

# A Case Study of Health Assessment of Ion Exchange Resin Samples of Power Plant and Process - Nutshell

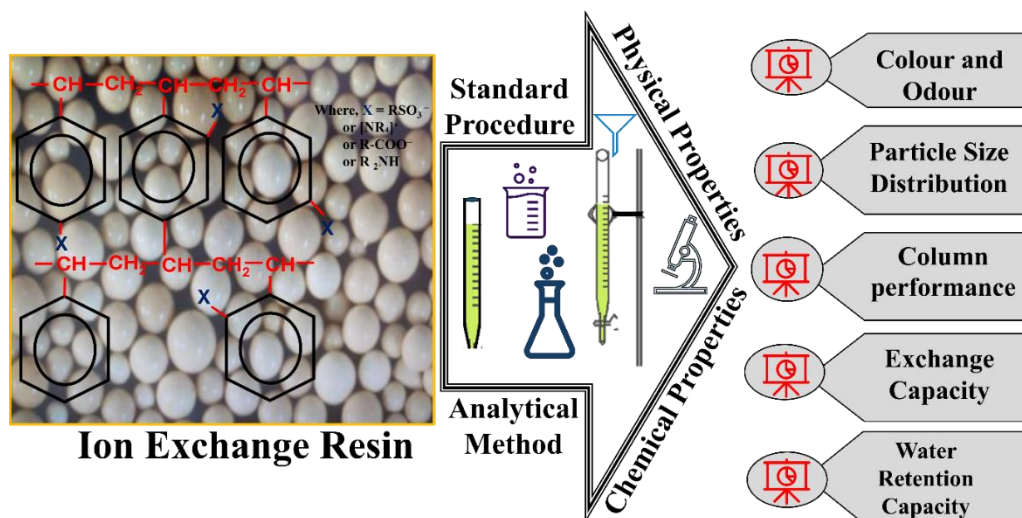
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**Abstract:** - Water pollution has significantly reduced the quality of the water, which has an effect on the operational efficiency of municipal and industrial water treatment systems. In this regard, water treatment by utilizing ion exchange resin is crucial to achieving desired water quality. Additionally, widespread application of resins for water treatment requirement of appropriate scientific and effective techniques and methodologies for evaluating both chemical and physical properties, such as exchange capacity. Using this concept, the current work offers a practical, standard ASTM systematic methodology to ascertain the physico-chemical characteristics of various ion exchange resins, including density, particle size, exchange capacity, water retention capacity, etc. Researchers and the academic and business communities will benefit from this work by being able to identify the different characteristics of ion exchange.

**Keywords:** Ion exchange resin, Water treatment, Health assessment, Exchange capacity, Density, Physio-Chemical parameters

**Graphical Abstract:**



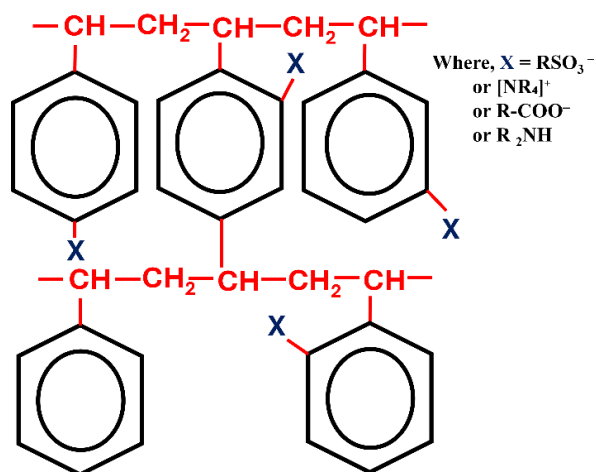
## 1. INTRODUCTION

In water chemistry, utilization of ion exchange resin for water treatment is a practical and in-expensive process to remove undesired dissolved pollutants, ions etc [1,2]. Water is an essential component for any industrial processes therefore its quality, accessibility, and dependability have an important impact on to run the industry[3–5]. To maintain the environmental responsibility and endurance industrial plants operations, establishments must implement comprehensive water management[6]. It is worth to mention that ionic impurities have a significant inferior impact on the water quality which impact on operational effectiveness of various sector such as boiler or industrial systems such as demineralization (DM) plant, condensate polishing units (CPU) etc. Hence, water treatment using ion exchange resin plays an important role in treating water which improve water quality as well as satisfying a variety of industrial, municipality and domestic requirements[7]. Ion exchange resin is a long chain polymer, synthesized through copolymerizing of styrene cross-linked with divinylbenzene (**Figure 1**). In general, ion exchange resins have ionizable functional groups that include positively charged cation and negatively charged anion. The resin's functionality has identified by ionizable

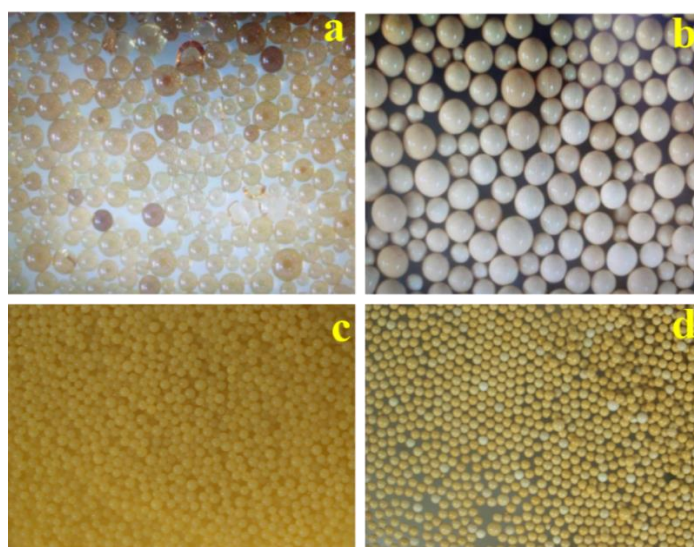
groups that are linked to the resin bead. There are four basic categories of resin are used in industrial application, namely (i) Strong Acid Cation (SAC) (ii) Strong Base Anion (SBA) (iii) Weak Acid Cation (WAC) (iv) Weak Base Anion (WBA)[8,9]. However, polyfunctional cation and anion exchange resin can be synthesized depending upon its application. An optical micrograph of various resin has been depicted in **figure 2**. Different functional group have been present in this resin and these are depicted in **table 1**. As mentioned earlier large quantities of various ion exchange resins are being utilised in various industries in various sector such as demineralized water plant, softening plant, and condensate polishing plant etc. to produce the required quantity and quality of treated water from water[1,6,10]. So, ion exchange resins must maintain their physio-chemical properties throughout their operational life to meet operational goal, which can only be done if the resin quality is routinely monitor and condition checked, and thereafter remedial action can be taken in time. As a result, for these industrial unit to operate effectively, and dependably, resins must undergo routine health assessment.

