Special Natural and Synthetic Materials for Water Pollution Control

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Abstract:
Beneficial use of environment has always been an important realization. The quality of environment in which we live indicates the standard of living. Urbanization and industrial development on one hand effects on the quality of life and on the other hand increasing industries develop a country economically, provides greater employment and higher standard of living but makes the environment more polluted. Of the various resources of environment, water is more severely threatened by pollution because of sewage and industrial waste disposal. Therefore proper methods should be developed to remove and recover these materials before things go out of control. A novel approach is the use of Ion exchange materials - Natural and Synthetic, which can be used to remove these ionic species by ion exchange, ion exclusion, absorption and sieve action processes.A regeneration cycle may be applied to recover these species from ion exchanger beds.

Keywords: *Environment, Pollution, Ion-Exchangers, Technology, Polymers.*

I. INTRODUCTION

Technology, development and environment are three interdependent impediments of the present day agro-industrial, scientifically advanced human society. The innovations in science and technology have helped accelerate the pace of development thus leading to higher growths. The emphasis on development and increased growth rate often sacrifices the environmental Interests. The problems which we face today of environmental degradation, ozone depletion and global warming are the consequences of this self-perpetual technology and development syndrome. It Is now abundantly clear that the developments around the world have engaged the mankind in an experiment of self-destruction, a destruction imminent if nothing is done to avert the present trend of neglect of environment.

Water pollution is causing a serious concern. We all need drinking water; we need water to support all our human and industrial needs. Indiscriminate disposal of industrial waste and effluent discharge has caused severe water pollution. It has highly polluted both the rivers and the ground water. The silting caused by the sediments from the effluent discharge has further eroded the river basins and degraded the quality of water.

Further the rivers, lakes and ponds in India are an excellent source of heat absorption in a tropical country such as ours; they are the sound base of our agro-based society. For this reason it is all the more essential to stop polluting the rivers and the natural water reservoirs.

II. WHAT ARE THE ION EXCHANGE MATERIALS?

Ion exchangers are insoluble, long chain polymers with a fixed surplus positive or negative charge over its matrix. This surplus charge on the matrix is balanced by the oppositely charged counter ions, which are movable or exchangeable. Materials of this type may be grouped as:

1. Natural & synthetic zeolites
2. Synthetic organic ion exchange resins
3. Synthetic inorganic ion exchange materials
4. Chelate ion exchangers
5. Ion exchange membranes

The possible use of ion exchange materials in recent post has proved to be beneficial in the field of water pollution control. The need of these materials was first noticed in the chemical industries where chemically pure water was invariably required. The use of these materials in the selective uptake of species particularly is ionic in nature.

A. Mechanism of Ion Exchange Process:

Let us consider the uniform, and spherical ion exchanger beads in a form placed in a well stirred solution of an electrolyte by Ion exchange being stoichiometric process, gives a replacement of counter ions A by an equivalent amount of other counter ions B. Due to the stoichiometry of .ion exchange the fluxes of the two counter ions A&B must be equal in magnitude. It is immaterial that the mobilities of counter ions A & B be quite different. Any excess flux of an ion (counter ion) will give a net transfer of electric charge and thus will produce an electric field (diffusion potential) which will slow down the faster ion and will accelerate the slower ion so that the flux will become equal.

The Donnan potential checks the entry of co-ions, but this does not hinder the exchange of counter ions. The charge transfer by counter ions A is balanced by an equivalent charge transfer by counter ions B.

Thus the ion exchange takes place in the following 5 steps
1. Migration of counter ion B from the solution into the film.
2. Migration of counter ion B from the film into the particle.
3. Chemical exchange between A&B.
4. Migration of counter ion A from the particle into the film.
5. Migration of counter ion A from the film into the solution

B. *Merits of these Materials:*

A scientific worker interested in the study of water pollution is faced with ever increasing demands and restrictions in designing new water treatment systems.

The growing energy shortage demands that water treatment process be more efficient than in past. Increased environmental restrictions on waste streams must be met. The use of ion exchange materials gives a logical means to reduce the above problems. When properly applied, these materials with their excellent chemical efficiencies can significantly reduce regerant usage and minimize wastes without loss of product quality.

The new materials have been prepared by different pioneering companies with improved qualities and applications, with their high exchange capacities, their ability to withstand extremes of temperature, chemical conditions and continued operations but also some of the molecular species, these materials have come to occupy a position of prominence in the field of pollution control. The great simplicity of the technique makes ion exchange very attractive and inexpensive tools for this purpose. The process of ion exchange, (as you all know) consists of passing the sample solution through an ion exchange column. This technique offers the advantage of multistage separation process with case of phase separation. Because of proper regeneration these ion-exchangers can be used over and again.

