Project Title: **Electrically Driven Technologies for Radioactive Aerosol Abatement**
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RESEARCH OBJECTIVE

The objective of this research program is to develop an improved understanding of how electrically driven processes, including electrocoalescence, acoustic agglomeration, and electric filtration, may be employed to efficiently treat problems caused by the formation of aerosols during DOE waste treatment operations. The production of aerosols during treatment and retrieval operations in radioactive waste tanks and during thermal treatment operations such as calcination presents a significant problem of cost, worker exposure, potential for release, and increased waste volume. Electrically driven technologies offer promise as remote technologies for improved treatment; however, existing theoretical models are not suitable for prediction and design.

The basis for the project is the general fact that for most particulate collection technology, the marginal collection efficiency increases as the aerosol to be separated increases in size. Using this as a premise, we are investigating mechanisms for increasing the size of particles in an effluent stream as a preprocessing step. Our work is aimed at employing recent advances in theoretical approaches and experimental techniques to improve our understanding of how electrical and acoustic methods may be employed most efficiently alone or in tandem to tackle aerosol problems. The fundamental understanding achieved may provide the basis for development of innovative new approaches and for optimizing removal processes.

RESEARCH PROGRESS AND IMPLICATIONS

Following is a summary of the work after 22 months of a 3-year project. A coupled experimental/theoretical approach has been undertaken using resources available at UT-Austin and ORNL.

There is still an incomplete picture of particle-particle interactions in the presence of external fields. Design codes for agglomeration processes will require more accurate models. Unfortunately, the dynamics of acoustic and electric agglomeration of the aerosols of interest occur on length scales that cannot be readily examined under realistic conditions. To address this problem, we have designed and built a simple experiment involving spherical particles falling through a vibrating glycerin bath. Experimental conditions were designed to match those of acoustic agglomeration of aerosols. The apparatus was oscillated at a frequency of 10 Hz with peak-to-peak displacements on the order of 10 mm. Particles of varying densities and diameters (0.4 mm to 1.0 mm) were placed into the oscillating flow. Video images of the particle dynamics were captured with both a personal video camcorder and high-speed digital camera. In parallel, computations were performed for the particle system in order to validate the experimental method and apparatus. Results from this experiment have produced one journal publication and a master's thesis for Jason Carter.

To characterize the details of electrocoalescence, a unit reactor was constructed. The chamber has internal dimensions of approximately 10 cm x 10 cm x 2 cm. The chamber is made of acrylic with two copper plates forming the top and bottom surfaces. A high voltage DC electric field is formed in the space between the copper plates. Experiments have been performed to determine the sedimentation rate of aerosols suspended in the field. Comparisons are being made with theory.

An apparatus for measuring the simultaneous effect of electric and acoustic fields on flowing aerosols has also been constructed. The apparatus allows continuous measurement of aerosol size distribution in the range of 0.4 to 200 micrometers along a 1-m length of a 10-cm square duct using a Malvern Spraytec RTS5000 laser-scattering device. Preliminary experiments involving the application of an electric field indicate the effect of the applied field in coalescing the droplets at moderate field levels and breakup of droplets at higher levels.

Progress has been made developing modeling tools capable of efficiently simulating the interactions of aerosols in applied fields. The basis of the model is the continuous BGK-Boltzmann equation. The solution approach employs the discontinuous Galerkin finite element method for hyperbolic systems with an element-by-element solution strategy along characteristic lines of the system. These lines result from the underlying finite-dimensional velocity space, which allows organization of the solution strategy in terms of computational wave fronts (fig. 1).

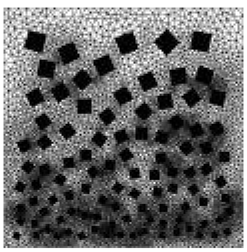
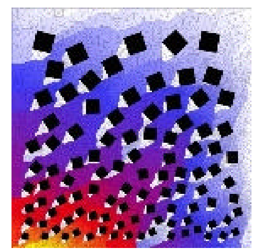


Figure 1. Tesselation of the space surrounding 100 aerosol particles of different sizes (*left*). Computational wave fronts in the (-1,-1) velocity direction (*right*). The color map indicates the elements per front in which physical information can be simultaneously processed.



In addition to the development of a novel lattice-free BGK-Boltzmann method, the motion of individual aerosol particles embedded in a fluid is planned to be incorporated through a Langevin-like equation.

PLANNED ACTIVITIES

We plan closely coupled experimental and theoretical work. Experiments will employ the apparatus described above to investigate particle-particle interactions at the fundamental level, and macroscopic particle agglomeration in flowing gas streams under applied fields. The experimental results will be compared with simulations for development and verification of design tools. In parallel with our research work, we will continue to develop contacts with potential end-users. We will attempt to run experiments in our experimental apparatus that match the aerosol characteristics and loading of important potential applications to determine relevance and feasibility for practical implementation.

INFORMATION ACCESS

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