**Table 1:** Main functional group present in resin [11]

Sl. No	Types Resin	Main Functional Group
1	Strong Acid Cation (SAC) Resin	Sulphonate (R-SO <sub>3</sub> <sup>-</sup> ) functional groups
2	Strong Base Anion (SBA) Resin	Quaternary ammonium functional groups.
3	Weak Acid Cation (WAC) Resin	Contained carboxylic acid functional groups (R-COO <sup>-</sup> )
4	Weak Base Anion (WBA) Resin	Polystyrene that was undergone chloromethylation, followed by amination with dimethylamine, primary amine



**Figure 1:** General chemical structure of ion exchange resin



**Figure 2:** Optical micrographs of various resin (not in scale) (a) SAC resin (b) SBA resin (c) WAC resin (d) WBA resin

In this widespread application of resins in water treatment chemistry required the adequate and effective techniques to evaluate their physical as well as their chemical properties. Several standard characterization approaches intended particular for resin were reported[12–15]. However, focused article for systematic analysis process to evaluate the resin properties such as particle size, total exchange capacity, salt splitting capacity, WRC etc are merely found in literature. In this present study will gives the efficient systematic process to analyse ion exchange resin's properties. Systematic resin sample analysis and assessment approach has been showing through block illustration (Figure 3).

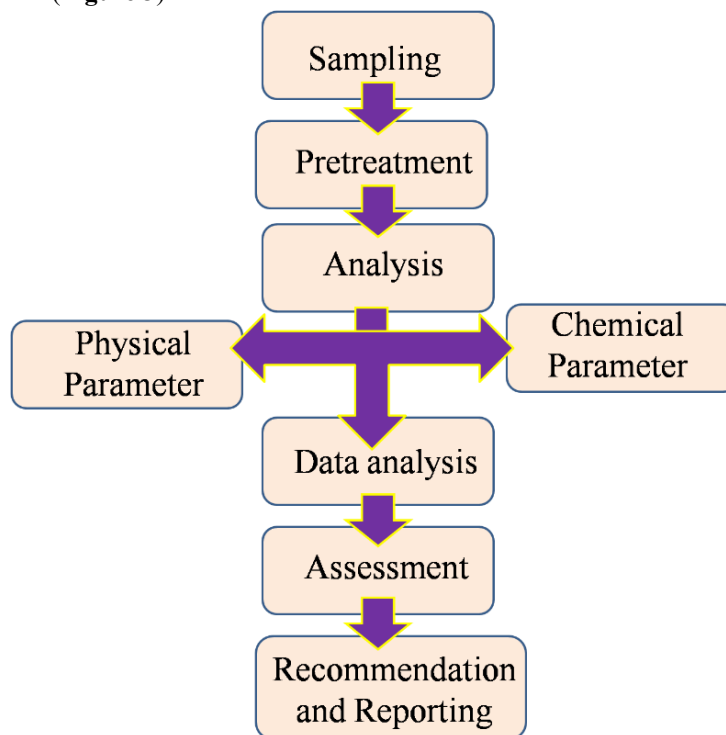


Figure 3: Block illustration for resin sample analysis process

In this context, to assess resin sample the following steps which includes sampling, pretreatment, analysis procedures, assessment of results must be followed.

## 2. Sampling and Pretreatment Process of Resin

To analyse resin sample, sampling is one of the important steps. In this practice ion exchange resin sample can be done in the procedure for dry or free-flowing material, and moist material. Note that for complete analysis, a minimum sample size of 1 litre is recommended. As soon as the sampling done, label, cardboard, or linen tags should be affixed to each sample container and sent for analysis. It is worth to note that sampling of resin sample should be done as per ASTM D2687 and IS-7330[16,17]. Before the physio-chemical analysis pretreatment of resin must be carried out. It explains how to alter ion-exchange resin into a specific ionic structure, and applies for fresh along with in service resin samples. The ionic form of an ion-exchange resin sample influences both its equivalent mass and its moisture content. This, in consequently, influences the numerical values derived in exchange capacity assessments, density, and particle size. To ensure a consistent basis for comparison, the resin should be transformed to a recognized ionic form before analysis. This process converts cationic resin into sodium form and anionic resin to chloride form prior to analysis. These forms have been selected since their characteristics allow materials to be processed: weighed and dried without risk of interference or deterioration. It is also recommended that pre-treatment of resin sample should be carried out as per ASTM D2187 and/or IS-7330[15,16].

