High-Gradient Permanent Magnetic Separator for Particle Collection

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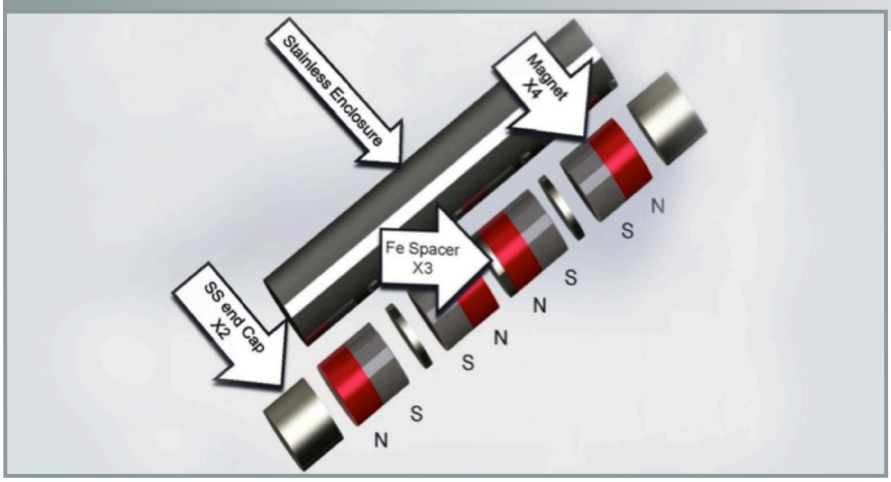

Technology Summary

If inhaled into the respiratory system, nanometer-sized particulate pollutants may cause adverse health effects in humans. Commercially available particle collectors can monitor ambient air quality, worker health and safety, and process manufacturing, whereas personal particulate monitors equipped with small vacuum pumps are available for use in exposure measurements. Researchers at ORNL developed a high-gradient permanent magnetic separator that is useful for particle collection. It can collect nanometer-sized particles with extremely high efficiency while avoiding the drawbacks of existing monitors and collectors, including size, cost, need for an external power source, and possible alteration of the particle state (such as a loss of water and/or volatile components) resulting in biased monitoring data.

The ORNL design uses two or more permanent magnets and spacers, and the physical process of magnetic separation exploits the differences in the materials' magnetic susceptibility. Like poles of each two-permanent-magnet pair are placed facing each other, as displayed in the figure, with spacers for separation. The magnet assembly may be enclosed in a casing of metal, plastic, or polymer. Permanent magnets are made from a magnetized material—generally a paramagnetic or ferromagnetic material—and create their own magnetic field, thus eliminating the need for an external power source.

Most rare earth oxides and actinide compounds are paramagnetic. Collection and concentration of actinides from water, air, or soil is useful for source identification in environmental monitoring, for soil decontamination, and for the detection of heavy metal contamination. Collection of aerosol particles by a high-gradient permanent magnetic separator relies on the attraction force resulting from imposing a magnetic field against drag and gravitational forces. Further development of a high-gradient permanent magnetic separator could result in its use for a wide range of applications as detector, collector, and high-throughput separator for particulate matter.

Advantages

- Collects particles smaller than 200 nanometers from any source (air, water, soil, etc.)
- Functions in low wind speed conditions and without an external power source
- Can be engineered to meet different needs/requirements
- Operates in both active and passive sampling modes

Potential Applications

- High-throughput detector, collector, and/or separator for air- or waterborne particulates
- Product development in instrumentation, drug, or chemical manufacturing
- Development of an advanced miniaturized passive aerosol collection system

Patent

Meng-Dawn Cheng, Larry R. Avens, and Gerard M. Ludtka. *Apparatus and Method of High-Gradient Permanent Magnetic Separator for Particle Collection,* Provisional US Patent Application 62/057,295, filed September 30, 2014.

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