Special Media:

Part 2 of 2

New Anion Exchange Resin—Polyvinylpyridine—Offers Options for Emerging Contaminants Remediation and Other Applications

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Summary: *With increasing scrutiny by regulatory officials of health risks associated with heavy metals and difficulty of removing many anion forms of these contaminants from drinking water, properties of a new resin emerging in this market offer some advantages. This is the second in a two-part series on special media.*

Strongly basic anion exchange resins were introduced to the field of water conditioning and purification in the late 1940s and rapidly became important tools in the industry.[1] Their persistent, positively charged active sites create the ability to remove undesirable, negatively charged species from water over a wide pH range providing an unparalleled technology for color/tannin reduction and water demineralization. These applications continue to account for the majority of strong base anion resin volume used in water treatment today.

However, the dramatic changes in the regulatory environment for water treatment over the past 25 years under the Safe Drinking Water Act (SDWA) have driven anionic contaminant removal to become an increasingly important segment of the industry. Arsenate, bromate, chromate, nitrate and perchlorate are among the anions finding their way onto lists of emerging drinking water contaminants at the U.S. Environmental Protection Agency (USEPA) and some state health departments. In fact, the chemistry of these problem ions and extremely low maximum contaminant levels (MCL) mandated by regulation are allowing anion exchange processes to compete for best available technology status with more traditional water purification methods, such as coagulation, filtration and adsorption to name a few. Every level of the water treatment marketplace— residential, commercial and municipal systems—holds opportunities.

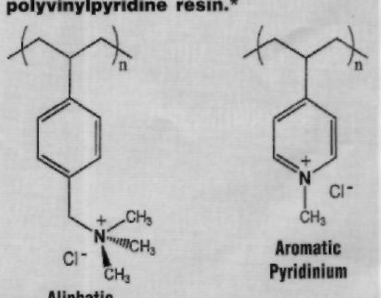
New chemistry for anion exchange

A significant portion of the advances in ion exchange technology enabling it to challenge traditional methods has been in design and process engineering. The most fundamental chemical aspects of strongly basic anion exchangers have only changed modestly in five decades. The resins typically used are standard polystyrene gel-type anion resins similar to those originally developed years ago. Admittedly, the resins themselves have improved. They now can be obtained in gel form or macroporous, as Type I or Type II, as polystyrene or acrylic based, and sulfate or nitrate selective—but chemically, the active sites of the resin have remained aliphatic quaternary ammonium groups (see Figure 1). These basic units provide the positive charges necessary for the polymeric resin to function as a negative ion exchanger.

Quaternary ammonium groups are not the only means of incorporating persistent positive charges in polymers. An advance in this aspect of ion exchange technology was the development of aromatic quaternary pyridinium resins (see Terminology). The basic building block of these polymeric materials is the vinylpyridine monomer. The basic structure can be seen in Figure 1.

Vinylpyridine is an organic chemical with an intrinsic, aromatic amine group that provides functionality to polymers containing the compound. Unlike the pendant amine groups that "hang" from the polymeric backbones of standard resins, the nitrogen atom of vinylpyridine's amine is an inherent part of the pyridine ring structure. Chemical modification of the pyridine sites of the polymer yields positively charged, strongly basic pyridinium active sites for anion exchange applications. The

Figure 1. Quaternary amine sites of a Type I polystyrene resin and a polyvinylpyridine resin.*



* Shown with chloride counter ions.