I.4: Upgradation of effluent treatment plant for zero discharge of rinse water

Electrochemical/chemical processes play a crucial role in the fabrication of accelerator components to meet specific functional requirements. Rinsing of components in between various steps of these processes generate a lot of waste water having metallic and non-metallic ions like nickel, copper, iron, aluminum, chloride, sulphate, phosphate, nitrate and fluoride. These ions are toxic in nature and may have harmful effects on physiochemical and biological processes of living organisms if discharged directly into water bodies.

Rinse water generated during electrochemical processes in chemical treatment laboratory is collected in two storage tanks of capacity 10 kiloliters each. Method of treatment consists of a pre-treatment section, a plant which is combination of clarifier-platter, lime dosing system and storage tank as shown in Figure I.4.1. The untreated effluent is transferred to the especially designed clarifier having capacity to treat 1 kiloliter of waste water per hour. Lime is dosed carefully and it is allowed to react with metal and non-metal ions (specifically fluorides and phosphates). Chemically transformed effluent is then passed through the platter that separates solid waste and the treated liquid stream and is collected in 5 kiloliter storage tank for further treatment. The sludge separated during this process is collected in an evaporator tank for drying. The dried sludge is collected in polythene bags and sent to Madhya Pradesh Waste Management Project, Pithampur, for land fill after treatment.

Fig. I.4.1: Pre-treatment system.

Pre-treated waste water is then passed through treatment section consisting of sand filter and high pressure carbon filter to remove suspended particles and organic contaminants. The filtered water is then passed through a Reverse Osmosis (RO) system of capacity 3 kiloliters per hour (shown in Figure I.4.2) to remove nitrate, sulphate, chloride and any other ions that are not removed in the earlier process. The measured conductivity and pH value of the partially treated water is around 50 micro siemens/cm and 8, respectively, which make it unsuitable for reuse and hence it is disposed of. An average of 100 kiloliters of waste water is treated annually with the existing system.

Fig. I.4.2: Reverse osmosis plant.

The above mentioned effluent treatment plant was upgraded by integrating it with a custom built ion exchange plant to remove the remaining ions for its reuse. To identify the type of resins to be used, experiments were carried out using artificial effluents prepared with varying concentrations of metallic and non-metallic ions expected in rinse water. Glass columns with different combination of anion and cation exchange resins were used for this purpose. Strong acidic cation resin having functional group -SO_3^- H^+ [INDION 225H] for cation removal, strong base anion having quarternary ammonium (type ii) functional group [INDION NIP] for anion removal and combination of INDION 225 H and strong base anion having quarternary ammonium (type i) functional group [INDION FFIP] for mixed bed (Polisher) were chosen for further treatment of permeate from RO outlet. Figure I.4.3 shows the new system consisting of (i) cation exchanger column filled with strong acid cation resin 225H (ii) anion exchanger column filled with strong basic anion resin NIP and (iii) mixed bed column containing both 225H and FFIP resins connected in series.

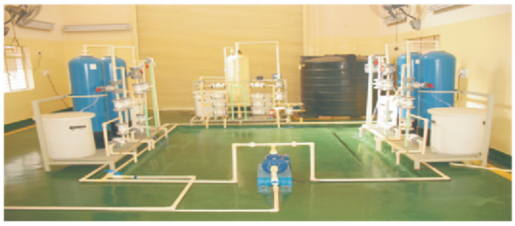

Fig. I.4.3: Ion exchange plant for zero discharge.

Another set of cation and anion exchanger was also installed in parallel, connecting RO outlet tank to mixed bed for continuous operation of the plant during regeneration of exhausted resins.

The quality of the treated waste water was analyzed to identify its suitability for reuse in chemical and electrochemical processes. The conductivity of the treated water is measured to be less than 10 micro siemens/cm and pH value is ~ 7.2, whereas metallic and non-metallic ions are below detectable limits. Annually, this has allowed reuse of ~100 kiloliters of waste water, for various other electrochemical and chemical processes, in our laboratory.

Reported by:
B.Q. Khattak (bqk@rrcat.gov.in) & colleagues