Grant: AFC316-42
Title: Removal of DPM, Silica, and Coal Dust Using High Volume Fog Generation

Organization: Clemson University

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Partnerships: Lhoist North America, Joy Global, Inc.

Topic: Health and Safety Interventions
Priority Area: Respirable Dust

Problem Statement and Justification: The problem that will be addressed in the proposed research is the elevated risk of respiratory illness that exists for the mining work force, which is caused by exposure to airborne particles in the mining environment. In particular, diesel particulate matter (DPM) is a growing concern in metal/nonmetal mines where more than 18,000 miners work in approximately 200 underground mines. DPM is a significant concern since the particles formed are virtually all submicron in size and easily penetrate into the lung. Furthermore, DPM particles reside in the mining environment for long periods due to an essentially zero settling velocity. DPM has been classified as a known human carcinogen and chronic exposure increases the risk of cardiovascular, cardiopulmonary, and respiratory disease. Evidence continues to accumulate suggesting that diesel exhaust in general and DPM in particular increase the risk of cancer. Because DPM is mostly confined to the nanoscale particle diameters, methods for removing it from vehicular exhaust are challenging, since the particles have virtually no inertia at these small diameters, and inertia is an effective way to force particles to impact a filter or other type of impactor. Hence, effective removal of DPM and other nanoparticles must rely in the diffusive motion of these small particles. Since the characteristic length of diffusion tends to be small for the time scales of a particle traveling through a finite sized scavenging system, the overall process of removing nanoparticles can be problematic. Though the problem that is the focus of the proposed work is DPM, the resulting technology will be effective at removing nanoparticles of any type of particle, including coal and silica. Furthermore, since nanoparticles are the more challenging type of particle to remove, success in this small diameter range will also be easily translated to larger coal and silica particles as well. The proposed technology is therefore universal in that it is effective on any type of particle as long as the source is localized.

Impact of the Research: The specific aims of the proposed research are to develop what is referred to here as a "fog scrubber" which is a method whereby a very large number density of fog drops are generated and are combined with the DPM particles in diesel exhaust. By combining nanoscale DPM particles with the relatively large fog drops (5um to 10um in diameter), the DPM particles are effectively "packaged" in drops that can be removed via proven inertially-based particle removal technologies, specifically, a cyclone separator, thereby providing a device for reducing dust levels in mines. The research community's knowledge of how drops can be used to scavenge particles will be significantly developed by the proposed research.

Objectives and Research Approach: The major output will be a fog scrubber capable of removing particles down to the 10nm range. This will enable removal of these dangerous particles of all kinds from point sources. Gaps in our knowledge of how nanoparticles and drops interact will be addressed.