designs, end usages and multitude of other factors make it difficult to lay down a single norm for replacing the resins. Each case must be considered separately. There are bound to be drops in operating capacity and the best time to change the resins is when the economics dictate it – a balance between increased regenerant cost and resin cost.

- Regular sampling and testing of the resins is a good way to study their condition at different times. It helps to plan a replacement much before the resins reach the values set out by the manufacturer.
- Plant log books are also a valuable guide in evaluating resin replacement. They follow the performance with respect to pressure drop, influent and treated water quality, unit capacity and chemical consumption. The gradual deterioration in unit performance is a sure indication of resin degradation and the log books play a vital role in predicting this effect much before the resin touches its low level of performance.

Resin Selection

When it is time to replace the resins, there are two options – to employ a new charge of the resins currently in use or to shop around for alternatives. Here are few hints to help you select the correct resins.

- Study the technical information sheets of the prospective resins. The substitute resins must in no way fall short of specifications.
- Check volume changes in the resin when it converts from one form to another. Remember the vessel in the plant has a fixed geometry and internal assembly. The selected resins must fit into the space available.
- Density is important when selecting the resins for mixed beds or layered beds. Incorrect density of the resin particles could lead to operational problems.
- Does the plant or design incorporate hot regeneration? Make sure the resins chosen are suitable for the system temperatures.
- Verify bed expansion characteristics to ascertain loss of resins during backwash.
- Is there a flow limitation on the resins? Ensure that this does not hinder essential supply of treated water.
- Check the head loss characteristics for obtaining the desired production of treated water from the resin.
- The selected resins must provide the required quality of treated water for the efficient working of downstream facilities at all times.
- What is the capacity expected from the new resins?
- Consult the technical literature on the resins or the manufacturer for the answers to all these questions.
- Call for a sample and have a practical evaluation done in the laboratory.
- See how the 'test resins' fare in the laboratory, under plant simulated conditions of flow rate and regeneration with respect to treated water quality and capacity.
- Carry out visual and microscopic examinations of the resin samples. The resins should have a minimum of strains and cracks and essentially be free of broken particles. This would ensure fewer problems and longer life of the resins.
- If these practical tests give satisfying results then one is close to selecting the resin. Determine the life expectancy of the resin. A resin must have low attrition losses and last long in order to bring down the make up and replacement costs.
- Such a life expectancy test may be conducted on the sample by repeated cycling of the resins under certain operating conditions. The resins are tested for breakage and other parameters after a set number of cycles, and compared with the original.
- When all the aspects given above are duly weighed, one would be in a position to select the right resins.
- Maintain control of the resins by checking the supplies received. See that they conform to the original 'test' sample and specifications laid down for best results.

For evaluation of resin and plant performance, Call : 022-3047 2024

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Ion Exchange Resins Maintenance & Replacement

Ion exchange resins are the heart of every demineralisation (DM) and purification plant. To get consistent and expected results from the DM plant, it is important to maintain the resins in good condition in a suitable environment. Here we discuss, in depth, how to prevent resins from fouling through proper maintenance, when to replace them and how to select the best alternate resins.

Resin Fouling

Ion exchange resins can become fouled with contaminants that hinder the exchange process and affect the life of the resins. Some of the common foulants present in water and their effects on resin performance are discussed below.

Iron/Heavy Metal Fouling Iron deposits on the resin beads not only block the pores but also catalyse the oxidising action of dissolved oxygen in water. Iron fouling of cation resins is noticeably less when hydrochloric acid is the regenerant. In case of softeners or units regenerated with sulphuric acid, an occasional wash with diluted hydrochloric acid removes most of the iron deposits from the resins. Iron fouling of anion resins can take place due to the presence of iron impurity in the regenerant solution.

In some cases, excessive use of aluminium sulphates in the pretreatment plant causes fouling of the cation resins. Aged aluminium oxide deposits on the resins are difficult to remove. The most effective method to prevent fouling by heavy metals is to eliminate these elements at source, rather than carry out cleaning operations on the fouled resin bed.

