PREFACE

DEVELOPMENT OF NUCLEAR GAS CLEANING AND FILTERING TECHNIQUES

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Some requirements needed to filter off-gases of nuclear facilities are relatively stringent, compared to those used in conventional industries. In gas filtration, for example, traces of vapors with concentrations that are already extremely low in the filter supply air must be retained. (One case in point is ^{131}I, which normally occurs in concentrations of $<10^{-15}$ g/m^3 in the exhaust air of nuclear power plants.) Nevertheless, the removal efficiencies demanded and achieved are ≥99.9%. As a rule, filters are used for exhaust air and off-gas cleaning. These filters are composed of sorbents of impregnated activated carbon as a bulk granulate. For specific requirements, such as filtering NO_x-bearing off-gas from reprocessing plants or off-gases of a reactor containment in the event of a core meltdown accident, special inorganic nonburnable sorbents have been developed.

Development of off-gas filters has recently focused on the following:

1. improvement of the substances used to impregnate activated carbon
2. filter construction to achieve longer filter service life with sufficient removal efficiency
3. behavior of inorganic sorbents under extreme conditions.

The detection of radioiodine compounds with removal characteristics less favorable than those of the usual test substance (methyl iodide labeled with radioiodine) has also been studied, especially with regard to filtering radioiodine-bearing off-gases from chemical process steps in reprocessing and off-gas treatment after major reactor accidents.

The removal of radioactive aerosols by filtration from the exhaust air of nuclear installations also requires that minute particles (with diameters in the submicron range) be retained. Removal efficiencies of ≥99.97% are required and have been attained. However, damage to the usual high-efficiency particulate air (HEPA) filter cells often occurs.[1] In addition, the Organization for Economic Cooperation and Development has found that knowledge of the behavior of HEPA filters during prolonged operation and under accident conditions is extremely unsatisfactory.[2] More recent studies[3] have examined the behavior of these filters under loads caused by differential pressure, humidity, and temperature, leading to the construction of high-stability HEPA filters.

In a core meltdown accident, the pressurized atmosphere of the reactor containment must be vented through retention systems for aerosols and iodine. This restriction has resulted in new requirements for retention techniques, which differ according to the reactor type and the accident model. As a result, several countries have begun to develop retention techniques based on different retention concepts. Some facilities have already been equipped with retention systems, such as stainless steel filters, Venturi scrubbers, and gravel or sand bed filters.

Construction of a major civilian reprocessing plant on a site far from the coast implies stringent criteria with respect to radioiodine removal. A technique must be developed that permits efficient removal of radioiodines and transfer of ^{129}I, which has a half-life of 1.6×10^7 yr, to a repository storage. The necessary work has been associated with a major improvement in aerosol removal.

Another very specialized problem results from the need to develop HF-resistant aerosol filters for fuel fabrication plants. In this case, stability to acids is the decisive parameter. The problem is solved by introducing nonwoven polycarbon mats, which reduce the temperature stability.[4] The space requirement of contaminated filters and sorbents is increasingly important in waste storage and has led to new developments.

The papers in this special section describe some of the new developments in nuclear gas cleaning and filtering techniques.

REFERENCES

1. E. H. CARBOUGH, "A Survey of HEPA Filter Experience," *Proc. 17th DOE Nuclear Air Cleaning Conf.*, Denver, Colorado, August 1-6, 1982, p. 790, U.S. Department of Energy (1983).

2. "Air Cleaning in Accident Situations," Organization for Economic Cooperation and Development, Paris (1984).

3. V. RÜDINGER et al., "Development of Glass-Fiber HEPA Filters of High Structural Strength on the Basis of the Establishment of the Failure Mechanisms," *Proc. 19th DOE/NRC Nuclear Air Cleaning Conf.*, Seattle, Washington, August 18-21, 1986, p. 947, U.S. Department of Energy (1987).

4. W. ALKEN et al., "Development of a HEPA Filter with High Structural Strength and High Resistance to the Effects of Humidity and Acids," *Proc. 18th DOE Nuclear Airborne Waste Management and Air Cleaning Conf.*, Baltimore, Maryland, August 12-16, 1984, p. 1085, U.S. Department of Energy (1985).