By Rick Andrew

PERCHLORATE REDUCTION

CLAIMS IN THE NSF/ANSI DWTU STANDARDS

Perchlorate has been the "contaminant du jour" in the water treatment community recently. NSF has received many inquiries regarding potential treatment technologies for perchlorate and their effectiveness and safety. This article summarizes the current state of efforts to address this hot topic from the point of view of the NSF/ANSI Drinking Water Treatment Unit (DWTU) Standards.

Perchlorate takes the form of an anion when dissolved in water (ClO_4). Anions may be treated in water by application of reverse osmosis (RO), ion exchange or distillation. There are many point-of-use (POU) RO systems available through retail outlets and from water treatment dealers. Dealer-distributed point-of-entry (POE) anion exchange resin systems are currently available in the marketplace, as well as POU distillation systems.

How Successful is Perchlorate Treatment?

Without recognized standard test protocols and third-party certification, it is difficult to know how well these devices perform and how safe they are without actually monitoring and analyzing specific installations. This approach of monitoring installations can be expensive because sample collection and analysis are required, along with professional interpretation of results. Data from specific installations may be difficult to extrapolate to predict results of similar treatment approaches at other locations that may have different levels of contamination or water chemistry.

NSF/ANSI DWTU Standards Evolve to Address Perchlorate

The increasing frequency of perchlorate-related inquiries to NSF by regulators, manufacturers and consumers began in 2002. These inquiries focused on perchlorate reduction performance and safety of various POU and POE DWTU systems. NSF shared this trend with the NSF Joint Committee on Drinking Water Treatment Units, the group responsible for development and maintenance of the NSF/ANSI DWTU Standards. The group recognized the importance of the issue and moved forward to address it.

NSF/ANSI 58—RO Systems

NSF initially developed a protocol for establishing perchlorate reduction performance of POU RO systems. NSF conducted validation testing and evolved the protocol to conform to the wishes of various stakeholders. Ultimately, in 2003 the Joint Committee adopted this protocol into NSF/ANSI 58 for RO systems. The requirements for perchlorate reduction in Standard 58 are described in Table 1.

Change Proposal

Currently, there is a proposal before the Joint Committee to revise the influent challenge level to 0.10 mg/L and the maximum allowable product water concentration to 0.006 mg/L. This proposal was sparked by research done by a manufacturer and conversations between the manufacturer and the California Department of Health Services (DHS). California DHS indicated that if available POU RO technology can achieve this minimum level of performance, it will be useful for many consumers in California who are faced with perchlorate contamination issues. The proposal is expected to be resolved in the end of 2004.

NSF/ANSI 53—Anion Exchange Systems

There are two unique aspects of anion exchange systems for perchlorate reduction that must be addressed from a Standards point of view—the potential for "nitrate dumping," and the issue of the potentially high capacities for perchlorate reduction that these systems will achieve. Due to these technical issues, the Joint Committee authorized formation of a task group to investigate and recommend specific approaches to develop requirements

Table 1. NSF/ANSI 58 Requirements for Perchlorate Reduction

Contaminant	Influent challenge level[1] mg/L	Maximum allowable product water level mg/L	U.S. EPA method(s)	Compound
Perchlorate	0.13	0.004	314.0	$NaClO_4$

Sodium perchlorate is added to the TDS influent challenge water as specified in NSF/ANSI 58-2004 to achieve the influent concentration specified in this table.

[1] Average influent challenge levels shall be specified with a tolerance of ± 10 percent.

Table 2. NSF/ANSI 53 Issues for Perchlorate Reduction Requirements

Issue	Possible Approach
Potential for "nitrate dumping"	1. Include nitrate in the perchlorate challenge water. Analyze for nitrate in the effluent. Require that nitrate not exceed a maximum allowable level. Include language in the product literature to inform consumers about the implications of treating water containing nitrate by anion exchange. 2. Include an option for systems to conform to "low nitrate" applications only. Include language in the product literature to inform consumers about the implications of treating water containing nitrate by anion exchange.
High capacity	1. Test to less than 200 percent of rated capacity. 2. Test smaller systems and scale results to larger systems. 3. Use modeling software to establish capacity.

for Certification of anion exchange technologies for perchlorate reduction under Standard 53. This task group was formed in 2003 and has made significant progress to date.

Anion exchange resins vary in their selectivity for perchlorate. Some anion exchange resins are highly selective, whereas others are less selective for perchlorate and may be influenced by other anions. If these other anions are present at high concentrations, it is possible that they may exchange onto the resin, and then be "dumped" in favor of those ions for which the resin is more selective as the resin becomes saturated. All of this may occur before the resin is exhausted in terms of the amount of perchlorate that will exchange.

This potential for dumping is of particular concern with respect to nitrate for several reasons: Nitrate tends to occur in waters that are contaminated with perchlorate; it tends to be present at relatively higher concentrations than perchlorate; and can be an acute health effects contaminant at high enough levels.

Therefore, the task group must address the potential of anion exchange systems to cause high levels of nitrate to occur in treated water through "nitrate dumping."

System capacities for POE systems are expected to be very high. All chemical reduction testing requirements currently included in Standard 53 involve testing up to 200 percent of the manufacturer's rated capacity, and cycling the system on and off on a prescribed schedule. There is concern by several manufacturers that the high capacities of anion exchange systems will result in lengthy tests that will not only be time consuming, but expensive as well.

In order to address the concerns over testing, the task group has been discussing some innovative possible solutions. The solution that the group feels is most likely to win support in the Joint Committee involves testing of scaled down units and scaling up results, but some task group members believe that the limited degree of scaling that will be achievable will not result in acceptable test lengths or costs. Other, less familiar approaches are also being discussed. One approach would utilize modeling to a large degree as opposed to testing. Because testing has always been the solid foundation of the NSF/ANIS DWTU Standards, this approach would require a great deal of supporting data and rationale in order to win support from the Joint Committee.

These issues and potential resolutions are summarized in Table 2.

NSF/ANSI 62—Distillation Systems

Although not yet underway, requirements will need to be developed for perchlorate reduction for distillation systems under Standard 62. It is likely that an approach similar to the one used to develop the requirements for RO systems under Standard 58 will be sufficient, as opposed to the involved task group approach required to address the technical issues with anion exchange resin systems.

Conclusion

The NSF/ANSI DWTU Standards are in a constant state of flux. The most common and important reason for this evolution is that new technologies emerge to address new water contamination issues on a regular basis. Recent examples of contaminant reduction requirements added to the NSF/ANSI DWTU Standards include MTBE, radon, arsenic and perchlorate. Additional work lies ahead to complete the adoption of requirements for trivalent arsenic reduction into NSF/ANSI 53.

As described in this article, work is underway by the Joint Committee and task groups to increase the scope of technologies and requirements for perchlorate reduction. The specifics of the contaminant and its properties, as well as the unique aspects of the treatment technologies, must be considered when developing these requirements. Measures must be taken to create a reproducible test protocol that addresses the technical concerns and product safety, and can be conducted within reasonable cost.

As this work on perchlorate reduction requirements proceeds by the expert volunteers of the Joint Committee and task groups, it is inevitable that we wonder, "will be the next 'contaminant du jour'?" *WQP*

About The Author
Rick Andrew is technical manager of the DWTU Program at NSF International, Ann Arbor, Mich. He has served in this role for more than two years, and has been with NSF's DWTU Program for more than five years. Andrew has a bachelor's degree in chemistry and a master's degree in business administration from the University of Michigan. He can be reached by E-mail at andrew@nsf.org.