C. *Applications.*

A technique Desal Resin Process which is based solely upon the use of two week electrolyte Ion exchange resins for treating breakish waters on an economical basis has more recently been developed. It has also been demonstrated that modifications of this process can be incorporated to treat acidic drainage waters, industrial waste effluents and sewage waste effluents.
The Desal resin process generally consists of a series of 3 columns (units).

(1) *Alkalization* unit containing Amberlite IRA- 68 in the bicarbonate form. When the influent is passed over this unit, ail the anionic constituents are retained by the resin releasing an equivalent amount of bicarbonate, as given by the following.

$$(R —NH)\ HCO + NaCI \rightleftharpoons (R\text{-}NH)\ CI + NaHCO_3$$

(2) The second unit is known as *de-alkalization units* contains Amberlite IEC-84 a weak-acid-cation exchange resin. In this unit, the bicarbonate salts are converted to carbonic acid, as denoted in the following equation.

$$R\text{-}COOH + NaHCO_3 \rightleftharpoons RCOO\ Na + CO_2 + H_2O$$

(3) The third unit, which may be said as Carbonation unit also contains Amberlite IRA-68 but in the free base form. In the free base form, Amberlite IRA-68 absorbs the carbonic acid from the effluent of IRC-84 unit as follows:

Regeneration $R\text{-}N + H_2CO_3$-------> (R — NH) HCO_3 upon exhaustion the first unit i.e. the alkalization unit is regenerated back to the free base form with a base say NH3

The second unit, i.e. the de-alkalization unit is regenerated to H form by an acid say HCI.

$$R—COO\ Na + HCI \rightleftharpoons RCOOH + NaCI$$

Since the carbonation unit is already in the bicarbonate form, the flow pattern is reversed for the next cycle, the third unit becomes the alkalization unit, and the first, the carbonation unit.

Besides the applications of above kind, it is possible to make use of the ion exchange materials for the removal of recovery of metal ions such as Ag, Au, Ni, Hg, Cd, Zn, etc.

In certain cases a new class of ion exchangers known as chelating ion exchangers are also being used for the recovery and removal of ionic impurities.

For example removal of mercury ionic impurities

D. *Mercury*

Mercury has received a great deal of attention in the field of environmental pollution, Organic and also inorganic compounds of mercury are very toxic in nature and therefore after monitoring the presence of these compounds in environment particularly in water, the method should be developed to remove these compounds. Most of the mercury in waste water comes form the chlor-alkali industries by mercury cells and form paper industries. A specific type of cation exchanger containing -SH group can be utilised to take mercury by complexing process.

Recently, chelate ion exchangers having -N-C = S group have been shown to be superior in the -N removal of traces of mercury from waste waters.

More recently an inorganic ion exchangers, tin thioglycolate was prepared by us and was used for the selective uptake of mercury. One distinct advantage of this material over the common ion exchangers is that the rate of sorption of mercury is very fast.

Similarly other metals can also be removed from waste waters using selective ion exchange materials. A table for some metals/ions is given below.

Table 1:

Element/Ion	**Inorganic Ion Exchangers**
Ar	**($Ti0_2$ + AI_2O_3) —Titanium**
Pb	**Stannic molybdate, Bismuth**
Ag	**Bismuth tungstate**
Au	**Chelating Ion Exhcangers**
Ni	**Stannic antimonite**
Hg	**Tin Thisglycoalte**
Cu	**Stannic Sulphide, Zinc silicate**
Alkali Metals	**Zirconium tungstate**
Fe $(CN_6)^{4-}$ **Fe$(CN_6)^{3-}$** **S CN^-**	**Hydrated tin oxide**
Cd	**Lead antmonate**
$NH4^+$	**Clinoptilolite (Zeolite)**

III. CONCLUSIONS

"Technology created our environmental problems- Technology can solve them". This frequently voiced platitude is too simple- but characteristic of those technocrats who still believe that man can master the environment through technology, the following formulation is likely to be more realistic: "Technology has enormously expanded the frontiers of the feasible." In the process, mistakes were made. The setting of new goals and an improved understanding of overall interrelationships constitute the prerequisites for rectifying-with the aid of technology-a part of the damage and for avoiding damages in the future.