

## SUMMARY

Environmental pollution has always been a major problem in the industrialized nations. This has become a major threat to the very existence of the mankind. Recently these nations have begun to think about the size and diversity of the environmental hazards resulting from the past and present industrial processes. The implimentation of more and more strict legislation to prevent pollution and environmental damage increased the social pressure on industries to develop new treatment methods for reducing the atmospheric emission and discharge into the streams or on land.

There are various of factors which contribute towards the environmental pollution. The unplanned rapid industrialization and the population explosion are the two main reasons for the pollution [1]. Out of which, major part of the pollution is occuring due to the continuous discharge of industrial waste into the environment. This has resulted in a threat to public health and general deterioration of the natural water resources in many parts of the world [2]. It also causes economical and ecological problems. Almost all of the pollutants if present in more than certain limit, causes adverse effect on human health. Exposure to chemicals like alkyl mercury and some organo chlorine compounds has caused intoxication, affecting large segment of the population.

Water is more prone to pollution than air. Natural fresh water contains micro organisms. These micro organisms require organic matter and oxygen for its growth. The self purification capacity of the water is due to the presence of these micro organisms. This capacity is badly affected by the pollution caused by the increasing population and industrialization.

Water pollution can be divided into two, depending on the sources 1) industrial water pollution, and 2) domestic sewage pollution. Water pollution is the immediate

result of the industrial development. The characteristics of the industrial effluent varies from one industry to other depending on the raw material and various production techniques used [3,4]. Industries like refineries, petrochemicals, oil drilling, dyes, textiles, pharmaceuticals etc. are producing large amount of effluents, most of which are highly toxic in nature. These effluents are generally discharged into the streams or on land after partial or complete treatment. Depending on the nature, the industrial water pollution can be divided into three 1) inorganic, 2) organic, and 3) physical pollution. Acidity, alkalinity, pH, heavy metals are the main inorganic pollutants. Physical pollution is mainly due to the turbidity, suspended solids, colour, odour, etc. High molecular compounds such as sugars, oils, fats, etc present in the waste water are the cause of organic pollution.

Gujarat has the biggest industrial estate in India. The rapid industrialization has posed a serious threat to state's environment along with the increased economy. Most of the industries are discharging their effluent to the nearby streams or to the land after partial or no treatment. This has made the main industrial belt from Mehsana in North Gujarat to Vapi in South Gujarat, a dangerous zone'[5]. Pollution from petrochemicals, refineries, textiles, and dye stuff making industries are severe in this region.

The Oil and Natural Gas Corporation of India Ltd., Mehsana project is producing more than 5000 m<sup>3</sup>/day of oil waste water which contain 9000 - 12000 mg/L of total dissolved salt and 200 mg/L of emulsified oil and grease. The Gujarat pollution control board regulation for the oil content in the effluent is 10 mg/L. So this effluent should be treated to remove the emulsified oil before disposal. Due to the high salinity of the effluent the biological treatment cannot be used for these oil well effluents [6]. Sludge formation and sludge disposal will be a severe problem when Al<sub>2</sub>(SO<sub>4</sub>)<sub>3</sub> and FeCl<sub>3</sub> salts are used as coagulants to remove the emulsified oil. Synthetic

polyelectrolytes are highly expensive and therefore it is not an economically cheap method for small scale industries. So it was decided to treat this effluent using a combined inorganic electrolytes. This result was compared with the result obtained by the treatment with individual electrolytes.

In the present study, the oil well effluent was treated with the combined inorganic electrolytes i.e,  $\text{Na}_2\text{SO}_4$  and  $\text{FeSO}_4$  in different concentration ratios and at varying pH values.. This results were compared with the oil removal efficiency of  $\text{FeCl}_3$ ,  $\text{FeSO}_4$  and  $\text{Na}_2\text{SO}_4$  when they were used individually. It was found that in case of the combined electrolytes, oil removal efficiency was much better than that of individual electrolytes. When the concentration of the combined electrolyte, i.e.,  $\text{Na}_2\text{SO}_4$  and  $\text{FeSO}_4$  increased from 250 mg/L to 500 mg/L the residual oil content in the effluent was reduced to 12 mg/L at pH 5. The oil removal efficiency of this combined electrolytes was high at pH 5, while pH 6 and 4 retained more oil in the effluent.

The optimum pH values for the oil removal in case of  $\text{FeSO}_4$ ,  $\text{FeCl}_3$  and  $\text{FeSO}_4$  is 5, 5 and 4. In case of these electrolytes also the treatment efficiency increased with increasing electrolyte concentration. with  $\text{FeSO}_4$  reduced the oil content to 25 mg/L,  $\text{FeCl}_3$  to 25 mg/L and  $\text{Na}_2\text{SO}_4$  to 19 mg/L when 100 mg/L of these electrolytes were added individually at respective optimum pH. This shows that the combination of the electrolytes is giving better removal efficiency than that of the individual electrolyte. Moreover the sludge formation is less when the combined electrolyte was used.