Organic Fouling Large molecular weight organic acids such as fulvic and humic acids, formed by decomposition of vegetable matters in water, can get adsorbed on anion exchange resins, but they do not get eluted during regeneration. Organically fouled resins result in lower operating capacity and high rinse requirements.

Resin structure plays an important role in determining the fouling resistance of resins. Isoporous resins (INDION® FF-IP and N-IP) which have equal porosity are found to be effective.

Use of scavenger resin beds (which are macroporous) reduces fouling of the downstream strong base resins to a considerable extent. Some improvement in performance of organically fouled resins can be achieved if washed with alkaline brine.

Oil Fouling Presence of oil in water can cause physical fouling of the resin surface. Oil fouling can be prevented by good pretreatment. Oil fouled resins can be cleaned by washing with caustic soda solution or with a suitable surface-active agent.

Polyelectrolyte Fouling Use of polyelectrolytes in pretreatment of water must be properly controlled. Excessive use of polyelectrolytes (which are high molecular weight organic substances) can cause irreversible fouling of the cation/anion resins depending on the type of polyelectrolyte involved.

Precipitation If a high concentration of sulphuric acid is used during cation regeneration, calcium sulphate precipitation can occur and create problems such as high pressure drop, leakage of hardness ions during service and, sometimes, breakage of the resin beads. Calcium sulphate precipitation can be treated by backwash or by a hydrochloric acid wash.

Resin Maintenance

In order to obtain peak water quality, it is essential to maintain the resins in right condition. Ion exchange resins are bound to undergo some changes with continuous usage. The changes are sometimes natural to the resins, but mostly the deterioration of the resins is due to poor influent water quality or inadequate maintenance. Given below are a few steps to be followed during regular maintenance of the resins.

- Check the nature of water entering the DM plant after pretreatment and filtration. This feed water should be of good quality with all foulants completely excluded. The pretreated water should be oil free and any chlorine left over from the upstream chlorinating system must be removed.
- Use best quality regenerants which conform to relevant IS specifications for optimum results and enhanced life of the resins.
- Even though utmost care is taken to minimise the impurities in feed water and regenerants, there can be a slippage of impurities down through the DM plant. In such cases, some treatment is necessary to restore the resins to their near original state. If such maintenance is not done, it could result in poor treated water quality, reduced plant capacities and higher expenditure for regeneration of the resins.
- When the resins turn dirty, they can be cleaned by a thorough extended backwash. Open manhole backwashes can also be given regularly to help maintain the resin bed in a clean condition. Air scouring of the resin bed is also an aid to cleaning which improves the condition of the resins considerably when backwash alone does not help.

  When resins are contaminated with heavy metals, an overnight soak in 10% hydrochloric acid (HCl) solution would help decontaminate the resins and provide better capacity and treated water quality.

  Resins that are reversibly fouled by organics can be safely cleaned with alkaline brine solution. This treatment works better when the solution is in contact for a longer period with the resins. In most cases an overnight soaking is adequate. Hypochlorite solutions are known to be more effective organic defoulants than alkaline brine, but at the same time can damage the resin due to the oxidising nature of the solution. Oil fouled resins are amenable to cleaning with a dilute solution of INDION 2523.