## 3. Analysis of Physical Parameters of Resin

- **Visual appearance and Odour:** Ion exchange resin is usually in the form of spherical microbeads with radius of 0.25 mm –1.43 mm, white or yellowish in colour, synthesized from an organic polymer material. Generally, beads are porous and have a characteristic odour. Figure 4 showing the visual appearance of different ion exchange resin.
- **Density:** Density of the ion exchange resin is an important characteristic. Two types of density are considered for a resin depending upon its physical state that is whether it is in dry or wet condition. If the resin is in dry condition, then the calculated density is called true density and if the resin is in wet condition, then the density is being called apparent density. This density depends on the functional group linked to the resin molecule and their nature of cross link. Generally, resins with higher cross-linkage and strong acidic (SAC) or basic resin (SBA) have greater densities than those that are weakly

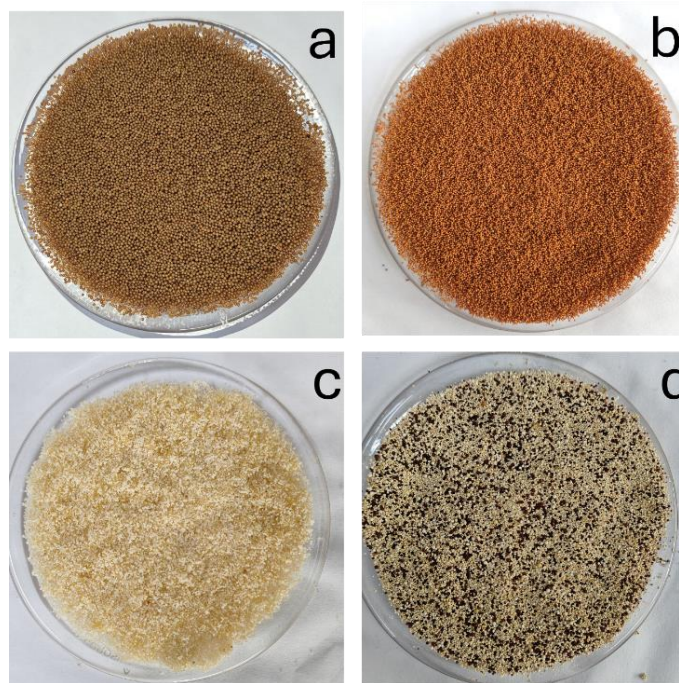
acidic (WAC) or basic resin (WBA). There are ASTM-D2187 and IS-7330 standard test method to evaluate the true and apparent density of resin sample. **Equation 1** shows the how to evaluate apparent density.

$$\text{Apparent Density (in g/ml)} = \frac{W}{V} \dots \text{equation 1}$$

Where, W =weight of wet resin sample (in gm), V = volume of sample wet resin sample (in ml)

- Particle Size Distribution:** Distribution of particle size of an ion-exchange resins is assessed in their totally hydrated stage and defined ionic form, providing a reliable basis for comparing size changes caused by particle breaking in usage. The procedure used is as per ASTM D2187 and/or IS 7330[15,16]. In this regards, effective size and uniformity coefficient are the two term is very essential to calculate. The sieve's opening diameter in millimeters that accumulates 90% of the resin particles is referred to as the effective size whereas uniformity coefficient can be calculated by dividing the sieve aperture (measured in millimetres) that holds 40% of the resin sample by the amount that holds 90% of the sample. An acceptable sequence of such sieves comprises of IS designations (with US standard numbers in brackets), 1180 micron (16), 850 micron (20), 600 micron (30), 500-micron, 425 micron (40), 355 micron (50), and 300 microns, as well as a lid and bottom collection pan for grading. Uniformity coefficient of resin is calculated by the following **equation 2**.

$$\text{Uniformity Coefficient} = \frac{\text{Mesh opening (mm) retaining 40\% of the Sample}}{\text{Effective Size}} \dots \text{equation 2}$$



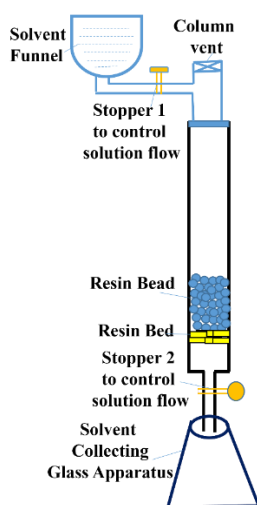
**Figure 4:** General visual appearance of various types of ion exchange resin (a) SAC resin (b) SBA resin (c) WAC resin (d) WBA resin

- Mechanical Strength of Resin Bead:** This method provides to determine the mechanical strength of ion exchange resin beads. The weight at which a bead breaks is its mechanical strength, sometimes referred to as its breaking strength. It is expressed in grams per bead. It is the maximum weight that may be applied to the skull without causing a fracture. When the mechanical strength of a bead is divided by its cross-sectional constant value, it is discovered that the mechanical strength usually increases as the bead's area increases.
- Fouling of resins:** Different kinds of organic compounds in a water source may inhibit an ion exchange resin's ability to function at its best. Compared to cation exchangers, anion-exchange resins are prone to these adverse effects. The signs of "organic fouling" include: (a) more frequent rinsing; (b) greater susceptibility to temperature and flow rate; (c) declining effluent quality; and (d) reduced capacity for operations. The organic fouling is the result of organic compounds bonding to an ion exchange resin's interface which prevents mobility of an ions to migrate easily through the resin. Which result in reduction of total capability. Effectiveness of ion exchange resin is usually evaluated using adsorption kinetic experiments, breakthrough graphs as well as spectroscopic studies[18,19].

- Kinetic Behaviour:** This procedure aims to assess variations in the kinetic performance of ion exchange resins utilized in mixed beds to produce water with improved quality levels. As per ASTM D6302 method, kinetic behaviour of Ion Exchange resins can be evaluated[20].

#### 4. ANALYSIS OF CHEMICAL PARAMETER OF RESIN

The number of functional groups which take part in the ion exchange process is the chemical properties of a resin sample. It is identified as the cation exchange capacity of cation-exchanging resin or the anion-exchanging resin. It is measured in milliequivalents of exchangeable ions per gram of resin. Moreover, these functional groups can be classified as bases or acids that are either weak or strong. This section will elaborate the calculation processes of exchange capacity of various resin samples. To determine exchange capacity of resin, first resin has been placed in a column as depicted in **figure 5** and then the respective solvent passed through the resin to evaluate the exchange capacity of respective resin as discussed in the below section.



