

Background:

Particulate matter that is less than 2.5 microns in diameter (PM_{2.5}) is a target pollutant in the National Ambient Air Quality Standard and has been linked to human health issues. There is a major potential impact from particulate emissions on both the environment and the health of personnel in and around military installations and equipment powered by gas turbines. Therefore, finding methods of reducing or eliminating PM_{2.5} emissions from gas turbine engines is a high priority within the Department of Defense. The formation of particulate matter during the gas turbine combustion process is related directly to the fuel droplet size entering the combustion zone. The influence of mean droplet size on particulate emissions derives from the manner in which each individual droplet evaporates. Published data shows that droplet size reduction will have a first order effect on PM_{2.5} reduction. Electrostatic fuel atomization has the ability to generate ultra fine (<10 microns) droplet distributions with maximum self-dispersal qualities.

Objective:

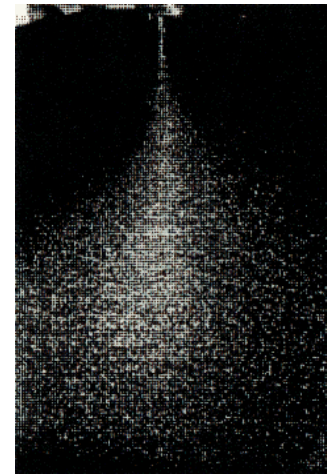
The purpose of this project is to develop electrostatic fuel atomization technology to achieve an 80 percent reduction in PM_{2.5} emissions from military gas turbine engines.

Summary of Process/Technology:

In an electrostatic fuel atomizer, two submerged electrodes are used to form a self-contained field emission electron gun assembly. The centrally located emitter electrode is positioned immediately upstream of a grounded orifice plate through which the fuel to be atomized exits. When a negative voltage is applied to the emitter, free charge is driven into the exiting fuel. The now charged fuel, once free of the confines of the device, automatically atomizes. Droplet development and dispersion is purely an electro-dynamic effect that is unencumbered by variations in fuel properties and flow rate. Aerodynamic or fluid dynamic forces are not involved, nor are they needed. The mean droplet size will be determined solely by the free charge density established within the fuel. Electrostatic atomization enables the electronic control of fuel droplet size and dispersion.

Benefit:

The self-dispersive mixing, enhanced droplet shattering, and narrow droplet distribution achieved with electrostatic atomization minimizes the PM_{2.5} formation paths resulting in dramatic reductions (80 percent) in particulate emissions. The atomizer is simple, rugged, compact, and low cost, which enables a "drop-in technology" that can be retrofitted to existing gas turbine engines. The insensitivity to flow rate and fuel properties offers maximum technology flexibility within the gas turbine community. The superior atomization provides robust combustion stability even at the lean and rich limits.



**Jet-A Fuel Exiting an
Electrostatic Atomizer**

Accomplishments:

This is an FY01 New Start project.

Contact Information:

Mr. David Guimond
Naval Surface Warfare Center
Carderock Division
Code 824
5001 South Broad Street
Philadelphia, PA 19112
Phone: (215) 897-8641
Fax: (215) 897-7564
E-mail: guimondp@nswccd.navy.mil