Ion Exchange Resins for Wastewater Recycling and Purification of Plating Bath

"In this case study, the special emphasis is on two applications in the chrome plating plant. First is the purification of spent chromic acid bath and second is chromic acid rinse water recycling and chromic acid recovery (from rinse water)."

By LANXESS India Private Limited

Introduction

Chemical processes comprise the steps of processing chemical starting materials, synthesising the products, isolating the generated materials from the reaction mixture and subsequent purification. In the broader context of the industrial process, they also include detoxifying waste streams to protect the environment and recovering valuable materials. Ion exchange resins offer a high potential for innovation in a range of applications. They enable processes involving complex chemistry to be configured with relatively simple apparatus. Most of these processes have already been implemented on an industrial scale, in the plating industry Lewatit® Ion Exchange Resins are used for following applications:

- Purification of concentrated chromic acid bath
- Chromic acid recovery/ rinse water recycling
- Trivalent chrome bath recycling
- Zn and Ni electrolyte bath recycling
- Acid purification/ retardation (HCl, H_2SO_4)
- Precious metal recovery (gold, silver, platinum, rhodium)

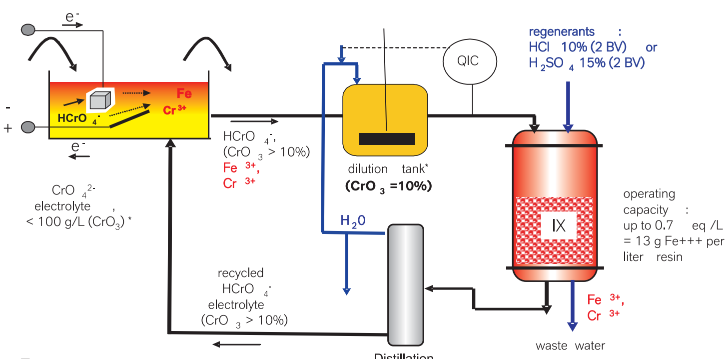

Figure 1

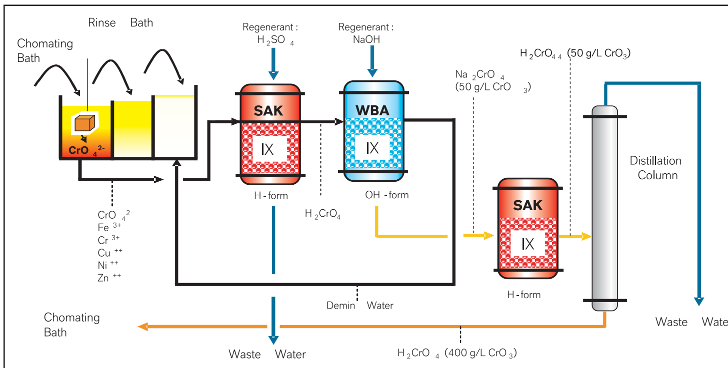

Figure 2

In this case study, special emphasis is on two applications in chrome plating plant:

- The purification of spent chromic acid bath, and
- Chromic acid rinse water recycling and chromic acid recovery (from rinse water)

Purification of Spent Chromic Acid Bath

Chromic acid baths are used in metal working plants for plating and passivation of metal surfaces. During operation these chrome (VI) containing electrolytes may accumulate different metal ions depending on the base material of the processed working piece. Iron, brass or other pre-electroplated metal layer liberate ions like Fe_3^+, Ni_2^+, Cu_2^+ or Zn_2^+ whereas Cr_3^+ originates from the cathodic reduction of the chromate containing electrolyte.