**Figure 5:** Column diagram for the analysis of exchange capacity of resin

##### 4.1. Analysis of Exchange Capacity Analysis of Strong Acid Cation (SAC) Resin

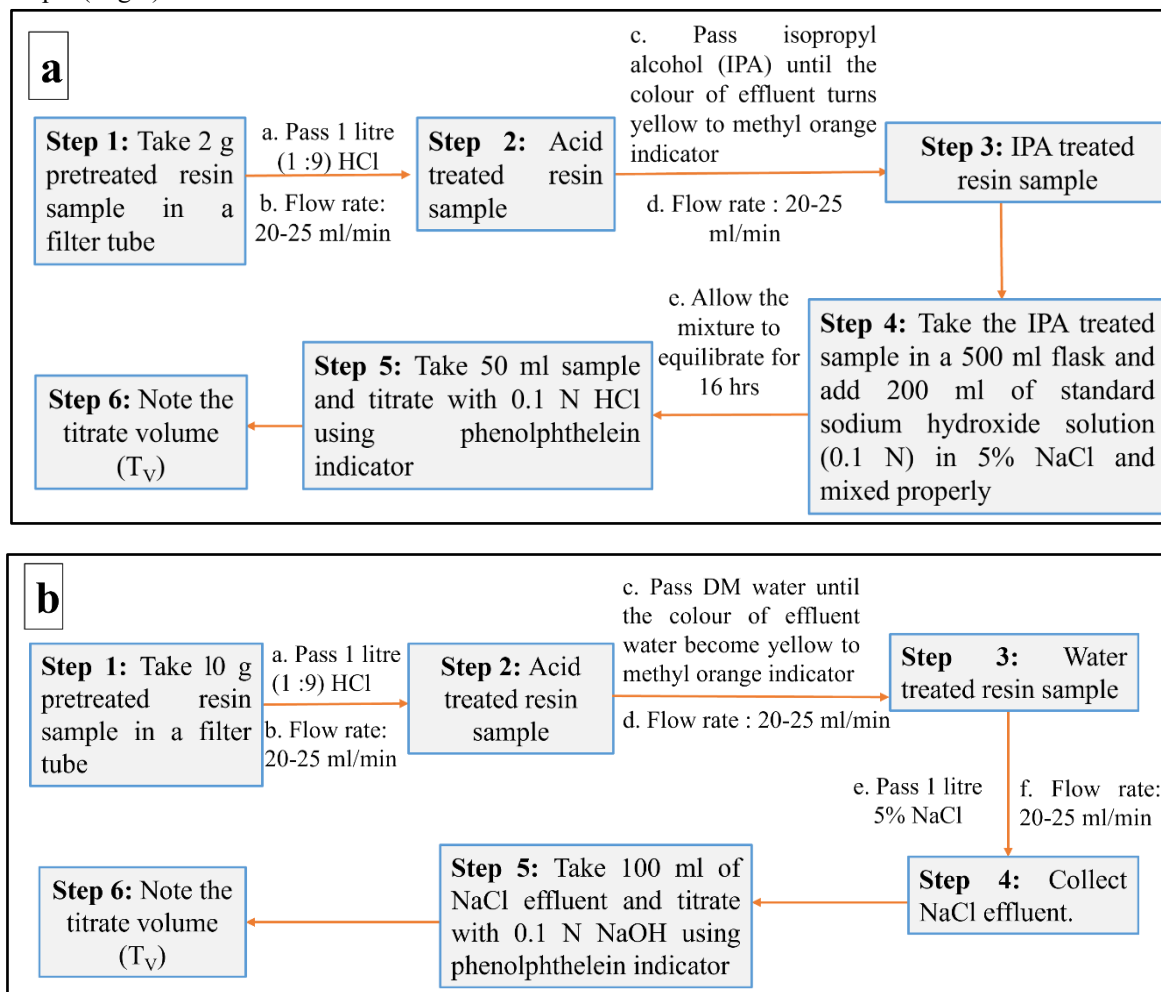
An essential characteristic of a resin is its exchange capacity, which represents the number of replaceable ions present in the resin. The unit of measurement is milligrams of ion per gram (mg/g) of resin capacity. To determine the exchange capacity of SAC resin, it undergoes equilibrium with a specific amount of NaOH (sodium hydroxide) solution in the presence of NaCl (sodium chloride). The remaining hydroxide ions are then titrated with standard HCl acid. Exchange capacity analysis of strong acid cation resin has been carried out in the following process given in **Figure 6a-b**. To calculate total exchange capacity (TEC) of SAC resin, 2 gm of pretreated SAC resin taking in a filter tube and passes about 1 litre dilute HCl (Conc. HCl: water = 1:9) at a flow rate of 20-25 ml/minute. After that isopropyl alcohol (IPA) has been passes through the SAC resin until the effluent colour turns yellow to the methyl orange indicator. Subsequently, this IPA treated SAC resin treated with 200 ml of 0.1N NaOH in 5% NaCl and allow the mixture to equilibrate for 16 hours. Finally, 50 ml of solution titrate with 0.1N HCl using phenolphthalein indicator and record the titrate volume ( $T_v$ ) to calculate total exchange capacity (TEC) as given in **equation 3**. Similar way, to calculate salt splitting capacity (SSC) of strong acid cation resin, HCl treated SAC resin sample washed with demineralized water to neutralize the resin sample. Afterwards 1 litre NaCl solution (5%) poured through neutralized resin with a flow rate of 20-25 ml/minute and collect the NaCl effluents. The collected NaCl effluent titrate with standard 0.1 N NaOH and recorded the titrate volume finally SSC has been calculated as given in **equation 4**. It is to be noted that calculation of exchange capacity of SAC resin could be done as per ASTM D2187 method.

$$\text{Total exchange capacity (TEC) of wet SAC resin (in meq/g)} = \frac{[(200 \times N1) - (T_v \times N2 \times 4)]}{w} \dots \text{equation 3}$$

Where,  $N1$  = Normality of standard sodium hydroxide solution,  $N2$  = Normality of standard hydrochloric acid,  $T_v$  = hydrochloric acid required for titration (in ml),  $w$  = Weight of wet resin sample (in gm).

$$\text{Salt Splitting Capacity (SSC) of wet SAC resin (in meq/g)} = \frac{T_v \times N \times 10}{w} \dots \dots \dots \text{equation 4}$$

Where, N= Normality of standard sodium hydroxide solution,  $T_v$  = NaOH required for titration (in ml), W =Weight of wet resin sample (in gm).