  Silica fouled anion resins are best rejuvenated with a hot (50°C) solution of caustic soda. Check the type of anion resins in the unit. If the unit contains a Type-II strong base anion exchanger then do not employ hot caustic soda; instead carry out double alkali regeneration employing twice the normal quantity of alkali.
- The frequency of cleaning will vary on a case to case basis. While annual, six-monthly or quarterly treatment can be considered a normal schedule, frequent cleaning of resins would indicate that the inputs to the exchanger need to be thoroughly investigated.
- In the ideal case of excellent feed water (clear and free of contaminants), the resins would work to give long and trouble free service. However natural decay takes place in every resin. This decay varies from one resin type to another and it takes quite some time before natural degradation begins to interfere with plant water quality and treatment economics.
- Besides chemical ageing and fouling, resins are susceptible to physical breakdown into finer particles. This is caused by a number of factors such as pressure drop, osmotic shock, thermal shock and volume changes taking place with every regeneration and exhaustion cycle. The formation of resin fines is therefore a normal phenomenon and the removal of these fines in good time is recommended.
- Observe the unit pressure drops. These should remain constant at a particular flow rate. As the drop across the bed increases, the resin bed should be given a backwash at a higher flow rate and for a longer period. Resin fines should be washed out to drain. It is ideal to give open manhole extended backwash for removal of the resin fines. After the backwash, scrape off the top few centimetres of the resin bed.
- Whenever the unit is opened, use the opportunity to check the unit's internal condition. Resins can get contaminated due to the corrosion of the vessel and its internals.
- Do not forget to check the resin bed depths whenever the unit is opened for backwash or internal inspection. Many capacity drop problems may be attributed to a lower volume of resins in the unit. Have the resin sample from the unit analysed and after careful consultation top up any shortfall or replace the resins.

Resin Replacement

Testing of resin samples throws light on the condition of the resins. The test results, when compared to either a 'control' sample collected at the time of resin charging or new resins, would help decide on resin replacement. Various parameters are reviewed below based on which one can decide whether to replace the resins.


Resin Evaluation

- Normally dirty resins don't require replacement. What they generally need is repeated cleaning with air and water to remove dirt and silt adhering to them. The dirty resins however indicate that equipment ahead is not functioning properly, the regenerants used are not clean or the backwash operation is not being done adequately in terms of flow rate or time. It is a reminder to carry out regular extended backwashes.
- A high percentage of 'cracked' beads is undesirable as they get converted to 'pieces' and need to be removed. So be prepared to top up or replace the charge that is badly cracked.
- Pieces of broken resin beads lead to pressure drop problems and must be kept to a minimum. A regular extensive backwash followed by scraping off about 10-15 centimetres of the top layers is required to ensure that there are only few broken resin beads left over in the bed. The resin bed level should then be made up with a new charge of crack-free and piece-free resins.
- The sieve analysis helps in checking the quantity of fines in the bed. These may appear in the original charge, or during the resin recycling. If the percentage of fines is more, then you would require a larger pump to yield the desired flow. The larger head in turn creates a greater force on the resin bed which may lead to further formation of fines. These resin fines must be removed from the bed by backwash operations and scraping off the top layers of the bed.
- The moisture content of the resins increases in due course. The effect is even more pronounced in cation resins. The increase takes place due to the normal ageing process of the resins. If it is accelerated, check for the presence of oxidants, heavy metals and high temperature. Increased moisture content of the resins is an indication of decrosslinking, which means weakening of the resin structure is taking place. The result is break down of the resins into fines along with attendant problems.

  There is a limit to moisture value, beyond which pressure drop and attrition increase rapidly. Determine this value from the resin manufacturer.
- The total capacity of the resins deceases with usage and anion resins are more susceptible. This decrease is due to the normal wear of the resins, but may also be caused by foulants such as heavy metals and organic matter. The capacity loss on account of foulants may be restored by certain curative treatment such as acid wash or a soak in alkaline brine. In case of irreversible fouling, no amount of treatment would be effective and the resins must be replaced.

  Resins operate at a capacity much below the total capacity limit. Normally a 30% decrease in total capacity indicates that the resins need replacement.
- The strong base capacity (SBC) also decreases with increased resin service and the decrease is quick in case of Type-II resins. As in the case of total capacity, a certain and substantial decrease in SBC is required to affect the silica removal capacity of the resins. The resin manufacturer can guide you in this regard.
- The actual operating capacity of any unit is the best indicator to understand whether the resins require replacement or not. The variety of system