of the river Aner and recorded their influence on planktons as water was alkaline and hard. The thermal fluctuations were wide with the result, that the plankton and animal movements were greatly affected. The DO content showed an inverse relationship with temperature and a positive relationship with plankton population. The salinity showed inverse relationship with plankton population. The analysis revealed that the DO ranged from 5.90 to 16.19 mg/l during May and Jan respectively and salinity from 128.49 to 392.97 mg/l. They concluded that in winter, minimum water temperature was more favorable, therefore, the number of organisms were high. The study also show direct relationship of DO and the planktons i.e. when DO was maximum, plankton population was also maximum. They found that the salinity showed direct relationship with pH and inverse relationship with DO.

A publication by the Council’s Biotechnology Applications in Aquaculture in its Aquaculture programme (2002) described different types of biofilter media such as bio-deck, biostart or bio-block. Further salient features of certain basic type of biofilters such as Packed Tower Filters (e.g. downflow trickling, upflow or down flow submerged), Expanded media filters, bed filters.
“up flow” sand, gravel, crushed shell filter and Rotating Biological Contactor filter has been given with their advantages and disadvantages.

United States Environmental Protection Agency (2002) in their publication revealed that DO concentrations of 2 mg/l or less can result in dead water bodies. Prolonged exposure to low DO conditions can suffocate adult fish and survival of eggs and larvae. Prolonged hot weather depresses Oxygen concentrations and may cause fish kills even in clean waters. Decomposition of excess weeds and algae can lead to oxygen depletion. Low DO concentrations also favour anaerobic bacterial activity that produces noxious gases or foul odors often associated with polluted water bodies.

Das, Baruah et.al. (2003) carried out studies on Bahini, Brahmaputra, and Bharalu rivers and some major drains carrying urban wastes in Guwahati city. The study revealed extremely polluted water quality of Bharalu river indicated by very low level of DO, high load of BOD, COD, phosphate and ammonical nitrogen making the river unsuitable for aquatic life. The major drains of the city also had low DO, high BOD, COD, Chloride, sulphate and ammonical nitrogen. They reported that the water quality of Bahini river and Brahmaputra river did not reveal gross deterioration.

Jayaraman, Gangadevi and Nayar (2003) conducted water quality studies on Karamana River at Kerala. They analysed the physio-chemical characteristics of water samples collected from the stations for a period of one year. They revealed that comparatively higher values of BOD and COD were observed during summer season, suggesting strong indication of contamination of organic matter in sewage effluents. They suggested certain
remedial measures for the conservation and sustainable management of this riverine system.

Rashmidevi and Gupta (2003) are of the opinion that constructed wetlands are now emerging as a low cost, eco-friendly alternative to conventional treatment systems for the treatment of waste water. They developed a procedure for the design of a horizontal sub surface flow wetland to provide tertiary treatment to the wastewater collected from the industries in the areas of Industrial Development. This design procedure can be used for designing Wetland for tertiary treatment of any industrial waste water.