**Figure 6:** Flow chart to analyse exchange capacity of resin (a) TEC and (b) SSC of strong acid cation resin

#### 4.2. Analysis of Exchange Capacity Analysis of Strong Basic Anion (SBA) Resin

In process of exchange capacity determination of SAB resin sample, the resin sample first converted to the chloride ( $\text{Cl}^-$ ) form followed by leaching of chloride ion from non-salt splitting and salt splitting groups with ammonium hydroxide and sodium nitrate respectively. The chloride, is then, calculated in the separate eluates. To evaluate the TEC and SSC of SBA resin samples, in the first step, 1 litre of (1:9) HCl solution (flow rate of 20-25 ml/minute) needs to pass through the 10 gm of pre-treated resin samples. Acid treated resin has been neutralised by IPA until the colour of the effluents turns to yellow while checking with methyl orange indicator. Then enough water has also been passed through the sample. After that, 500 ml of (1:19)  $\text{NH}_4\text{OH}$  solution passed through the resin and again 500 ml DM water pass through the resin at same flow rate. Collect the total 1 litre of effluent in a flask and mixed it properly. From 1 litre of collected effluent, take 100 ml effluents and add 3-4 drops of methyl orange indicator the add (1:9)  $\text{HNO}_3$  dropwise until the solution colour turns red. After that, 1:19  $\text{NH}_4\text{OH}$  solution add dropwise until the solution turns just yellow. Finally, 3-4 drops  $\text{K}_2\text{CrO}_4$  added into the final mixture and titrate with standard 0.1 N silver nitrate ( $\text{AgNO}_3$ ) and note down the titrate volume ( $T_{v1}$ ). On the other hand, approximate 200 ml 5% NaCl solution passed through the  $\text{NH}_4\text{OH}$  treated resin sample afterwards 800 ml DM water again passed through the resin. From here, 1 litre of NaCl effluents again collected in a flask and from there 100 ml of NaCl effluent titrated with standard 0.1 N HCl using bromocresol green indicator and write down the titrate volume ( $T_{v2}$ ). Then again, NaCl treated resin treat with 1 litre of 2%  $\text{NaNO}_3$  at same flow rate as earlier and collect the effluent. From the  $\text{NaNO}_3$  treated effluent, take 100 ml of effluent in a flask and add 1 drop of phenolphthalein and methyl orange indicator each respectively. Add 1:9  $\text{HNO}_3$  dropwise or 1:19  $\text{NH}_4\text{OH}$  to adjust the pH where the phenolphthalein indication solution is colourless and methyl orange colour turns yellow. After that, add 1 millilitre of  $\text{K}_2\text{CrO}_4$  and titrate with 0.1N  $\text{AgNO}_3$  until the colour turns orange and persists for 30 seconds. Lastly, record the  $T_{v3}$  (titrate volume). A flow chart has been given in figure 7. Equation 5-6 are used to determine the SAB resin sample's exchange capacity.

$$\text{Salt splitting capacity wet SBA resin (in meq/g)} = \frac{T_{v3} * N1 * 10}{w} \dots\dots\dots \text{Equation 5}$$

$$\text{Total exchange capacity (TEC) wet SBA resin (in } \frac{\text{meq}}{\text{g}} \text{)} = \frac{10 [(T_{v1} + T_{v3}) * N1 - (T_{v2} * N2)]}{w} \dots\dots\dots \text{Equation 6}$$

Where,  $T_{v1}$  = volume of silver nitrate (in ml),  $T_{v2}$  = Volume of hydrochloric acid (in ml),  $T_{v3}$  = Volume of silver nitrate (in ml),  $N1$  = Normality of silver nitrate solution,  $N2$  = Normality of hydrochloric acid solution,  $W$  = Weight of wet resin sample (in gm).

