CHAPTER 9.
REMEDIAL MEASURES
9. REMEDIAL MEASURES:

9.1. Waste water treatment procedure:

Polluted water is nearly as bad as no water at all and water polluted with toxic metals is as worse as poison. Such water should be treated in order to make it environmentally safe. Waste water treatment and water pollution control are two environmental expenses which the industry and municipalities should pay. The surface water of Sukhna nalla and Kasalaya disposal points at Parwanoo and Gurmukh nalla at Barotiwala in Solan district of Himachal pradesh has been found to be polluted due to variety of industrial effluents which are being thrown in these nallas without proper treatment. Although most of the industrial units claim to have (ETP) effluent treatment plant yet the water is polluted at the effluent sites in the nallas of the study area. The data accruing from the present study suggests that some sort of environmental management is lacking either in industrial units by the State Pollution Control Board. The different classes of impurities at Parwanoo and Barotiwal are given in Table 72.

The main purpose of the waste water treatment is to reduce the amount of suspended solids materials in these waters. All the impurities of these regions are not possible to be removed but they may be reduced to such an extent that water becomes suitable for intended use. Keeping in view the
analysis reports following types of impurities may be considered in these regions.

Table 72

<table>
<thead>
<tr>
<th>Class of Impurity</th>
<th>Cause of Impurity</th>
<th>Result of Impurity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mineral/Particles</td>
<td></td>
<td></td>
</tr>
<tr>
<td>a) Suspended</td>
<td>Particles of sand clay etc.</td>
<td>Turbidity</td>
</tr>
<tr>
<td>b) Dissolved</td>
<td>Carbonate, bicarbonate of Ca and Mg Hardness and alkalinity</td>
<td>Hardness</td>
</tr>
<tr>
<td></td>
<td>Ca and Mg Sulphate</td>
<td>Hardness, Corrosion of boilers.</td>
</tr>
<tr>
<td></td>
<td>Ca and Mg Chlorides</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sodium Carbonate bicarbonate</td>
<td>Alkalinity and Softness</td>
</tr>
<tr>
<td></td>
<td>Sodium Chloride</td>
<td>Brackish water and taste</td>
</tr>
<tr>
<td>Organic</td>
<td></td>
<td></td>
</tr>
<tr>
<td>a) Suspended</td>
<td>Decayed leaves, algae, peat pollen, fungi etc.</td>
<td>Green, brown colour, taste, acidity, waste suspension.</td>
</tr>
<tr>
<td>1. Vegetable</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Animal</td>
<td>Dead animals, hair, insects, skin, scales etc.</td>
<td>Bacteria viruses dangerous to health</td>
</tr>
<tr>
<td>Heavy metals</td>
<td>Trace elemental Cu, Co, Ni, Pb, Hg, Mn, Cd and Zn etc.</td>
<td>Mainly due to Industrial effluents Enhanced levels of these elements in surface water may lead to their seepage to the underground water</td>
</tr>
</tbody>
</table>
Keeping in view the pollution of surface water of these regions due to a variety of pollutants such as industrial effluents, municipal sewage, agricultural wastes etc. The author is of the view that the surface water pollution may lead to contamination of underground water table in these areas. Hence, it is suggested that the drinking water from hand pumps and other water bodies such as wells etc. should be treated properly. The various treatment processes given below may be used to reduce the pollution of water by the industries in order to make the effluents environmentally safe.

9.2. REMOVAL OF DISSOLVED GASES:

The dissolved gases such as carbon dioxide, oxygen, chlorine, \( \text{H}_2\text{S} \) may be removed by boiling, decompression or by means of chemical treatment. Except for oxygen and nitrogen all other gases can be reduced by aeration. Aeration process removes \( \text{CO}_2 \), \( \text{H}_2\text{S} \) and odours very rapidly. Following are the methods of aeration.

1. By mechanically agitating water.
2. By diffusing compressed air inside the water.
3. Mixing air in waste under pressure.
4. By spraying water into atmosphere through nozzles to 2-3 meters.
5. Flowing water through perforated trays and beds, so that the water filters through them.
6. Flowing water over wires taps etc. so that water is exposed to sun light as much as possible.

9.3. REMOVAL OF COLLOIDAL IMPURITIES, COLOUR, TASTE, ODOUR AND COAGULATION:

The polluted water normally has colloidal impurities which are even finer than 0.0001 mm and also carry electrical charge on them. Due to electrical charge they remain in motion and never settle down. If, when water is turbid due to presence of such fine colloidal impurities, plain sedimentation is of no use and coagulation becomes necessary particularly when turbidity is more than 40-55 ppm.

