

MUNICIPAL POTABLE WATER SYSTEMS

Low Waste Nitrate Removal System for Potable Water

Rohm and Haas Company has developed a unique nitrate removal system - the Advanced Amberpack™ Municipal System for nitrate removal. By combining a nitrate-selective resin with patented fractal distribution technology, Rohm and Haas has created a simple, modular system that has a small footprint and an exceptionally low volume waste stream (yields up to 99%). The unique system is designed to overcome the traditional problems in removing nitrates from potable water, including disposal of high volume waste streams from conventional ion exchange systems, high capital and operating costs associated with other low waste ion exchange system designs, and the low water yields with electrolytic processes. The Advanced Amberpack™ Municipal System for nitrate removal is currently available for purchase worldwide.

Nitrate in potable water

In agricultural regions, ground water can become contaminated with nitrate. According to the US Environmental Protection Agency, while nitrate is not toxic for adults, it is believed to be linked to some serious conditions in infants. Current European Community (EC) standards set the maximum level of nitrate in potable water at 50 mg/L. Current U.S. Environmental Protection Agency (EPA) standards set the maximum level of nitrate in potable water at 10 ppm expressed as nitrate. Many regions are increasingly concerned with nitrate levels in public water supplies.

Nitrate selective resin

Ion exchange is an important technology for selective contaminant removal from potable water. Nitrate-selective resins have a better affinity for nitrate than for chloride, sulphate and bicarbonate compared to conventional strongly basic resins – which allows for more efficient removal of nitrate from water. The reaction is an equilibrium (R represents the resin, which is initially in the chloride form):



When the feed water contains a high amount of sulphate, generally when SO_4/NO_3 is greater than 1, the use of a nitrate-selective resin is indispensable, otherwise sulphate ions will displace nitrate ions during use. The Rohm and Haas resin used in the Advanced Amberpack™ Municipal System for nitrate removal is a nitrate-selective resin registered in Europe and the U.S. for potable water applications.

Fractal technology and low waste

Minimizing waste is the key to making ion exchange processes sustainable and economical. The patented fractal distribution technology allows the Advanced Amberpack™ Municipal System to be among the lowest waste ion exchange systems available for the treatment of potable water. Brine waste volumes can be minimized to 0.3 % to 1 % of the total water produced, generating >99 % yield!

The fractal distribution concept derives from mathematical modeling of flow through a vessel. Using fractal distribution, the Advanced Amberpack™ Municipal System is designed to ensure uniform flow across the resin bed. This uniform flow minimizes turbulence and dead zones, which are partially responsible for inefficient operation and high waste stream volume. Figure 1 illustrates the schematic principle: the distance from the inlet point to each outlet orifice is constant. There tends to be no preference for the path closer to the inlet. Distribution is dramatically improved!

FIGURE 1:
Fractal near perfect distribution

New Fractal Distributor

- Uniform distribution

Standard Distributor

- Pressure driven process
- Creates dilute wave fronts

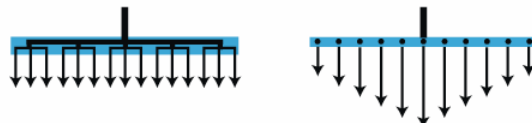
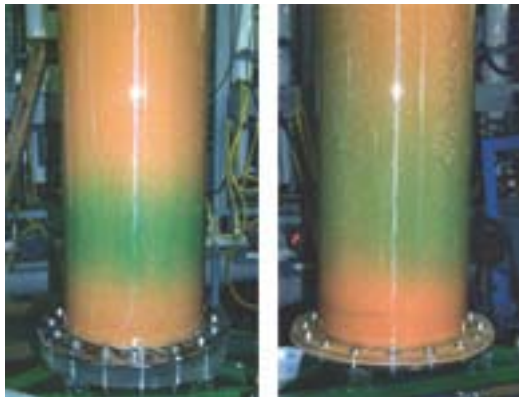


FIGURE 2:
 Near Perfect fractal distributor from
 the pictured fractal distributor from
 Amalgamated Research, Inc.

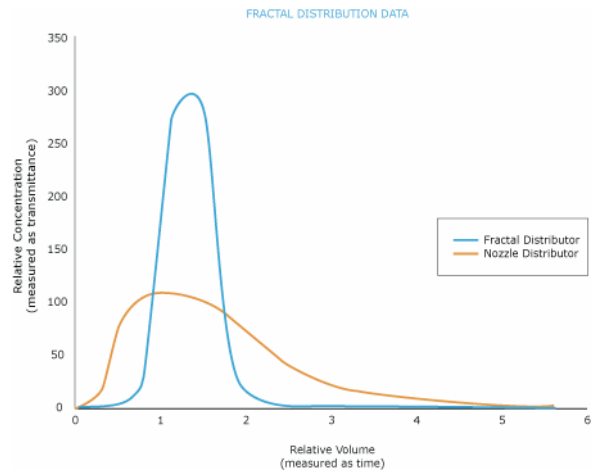


FIGURE 3a: FIGURE 3b:
 Fractal distribution/Conventional distribution



Most brine waste in ion exchange processes is the result of poor distribution, which leads to mixing of the brine fraction and rinse fractions of the regenerant streams. This mixing creates larger volumes of diluted regenerant solution and thus more waste. The fractal distributors used in the Advanced Amberpack™ Municipal System yield near perfect plug flow, greatly reducing this mixing between fractions and reducing the waste to near theoretically low levels. Figures 3 and 4 show the plug flow capabilities of fractal distributors versus conventional distributors.