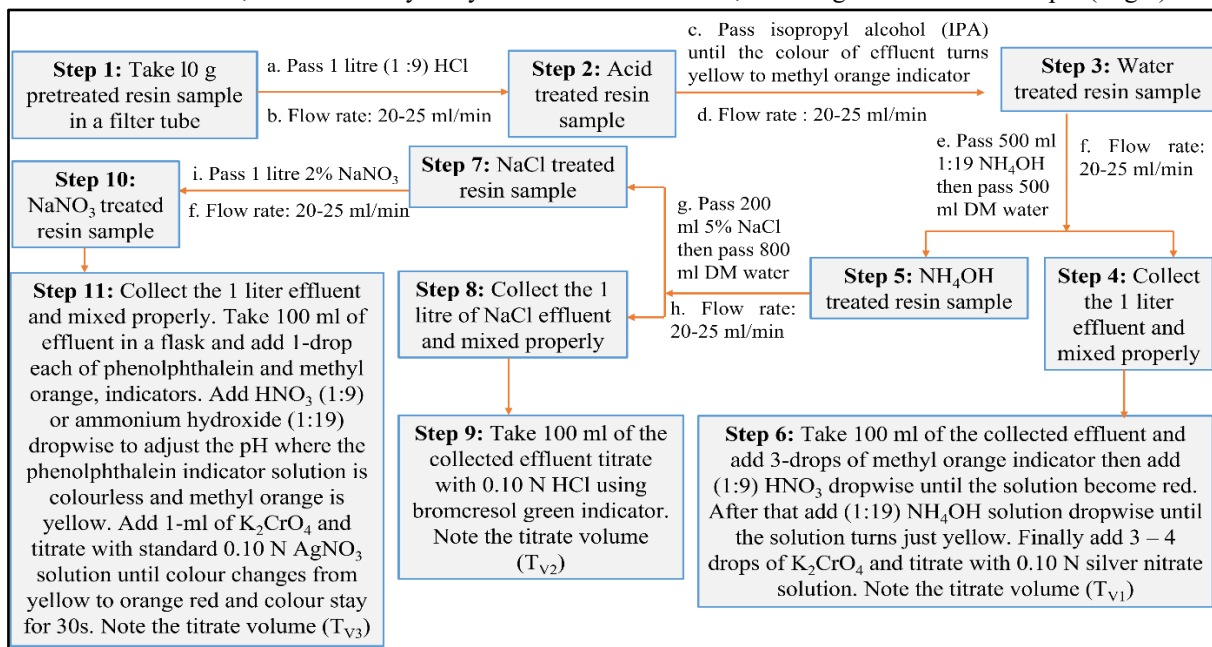


Figure 7: Flow chart to analyse TEC and SSC of strong basic anion (SBA) resin

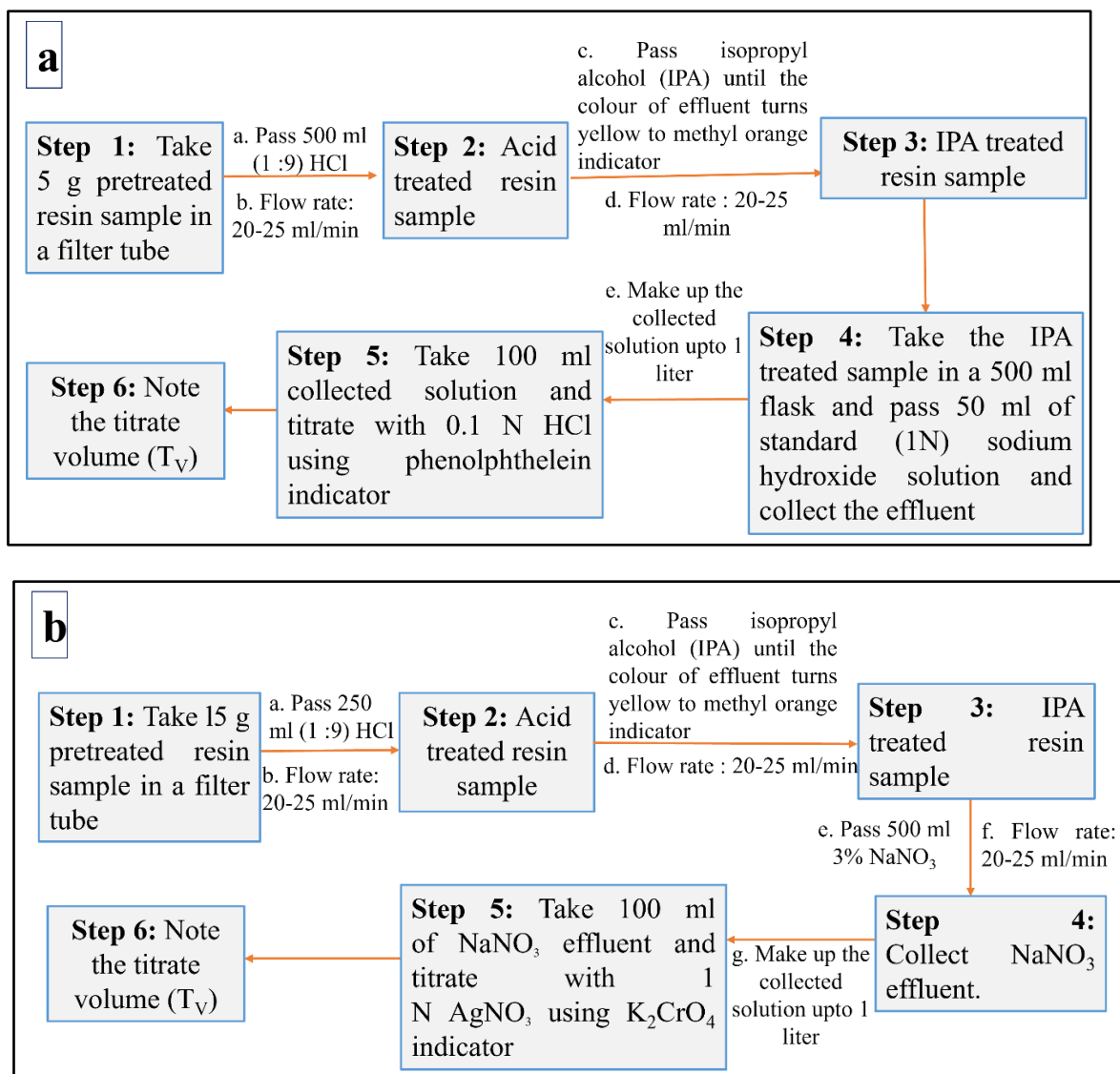
**4.3. Analysis of Total Exchange Capacity Analysis of Weak Acid Cation (WAC) and Weak Base Anion (WBA) Resin**

To evaluate TEC of WAC resin, the resin has to transformed into replaceable hydrogen ion ( $H^+$ ) which is titrate to analyse TEC of WAC resin. In the process of TEC determination of WAC resin, 5 gm of pretreated SAC resin taking in a filter tube and passes about 1 litre dilute HCl (Conc. HCl: water = 1:9) at a flow rate of 20-25 ml/minute. After that isopropyl alcohol (IPA) has been passes through the SAC resin until the effluent colour turns yellow to the methyl orange indicator. Subsequently, this IPA treated WAC resin transferred in a 500 ml flask and slowly pass 50 ml of NaOH (1N) solution. After that collect the effluent and makeup to 1 litre. From the 1 litre effluent, take 100 ml effluent and titrate with 0.1N HCl solution using phenolphthalein indicator. Finally note down the titrate volume ( $T_v$ ) and calculate the TEC of WAC resin using **equation 7**. Calculation of TEC of WAC and WBA resin will be discussed in this section. For WBA resin sample, take 15 gm of pretreated resin sample in a filter tube and pass 500 ml of 1:9 HCl solution Flow rate will be 20-25 ml/minute. Then, acid treated WBA resin has to treat with IPA until the effluent colour turns yellow. After that 500 ml 3%  $NaNO_3$  solution passes through the IPA treated resin and collect the effluent and make up to 1 litre. From the 1 litre  $NaNO_3$  make up solution, take 100 ml effluent and titrated with 1N  $AgNO_3$ . Note the titrate volume to calculate the exchange capacity of WBA resin using the **equation 8**. **Figure 8a-b** demonstrate the flow chart to analyse TEC of WAC and WBA resin respectively.

