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Total Water Management

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Importance Of Weak Base Resin In Water Treatment

The process of demineralisation (DM) of water involves the use of both cation and anion exchange resins. The cation resin converts the salts present in water into acids which are then neutralised by the anion resin, producing demineralised water. The resins are further classified into weak and strong cation and anion resins based on the functional groups.

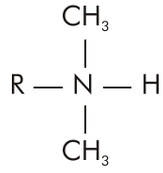
This article attempts to highlight the role played by weak base anion (WBA) exchange resins in water treatment and brings out the advantages of using this resin.

Functional group

Functional groups of WBA resin are derived from the secondary amine used at the time of amination process during the manufacture of resin. The different amine functionalities can be depicted as:

Primary	$(R - NH_2)$
Secondary	$(R = NH)$
Tertiary	$(R = N)$

The structure of WBA resin with secondary amine functionality can be shown as:



where R is resin matrix.

Most of the commercially available weak base anion exchange resins are made by co-polymerisation of styrene and divinyl benzene. The polymer beads are chloromethylated and aminated using a secondary amine. The process introduces tertiary ammonium functionality to the resin.

Regeneration efficiency

The weak base resins remove the mineral acids present in cation treated water with efficiency close to 90%. However, the resins are incapable of removing the weak acids like carbonic and silicic acids. A strong base resin is therefore used in combination with the weak base resin either in the same unit or in a separate column if the application calls for removal of weak acids as well.

Resistance to fouling by organics

Weak base resins available in the market have a macroporous structure with surface area in excess of 5 m^2/gm and pore diameters upto 800 Angstrom. Presence of large pores in weak base anion resins is significant while treating surface water containing organic matter of vegetable or animal origin. Organic matter is present in water in the form of high molecular weight carboxylic acids that are negatively charged and are therefore taken up by strong base anion (SBA) exchange resins used in the DM plant. Organic matter taken up by the anion exchange resin is not easily eluted during regeneration and gets accumulated in the resin structure which leads to fouling.

Fouled resins are characterised by long rinse, an increase in conductivity of treated water and loss of capacity of resin. The use of macroporous weak base resin ahead of the strong base resin minimises the risk of fouling due to organic matter.

Kinetics

Strong base groups are often introduced to improve the kinetics of the weak base resin. Accordingly, commercially available weak base resins contain strong base groups to the extent of 20 – 30%. Kinetics of weak base resins are controlled by particle diffusion, hence the exchange capacity of a weak base resin is shown as a function of exhaustion time in resin literature. The longer the exhaustion time, the higher the capacity extractable from the resin and vice versa. Therefore it is advisable to design DM plants with long service cycle whenever a weak base resin is used.

Volume change

Weak base anion resins are characterised by a large volume change. On complete exhaustion, volume increase can be upto 20%. Increase in volume is proportional to the extent to which the resin is exhausted. This is an important factor to be considered while designing water treatment plants.

Factors affecting exchange capacity

As already noted, exchange capacity of a weak base anion exchange resin depends on exhaustion time. The exchange capacity is also a function of the ratio of bivalent anions to EMA. The higher the ratio of bivalent anions, the higher the capacity. The capacity of a weak base resin is also significantly affected by the presence of free carbon dioxide. A capacity increase upto 10% can be expected if the weak base unit is installed ahead of the degasser in the DM plant.

Regeneration of weak base resins

Weak base functional groups present in the resin get easily regenerated and hence even a weak base like ammonia or soda ash can be used for regeneration. As noted earlier, the weak base resin can be used in combination with strong base resin either in a single unit or two separate units. Fresh alkali is used initially to regenerate the strong base resin and the used alkali is then reused to regenerate the weak base resin. This system of regeneration is known as *thoroughfare* regeneration and produces an effluent containing the least unreacted alkali.

The reaction of neutralisation of mineral acids goes to completion and hence it is irrelevant whether the resin is regenerated in co-current or counter current mode.

Advantages of WBA resins

In most of the plants, WBA resins are invariably used where the proportion of neutral salts is higher than alkaline salts.

Following are the benefits of WBA resins:

- They give high operating capacity.
- Can be regenerated with caustic, soda ash and liquor ammonia.
- In combination with strong base anion (SBA) resins, yield efficiency is upto 90 %.
- They protect the downstream SBA unit from organic fouling.
- Can be operated at high temperature.

Applications

WBA resins are used extensively in

- Demineralisation systems
- Layered bed anion units

WBA resins are generally used in combination with SBA either in separate units or in a single unit like the layered bed anion system. The main objective of this is to increase the efficiency of water treatment systems. It has been used to improve the kinetics of WBA resin by increasing the strong base functionality in different ratios in the resin matrix. After exhaustion of the unit, the caustic is passed first through the SBA unit, either in counter current or co-current mode, and the caustic released from the SBA unit is then passed through the WBA unit. The combination of SBA and WBA exchanges all the anions from the water and converts it into good quality demineralised water.

When both SBA and WBA resins are charged into single unit, it is termed *layered bed* anion. This system is cost-effective as it saves on capital cost and as less head is required to pump the water. In the layered bed anion unit, WBA is placed on top of the SBA resin. Hence care needs to be taken, at the time of backwash operation, that the two resins do not get mixed, as otherwise this can affect the quality of treated water. The density difference between SBA and WBA is quite low, therefore the backwash flow rate becomes critical so as not to allow the two resins to mix.

Conclusion

The introduction of weak base anion exchange resin has revolutionised the design of DM plants. It produces an almost neutral effluent and has helped to bring down the cost of demineralised water. Also, the use of weak base resins has considerably reduced the risk of fouling of strong base resins by organic matter present in surface water.

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