FIGURE 4:
 Fractal distribution data



Additional features also contribute to the low waste performance of the system: the flat head design practically eliminates the excess water retained in typical dished head pressure vessels and the recovered rinse water tank allows further decrease of the service waters.

Simple and modular system

In addition to low waste generation, the Advanced Amberpack™ Municipal System is notable for its simple and modular design. While the basic components remain constant, the Advanced Amberpack™ Municipal System can be adapted to specific customers needs based on distinct potable water treatment specifications. Vessels can be operated independently and in parallel. Two to four vessels are required depending on the flow rate:

- 60 m³/h (260 gpm) : 2 small vessels;
- 120 m³/h (520 gpm) : 3 small vessels;
- 180 m³/h (780 gpm) : 4 small vessels.

Each vessel requires only 4 simple valves. The entire process is automated and controlled with an operator-friendly touch screen Programmable Logic Controller (PLC).

Small footprint

Minimizing the excess volume in the vessel design of the Advanced Amberpack™ Municipal System results in relatively small vessels. When skid mounted, the footprint

- of the service vessel skid is 3.5 m by 1.8 m for a 2 vessel unit (12.5 ft by 5.9 ft);
- of the regeneration skid is 3.5 m by 2.2 m (12.5 ft by 7.2 ft).

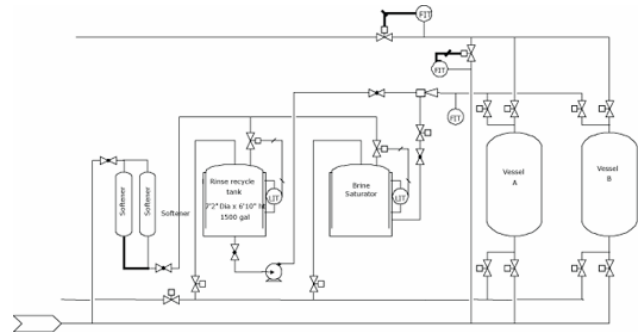
The system is only 3 m (10 ft) tall. This low profile and small footprint allow for placement onto small well sites in a manner that is unobtrusive to the local community. This can save on land and building costs for new well sites.

Other characteristics

The Advanced Amberpack™ Municipal System is a packaged ion exchange plant with packed bed columns. The vessels are designed to receive the raw water in the bottom, treat it in a up-flow direction and discharge it through the top of the vessel. All process water piping is DN100. Brine and rinse streams enter the top of the vessels, flow in a down-flow manner, and exit the bottom through DN50 piping. The requirements to run an Advanced Amberpack™ Municipal System are a feed water quality with less than 1 ppm suspended materials and 6 bar pressure (87 psi) and a standard electric power connection. The skid is available built according to European standards or US standards.

Figure 5 shows a schematic diagram of a typical Advanced Amberpack™ Municipal System. A calculation model is available to help Rohm and Haas customers forecast system performance and brine consumption, based on an analysis of their water.

FIGURE 5:
Schematic diagram of a two tank system



Full scale plants using the fractal technology are already operating successfully in France, the UK and in the USA.

More potable water applications

Rohm and Haas has a portfolio of products for removal of contaminants from potable water. Contaminants targeted by the selective media include nitrate, perchlorate, arsenic, boron, radium, uranium, heavy metals, mercury, organics and chromate.

The Advanced Amberpack™ Municipal System is currently available for the selective removal of nitrate. In the future, the Advanced Amberpack™ platform will be expanded to include additional potable water needs in conjunction with the Rohm and Haas portfolio of contaminant selective media.

In addition to brine waste reduction efforts, Rohm and Haas is actively developing systems that will allow municipal customers to engage in other sustainable development initiatives. Rohm and Haas is currently conducting a field trial of its Residuals Management system for Nitrate Destruction. When commercial, this modular system will work in tandem with the Advanced Amberpack™ Municipal System for nitrate removal to provide a complete residuals management solution to municipalities.

FIGURE 6:
Advanced Amberpack™ Municipal System
for nitrate removal in California (USA).



For more information on the Advanced Amberpack™ Municipal System for nitrate removal, Rohm and Haas contaminant selective media or the Residuals Management system for Nitrate Destruction, please contact your local Rohm and Haas Company representative.

About Rohm and Haas Company

Leading the way since 1909, Rohm and Haas is a global pioneer in the creation and development of innovative technologies and solutions for the specialty materials industry.

The company's technologies are found in a wide range of markets including: Building and Construction, Electronics, Food and Retail, Household and Personal Care, Industrial Process, Packaging, Paper, Transportation and Water. Our innovative technologies and solutions help to improve life everyday, around the world.

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Ion exchange resins and polymeric adsorbents, as produced, contain by-products resulting from the manufacturing process. The user must determine the extent to which organic by-products must be removed for any particular use and establish techniques to assure that the appropriate level of purity is achieved for that use. The user must ensure compliance with all prudent safety standards and regulatory requirements governing the application. Except where specifically otherwise stated,

Rohm and Haas does not recommend its ion exchange resins or polymeric adsorbents, as supplied, as being suitable or appropriately pure for any particular use. Consult your Rohm and Haas technical representative for further information. Acidic and basic regenerant solutions are corrosive and should be handled in a manner that will prevent eye and skin contact. Nitric acid and other strong oxidizing agents can cause explosive type reactions when mixed with Ion Exchange resins. Proper design of process equipment to prevent rapid buildup of pressure is necessary if use of an oxidizing agent such as nitric acid is contemplated. Before using strong oxidizing agents in contact with Ion Exchange Resins, consult sources knowledgeable in the handling of these materials.

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