$$\text{Total Exchange capacity wet WAC resin (in meq/g)} = \frac{T_v * N * 10}{w} \dots\dots\dots \text{Equation 7}$$

$$\text{Total Exchange capacity wet WBA resin (in meq/g)} = \frac{T_v * N * 10}{w} \dots\dots\dots \text{Equation 8}$$

Where,  $N$  = Normality of standard  $AgNO_3$  solution,  $T_v$  =  $AgNO_3$  required for titration (in ml),  $W$  = Weight of wet resin sample (in gm).



**Figure 8:** Flow chart to analyse (d) total exchange capacity of weak acid cation resin (e) total exchange capacity of weak basic anion resin

#### 4.4. Water Retention Capacity (WRC):

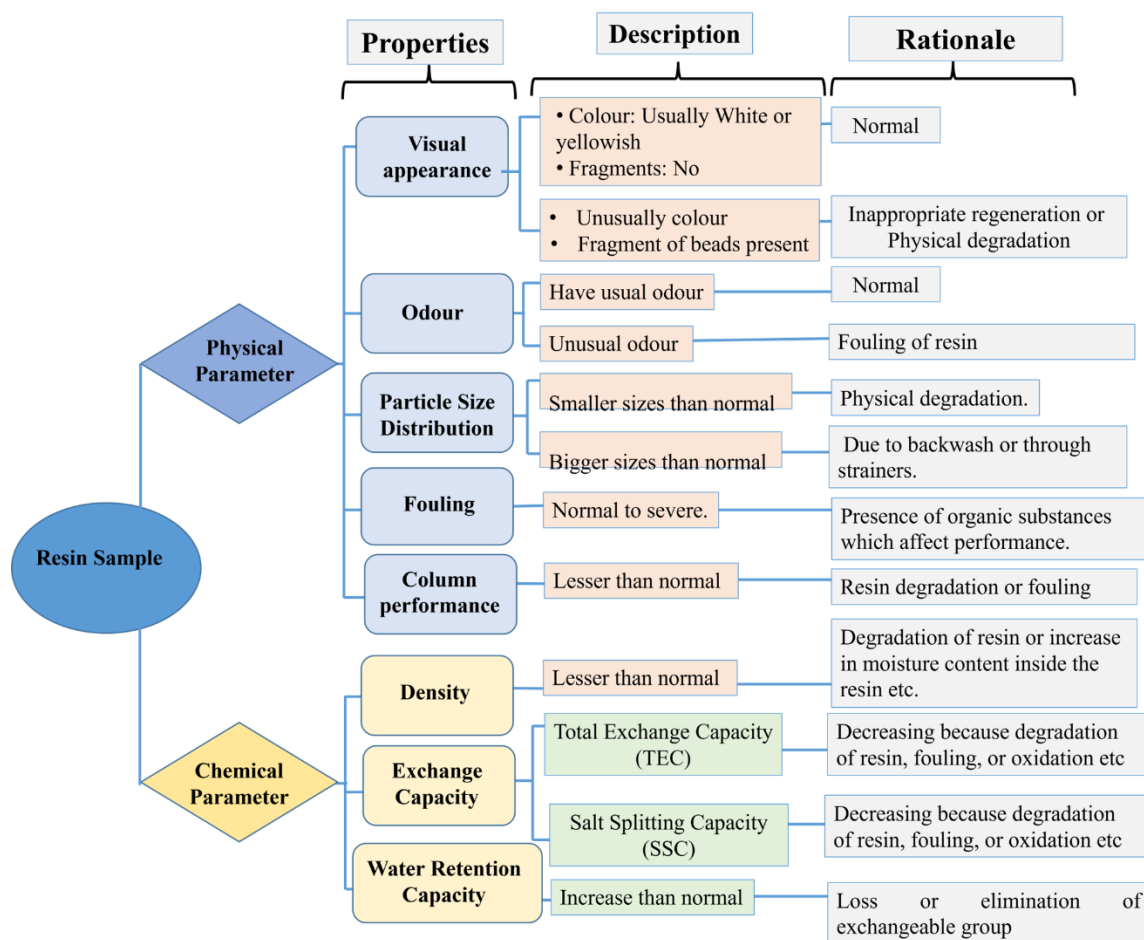
WRC is one of the essential parameters for a resin sample which allow to evaluate amount of water can retain in resin sample. This test consists of the calculation (equation 9) of the weight loss on drying at temperature  $104\text{ }^\circ\text{C} \pm 2\text{ }^\circ\text{C}$ . WRC analysis of resin sample should be done as per ASTM D2187 test procedure.

$$\text{Water Retention Capacity (in \%)} = \frac{A-B}{A} \times 100 \% \text{ .....equation 9}$$

Ahere: A = weight of wet sample used (g) , and B = weight of dry sample obtained (g).

### 5. SUMMARY OF ASSESSMENT PROCESS

The above physical and chemical parameters analysis such as visual appearance and odour, distribution of particle sizes and fine content, organic fouling of resins, TEC, SSC, water retention capacity (WRC) etc below interference may be carried out as describe in figure 9.



**Figure 9:** Various Physico-chemical parameters of resin and their properties with prospective

Various physical and chemical parameter assessment of ion exchange resins need be done to satisfy different requirements for their ion exchange properties, uniformity particle size, purity, mechanical strength, chemical properties, and stability etc. In general, minimum life period of an anion exchange resin is 3-5 years whereas for cation exchange resin is 10-15 years. It is necessary to analyse ion exchange resins on a regular basis because in-service resin gets oxidizes, deteriorate, and lose their properties. Regenerating the resin is necessary for reuse once all its ion exchange sites have been exhausted.