The coagulation involves two phenomena:

1. Floc Formation:

   When coagulant is added to the water, and thoroughly mixed it produces thick insoluble gelatinous precipitate. This precipitate is called floc. The floc has property of arresting the suspended impurities in water during its downward settlement towards the bottom of tank. The gelatinous precipitate has therefore the property of removing fine and colloidal particles quickly. The coagulation process also removes colour and taste in general. The floc ions are electrically charged (+ve) attract the colloidal particles and cause their removal easily by settlement at the bottom of the vessel.

   The principal coagulants which may be used alone or in combination are sodium aluminate, sodium aluminat...
aluminium sulphate, aluminium sulphate, sodium aluminate + ferric chloride, aluminium sulphate + caustic soda, ferric chloride alone, aluminium sulphate + hydrated lime, polyelectrolytes, ferrous sulphate, copper sulphates, sodium aluminate + magnesium chloride, copper sulphate + hydrated lime, ferric sulphate, ferric sulphate + hydrated lime, ferrous sulphate + hydrated lime etc.

**Operation of Dry Fed devices:**

There are different types of devices which may be used for dry feeding. The dry fed devices as shown in fig. may be used. Dry powder of coagulant with agitating plates which prevent the chemical from being stabilized, may be used. At the bottom of the hopper, a revolving helical screw or the toothed wheel is fixed. The rotation of helical screw or tooth wheel is reputed through a venturi device in the raw water pipe. Mixing channels help to mix the raw water and coagulant.

9.4. **REMOVAL OF IRON AND MANGANESE:**

Manganese and iron are generally found together. Iron occurs as ferrous sulphate and ferrous bicarbonates. The presence of iron and manganese in excess of 0.2 ppm renders water objectionable due to the following reasons.

1. They cause corrosion.
2. They impart taste and odour.
3. They cause troubles in various manufacturing processes and make them uneconomical.
4. They cause spots on clothing during washing.

5. They make water reddish due to presence of iron bacteria.

The removal of iron and manganese can be done by any one of the following methods:

1. By base exchange processes.
2. By chlorination.
3. By aeration of water.

Iron alone in the absence of organic matter can usually be removed by aeration of any type, followed by sedimentation and filtration. Combination of iron and manganese or iron alone bound to organic matter may require aeration in multiple coke trays containing coke, gravel or crushed pyrolensite. Pyrolensite is a negative manganese dioxide. The metaphosphates may be used to prevent precipitation of iron or manganese. Their use is generally done when iron concentration is less than 1 ppm.

9.5. REMOVAL OF SILICA:

The following methods may be used for removal of Silica:

1. By the use of magnesium hydroxide with carbon dioxide, calcium bicarbonate or magnesium bicarbonate which produce magnesium carbonate absorbing silica.
2. Application of ferric sulphate and lime to develop ferric hydroxide which absorbs silica.
9.6. **REMOVAL OF TASTE, ODOUR AND COLOUR:**

The taste odour, and colour may be removed by the process of coagulation followed by filtration, prechlorination, super chlorination followed by dechlorination and use of chlorine dioxide etc.

9.7. **REMOVAL OF TEMPORARY HARDNESS:**

This hardness of water may be removed by either boiling or by adding lime. Chemical reaction may be expressed as follows:

\[ \text{Ca(HCO}_3\text{)}_2 + \text{Heating} \rightarrow \text{CaCO}_3 + \text{H}_2\text{O} + \text{CO}_2. \]

\[ \text{Ca(HCO}_3\text{)}_2 + \text{Ca(OH}_2\text{)} \rightarrow 2\text{CaCO}_3 + 2\text{H}_2\text{O}. \]

\[ \text{Mg(HCO}_3\text{)}_2 + \text{Ca(OH}_2\text{)} \rightarrow \text{CaCO}_3 + \text{MgCO}_3 + 2\text{H}_2\text{O}. \]

9.8 **REMOVAL OF PERMANENT HARDNESS:**

The following methods may be adopted for removal of permanent hardness of water:

1. Zeolite process.
2. Demineralization process.
3. Lime Soda process.

9.8.1. **Lime Soda Process**

Hydrated lime removes permanent hardness due to magnesium sulphate, magnesium chloride, and calcium chloride while washing soda eliminates permanent hardness due to calcium sulphate, calcium chloride, and magnesium chloride.