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Technical Concept of Ion Exchange Unit

The ion exchange column is arranged in a bypass to chromic acid bath. Usually chrome electrolyte has to be diluted down to chrome-oxide concentration of 10% before entering into ion exchanger. Downstream the ion exchanger, acid is concentrated by water evaporation. The process is started, when metal concentration in the bath has reached a certain level. Several cycles are run, until the bath concentration has been decreased to the targeted level. Thereby the column is operated downstream with downstream regeneration. Specific flow velocity in service as well as in regeneration is in a range of 2-5BV/h. It is recommended to use a candle filter upstream of ion exchange filter to protect it from getting plugged by suspended particles. It is recommended to have two columns so that regeneration and service can be carried out in parallel. Due to short cycles usually running in this application, service cycle time is of the same duration as the time required for regeneration. Basic parameter required for layout of plant is the amount of metal which is dissolved in acid bath per hour. Layout of plant must be carried out in a way that capacity of column is high enough to remove metal in a given time frame. Thereby minimum design capacity is the one that potentially can remove all metal impurity when it is continuously running.

Chromic Acid Rinse Water Recycling & Chromic Acid Recovery (from Rinse Water)

The other application of IX resin in chromic acid bath is the recycling of plating rinse water and recovery of chromic acid from the rinse water. The flow diagram in Figure 2 describes the process in detail. The metal impurities such as Fe_3^+, Zn_2^+, are removed by the first cation exchange resin column and at the outlet of the column, the water containing H_2CrO_4 is then passed through the another column of anion exchange resin. The anion exchange resin adsorbs the chromic acid and the water at the outlet of the anion column is free from all the impurities and also the chromic acid. The treated water quality at the outlet of anion exchange resin column, the expected conductivity is <5-microsiemens/cm^2. This water then can be recycled back to the rinse water tank.

Regeneration Procedure

Typically, the exhausted cation resin is regenerated with 2BV of 10% HCl or 15% H_2SO_4. Although HCl has better regenerating properties the introduction of chloride into the process stream is generally not aspired. If, however, HCl is considered for the regeneration (2BV of 10% hydrochloric acid) additional water wash should be performed to lower the chloride content as much as possible. The exhausted anion resin column is regenerated with 2BV of 4% NaOH. The regenerant waste of anion resin column is nothing but the Na_2CrO_4, which is then fed to the third cation resin column to recover the chromic acid. The chromic acid recovered from the third column is approximately 50gm/ltr conc. To concentrate further it is to be passed through the distillation column to evaporate the water.

Chrome Recovery Unit

LEWATIT resins are installed in one of the big plating unit located in north of India. Two Filter columns of Lewatit K-2629 and Lewatit K-4367 special applications resins are installed for the recycling of the plating bath rinse water, and one more resin column is used for the recovery of chromic acid. The average flow is 2cbm/hr and running continuously for 24hrs in a day, and the cycle time is about 144hrs (6 days). The treated water quality achieved at the outlet of the second column is cond. <3-microsiemens/cm^2 and chrome - NIL/ND. The cycle is stopped when the chrome is detected at the outlet of second column. Economic considerations indicated specific operating costs in a range of a few Euro Cents per cubic-meter of water, including capital cost and depreciation of investment cost. These resins are operating since last 1yr and have been regenerated several times. The regeneration efficiency of the resin has been proven as there is not a drop in the operating cycle time since the first cycle. The user is very satisfied to get the cost benefit and also a considerable cost saving in treatment of wastewater. The ROI period is only 6 months. The user gets several benefits like reduced consumption of fresh water, no treatment cost for the raw water treatment, chromic acid recovery, and substantial reductions in wastewater volume and treatment cost. This plant experience was encouraging to other customers to invest in resin based treatment to solve their wastewater problems. In the meantime more than five plants have been installed in India and all of them are operating with satisfying results.

About the Contributor

With over 100 products, LANXESS offers a range of ion exchange resins that can be used as a modular system to create individually tailored solutions. Collaboration is an attractive option for customers not only due to the high-quality products this enables, but also in particular because of the quality of technical service it delivers. Chemists and process technicians from the applications laboratory handles customer inquiries and collaborates on projects.

We look forward to your feedback on this case study. To know more about the contributor, you can write to us at content@eawater.com