**Table 2:** Regeneration agents of different type of resin[16]

Type of resin	Regenerating agents
Strong acid cation (SAC)	2 to 3 times the stoichiometric quantity (HCl or H <sub>2</sub> SO <sub>4</sub> ) or chloride brine
Weak acid cation (WAC)	no excess (HCl, H <sub>2</sub> CO <sub>3</sub> or H <sub>2</sub> SO <sub>4</sub> )
Strong base anion (SBA)	2 to 3 times the stoichiometric quantity (NaOH or Brine solution)
Weak base anion (WBA)	1 to 2 times the stoichiometric quantity (NaOH, NH <sub>4</sub> OH, (NH <sub>4</sub> ) <sub>2</sub> CO <sub>3</sub> )

In regeneration process mainly mineral acid or NaOH solution used. It is also recommended to substitute the resin when alkaline brine treatments or other chemical treatments are no longer effective to produce the necessary effluent quality or quantity. If the exchange capacity decreased to 45 % – 50%, periodical alkaline brine treatment with 10% NaCl + 2% NaOH at 50 ± 2 °C should be done for 8 – 16 hrs soaking period as per requirement for preservation of exchangeable site. When the capacity has dropped to 65–70% of the initial capacity and improvement is not achievable through alternative methods, resins may need to be replaced.

## 6. EXPERIMENTAL ANALYSIS OF VARIOUS ION-EXCHANGE RESIN SAMPLES:

The ion-exchange resins i.e. SAC (strong acid cation), SBA (strong basic anion), WBA (weak base anion), WAC (weak acid cation) samples has been collected from one of the NTPC plant for their health assessment. The health assessment has been performed as per the process explained above sections. The chemicals utilized for the analysis of resin samples are sodium hydroxide (NaOH), hydrochloric acid (HCl), phenolphthalein reagent indicator, methyl orange indicator etc. All chemicals and reagents were analytical grade, and no further purification was carried out prior to use. The experimental results further compared with ideal parameter value, which ultimately determine the assessment of health of the ion-exchange resin samples.

**Table 3:** Experimental results

SN	Sample Description	Total exchange capacity as gm of CaCO <sub>3</sub> /lit of resin	Salt splitting capacity (SSC) as gm of CaCO <sub>3</sub> /lit of resin	WRC (%age)	Density (gm/ml)	Bead Strength/ (gm/bead)
1	SAC-1	78.7	76.4	56.4	0.7445	774.6
2	SAC-2	76.5	74.5	57.6	0.7456	785
3	SAC-3	76.0	73.7	58.7	0.7395	1118
4	SAC-4	59.0	53.8	65.3	0.7585	262.6
5	SBA-1	53.4	48.1	52.5	0.6842	745.8
6	SBA-2	53.7	49.3	52.8	0.6809	678.2
7	SBA-3	35.2	32.3	62.7	0.7030	322.7
8	SBA-4	53.4	48.9	53.2	0.6878	1033.5
9	WAC-1	101.6	-	53.6	0.7726	530.5
10	WAC-2	105.6	-	54.9	0.7723	1201.3
11	WAC-3	104.3	-	59.8	0.7210	525.4
12	WAC-4	102.7	-	55.9	0.7451	855.6
13	WBA-1	70.5	-	50.2	0.7321	1234.1
14	WBA-2	69.1	-	54.6	0.7123	510.3
15	WBA-3	67.0	-	53.8	0.7331	355.4
16	WBA-4	67.9	-	54.8	0.7263	330.6

Expected TEC/SSC for new SAC resin = approx. 100 gm CaCO<sub>3</sub> / lit of resin, SBA resin = approx. 60 gm CaCO<sub>3</sub> / lit of resin, WAC resin = approx. 200 gm CaCO<sub>3</sub> / lit of resin, WBA resin = approx. 80 gm CaCO<sub>3</sub> / lit of resin.

## 7. RESULTS AND DISCUSSIONS

Analytical data of SAC-4, SBA-3, WAC-1, 2, 3 & WAC-4 resin samples reveals that exchange capacity is significantly decreased more than 40 % particularly w.r.t. salt splitting capacity (SSC) compares to their ideal value. This decrease of SSC indicate that resin are capable to treat 50% of water only. Along with this, there is sharp decrease in bead strength of ion-exchange resin beads of SAC-4, SBA-3, WAC-1, 2, 3 & WAC-4 resin samples. This suggest that cracking tendency of these resins will increase during the process.

All other resin samples are normal with respect to the ideal value of exchange capacity.

## 8. CONCLUSION

In a nutshell, removing of undesirable ions, impurities etc for water, utilization of resin in the water treatment process becomes a critical aspect to maintaining machinery function and longevity in industries such as power plant, cement industry which demand large quantity and quality of water. In this regard, extensive application of resins in water treatment chemistry necessitates suitable, effective techniques and methods for evaluating both chemical and physical properties, such as the exchange capacity of ion exchange resins. Considering this, the present study provides a standard systematic analytical technique that is successfully assess the physicochemical parameters, including density, particle size, exchange capacity, water retention capacity, etc of different ion exchange resins. In conclusion. in this manuscript, a systematic in-depth standard ASTM approach has been described to edify the water chemistry professional/researcher enlighten with the fundamental techniques and analytical approach which helps to give knowledge about the resin properties. In this manuscript also deals with the standard methodical approach to evaluate the various physical as well as chemical properties of an ion exchange resin in a simple and concise way so that one can easily access resin behavior. Finally, this manuscript will be a one-step ideal stoppage from where researchers/ academicians get a standard theoretical approach in-line with experimental data to produce quality water by analysing the Ion exchange resin for sustainable development.

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## DECLARATIONS

Conflict of interest: The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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