Low rainfall in Gujarat has made most of the regions in this state arid or semi-arid. Mehsana in North Gujarat is a semi-arid region and receives only 600 mm rainfall annually. Every drop of water is precious in this area. So it was decided to use the treated oil well effluent for improving the agricultural production of this region.

The use of oil well effluent for agriculture purpose is a difficult task. This difficulty varies with the various treatment methods used, the salinity level of the treated effluent and also the salt tolerance capacity of the plants. The hazardous effect of the use of this water for irrigation depends on many factors such as soil type, initial salt content in soil, amount and nature of the salt in irrigation water etc. Composition of the water and also the reaction of a particular soil towards the irrigation water should be known to determine the suitability of the water for irrigation [7]. Cation exchange capacity (CEC), pH, soil and water conductivity, Na/Ca + K + Mg ratio have all been used to predict the soil behaviour towards irrigation water.

In order to study the effect of the treatment oil well effluent on the exchange composition of the soil of Mehsana region, the soil samples collected (1 - 100 cm depth) from this area were treated with oil well effluent containing 9000 mg/L total dissolved salt (TDS), 1500 mg/L, 3000 mg/L and 5000 mg/L salt content at varying pH values (i.e., 7.5, 5.5. and 4.5). At pH 7.5, the sodium content in the exchange complex of the soil did not increase even when concentrated effluent containing 9000 mg/L TDS was applied. But at a lower pH, the sodium content as well as Ca content increased. But the Na/Na + Ca + K percentage was very less than the maximum limit of Na% in soil to keep the soil more permeable. It is known that the sodic soil can be reclaimed by the addition of gypsum or  $\text{CaCl}_2$  to the soil [8,9]. This will increase the Ca content in the soil which keeps the soil more permeable. In order to see this effect,  $\text{CaCO}_3$ ,  $\text{Ca}(\text{CH}_3\text{COO})_2$  and KCl were added individually to soil and irrigation water. In these cases the Ca content in the exchange complex increases abnormally. In case of  $\text{Ca}(\text{CH}_3\text{COO})_2$  the uptake was more at pH 5.5, whereas in  $\text{CaCO}_3$  it was at 4.5. This may be because of the more solubility of the  $\text{Ca}(\text{CH}_3\text{COO})_2$  in water at higher pH. In these cases, the Na/Ca + K% were very low showing that permeability of the soil can be

retained even when the effluent with high TDS is used, by the addition of  $\text{CaCO}_3$  to soil or by  $\text{Ca}(\text{CH}_3\text{COO})_2$  to the irrigation water.

Number of field trials were conducted to assess the specific condition under which this treated effluent containing high TDS can be used for irrigation. Different trees and field crops were planted. Initially normal water was used for growing the saplings till the saplings were established. Treatments involving well water and irrigation water with 2 : 1, 4 : 1 and concentrated effluent (9000 mg/L TDS) were applied. The treatment did not change the pH of the soil. Neither the reduction of pH nor the different treatment caused any damage to the plants. No visible symptoms of salt damage was also seen on leaves. It is felt that under more moist regime, adsorption of sodium in the exchange complex will be less and the continuous hard pan formation can be reduced as the distance between the trees are increased.

The dye stuff making industries and textile industries are the major source of colour and organic pollution in Gujarat. The highly coloured effluent reduces the penetration of the sunlight to the water, affects the photosynthesis of phytoplankton, which in turn affects the self purification capacity of the streams [19,11].

Vat dyes are widely used for dyeing cotton and wool, since they are most resistant to washing and sunlight. The solubilized vat dyes used for the dyeing purpose are the leucosulphuric ester of the insoluble vat dye. The material for dyeing is first dipped into the solution of the solubilized vat dye and is oxidised to its insoluble form (vat dye) by oxidising agents in acid medium [12]. Sunlight also has the capacity to oxidise the solubilized vat dye to the insoluble form. Effluent containing solubilized vat yellow dye was adjusted to different pH values and exposed to sunlight to find out the removal efficiency. The effect of total dissolved salt on the precipitation of vat dye was also determined. The residual dye content was analysed by UV - Vis

spectrophotometry and also by HPLC. Both the results were in good agreement. It was found that TDS has good effect on the oxidation of solubilized vat dye to insoluble vat form in presence of sunlight. The optimum pH was found to be between 6 and 7. As the concentration of dye increased above 300 mg/L, the sunlight photooxidation method was not efficient because of the less penetration of sunlight into the effluent.

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