Chemical reactions taking place may be represented as given below:

\[ \text{CO}_2 + \text{Ca(OH)}_2 = \text{CaCO}_3 + \text{H}_2\text{O}. \]
MgSO₄ + Ca(OH)₂ = Mg(OH)₂ + CaSO₄.
CaSO₄ + Na₂CO₃ = CaCO₃ + Na₂SO₄.
MgCl₂ + Ca(OH)₂ = Mg(OH)₂ + CaCl₂.
Mg(HCO₃) + Ca(OH)₂ = CaCO₃ + MgCO₃ + H₂O.

a. Excess lime treatment:

In this method raw water is overtreated with lime in order to completely precipitate magnesium and soda ash is added to neutralize the excess lime, converting all alkalinity to sodium alkalinity.

b. Recarbonation:

In this process excess lime is added to raw water and excess lime is then neutralized by the action of CO₂.

9.9. TREATMENT OF INDUSTRIAL EFFLUENTS:

The effluent of various industries require proper designing and treatment for their safe disposal. The existing waste water treatment processes generally fall in two broad classes. Primary treatment involving removal of grit, screening, grinding, flocculation and sedimentation. Secondary treatment involves controlled biological assimilation and degradation processes that occur in nature due to microorganisms.

In Parwanoo and Barwotiwa main polluting industries have been recognised as paper and pulp industries electroplating units and steel industries, food processing industries etc. The industrial effluents of these industries may be treated as follows:
6.4 Flow chart representing recycling of waste-water of electroplating industry.

6.6.3 Flow chart representing recycling of waste-water of paper industry.
9.9.1 Paper Industry:

The treatment of effluent of paper industries may be done in two stages:

1. Primary treatment - It is also designated as chemical clarification. In primary treatment, chemical clarification is done in three stages.
   i. Chemical coagulation with hydrated lime.
   ii. Chemical coagulation with (alum + lime) at pH = 10.5 to 11.0.
   iii. pH adjustment to 6.7

   The first and second stages are followed by floculation and sedimentation. Thus with primary treatment, we achieve removal of BOD and COD upto 90% respectively.

2. Secondary treatment - which is called "activated sludge process". In secondary treatment the activated sludge process is capable of converting most organic waste (soluble and insoluble) into highly reduced BOD and COD values. The process is performed in presence of heterogenous microbial culture composed of bacteria, protozoa, rotifiers and fungi. After secondary treatment, the increased biomass is disposed off and the remainder returned to aeration units.

   The flow sheet of the process is shown in Fig. 63.

   The dewatered sludge is heated and ash is used to make concrete blocks or bricks.

9.9.2 Electroplating Industry:

The recommended method for the removal of wastes is as follows:-
FERRIC SULPHATE TREATEO FIT I UCNTS JO DISCHARGE

65 FLOW CHART REPRESENTS RECYCLING OF WASTE-WATER OF STEEL INDUSTRY
The cyanide effluent can be treated by alkaline chlorination in one reactor, the chromium by ferrous sulphate reduction in another reactor and the two treated effluents, mixed together along with acid effluents containing other toxic metals in a third reactor to precipitate the heavy metals at a pH of 8.5 and above. The metals are treated with FeSO₄ to reduce Cr(VI) ions and others are precipitated by adjusting the pH. The sludge containing metal precipitates may be dried on sand beds and disposed of on fallow land as a filling material. The flow sheet combining all these operations is presented in Fig. 64.

9.9.3. Steel Industry:

Iron and steel industry discharges a large quantity of suspended and colloidal matter. They reduce the penetration of sunlight and thereby photosynthetic activity of micro-organisms present in polluted water bodies. They also lead to heavy siltation of streams and affect the flow and life in water bodies.

The average chemical characteristic of by-product coke over effluents consists of the following.

1. Dissolved solids.
2. Cyanide = 12-50 mg/l.
3. Phenol = 140 - 150 mg/l.
4. Sulphide = 30 - 40 mg/l.
5. C.O.D. = 1400 - 2000 mg/l.
6. B.O.D. = 700 - 1200 mg/l.
7. Total alkalinity as CaCO₃ = 900 - 1500 mg/l.

The treatment of effluents discharged from steel industry may be done according to the flowchart given in Fig. 65.