Perfluorooctyl Sulfonates (PFOS): Treatment Options and Sampling Methods

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The ultimate degradation product of perflurooctyl sulfonates (PFOS) in the environment is perfluorooctanesulfonic acid (PFOSA), which has been found to be extremely stable in the environment and to bioaccumulate. These chemicals have been found in animals worldwide, including remote locations such as Siberia and Antarctica, and in international blood banks. Persistence, bioaccumulation and toxicity concerns led 3M, manufacturer of >95% of PFOS, to voluntarily phase out production. The U.S Environmental Protection Agency (EPA), believing that 3M was the sole manufacturer of PFOS, issued a proposed Toxic Substances Control Act (TSCA) Significant New Use Rule (SNUR) for 90 fully fluorinated sulfonate compounds (PFAS) manufactured by 3M, which EPA refers to collectively as "PFOS". The SNUR would have the effect of eliminating most manufacturing and importing of PFOS into the United States; TSCA Low Volume Exemptions (LVE) which would allow import of non-3M manufactured PFOS compounds have recently been denied.

The vast majority of PFOS chemicals are used in water-, grease- and stain-proofing applications. PFOS can be found in new clothes, new furniture, carpet, and even microwavable popcorn bags. Specialty chemicals are a smaller portion of the PFOS market and the semiconductor industry is a small user of PFOS specialty chemicals. When PFOS is used as a surfactant in semiconductor chemicals, it typically comprises <<1% of the chemical mixture; thus, it is not required to be listed on the material safety data sheet (MSDS). A survey conducted by the semiconductor industry identified PFOS in certain plating chemistries, Chemical Mechanical Planarization (CMP) chemicals, photoresists, developers, strippers, antireflective coatings (ARCs), buffered oxide etch (BOE) solutions, cleaning solutions, and in low dielectric constant spin on chemicals. Use of PFOS in chemically amplified resists and ARCs is critical to the properties and proper functioning of these chemicals.

Whenever possible, semiconductor manufacturers prefer to utilize alternative chemistries to PFOS; however, alternatives are not available for all uses. After a thorough analysis of PFOS uses and alternatives, the semiconductor industry requested an exemption from the proposed SNUR for resists and ARCs only, citing that other uses are not critical across the industry or that alternatives are immediately available.

The PFOS issue has led semiconductor manufacturers to investigate analytical methods for determining if these substances persist in facility exhausts or wastewater, and for industrial hygiene sampling. This paper will discuss how a semiconductor manufacturer may deal with the PFOS issue, including a review of possible waste streams, analytical methods for sampling, waste treatment options, and industrial hygiene sampling. It will also include results of industrial hygiene sampling conducted at one semiconductor manufacturing facility.