Title: **Innovative Coal Solids-Flow Monitoring and Measurement Using Phase-Doppler and Mie Scattering Technique**

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Grant Number:DE-FG26-06NT42743
Performance Period: January 2006-January 2009

OBJECTIVE(S)

Fuel flow to individual burners is complicated and difficult to determine on coal fired boilers, since coal solids are transported in a gas suspension that is governed by the complex physics of two-phase flow. Total fuel flow to the pulverizer is usually indicated by the gravimetric feeders and air flow into the pulverizer is measured by flow venturies or by other methods. The flow of air and coal can be easily controlled by damper position and speed control of the feeders, respectively. However, the distribution of the inhomogeneous coal solids suspension is difficult and depends on a lot of variables..

In this paper, laser based phase Doppler particle analyzer (PDPA) is used to measure the particle size and velocity. PDPA system is using Mie scattering theory which is the straightforward application of Maxwell's equations to an isotropic, homogeneous, dielectric sphere. The purpose of the experiments is to measure the particle size and velocity and analyze them using statistical method to see which factor will affect particle performance.

ACCOMPLISHMENTS TO DATE:

The preliminary particle testing using the laser-based phase Doppler particle analyzer (PDPA) was carefully prepared and conducted. To control the amount and rate of particles crossing the beams, the hopper system was designed and fabricated. The designed hopper is a simple, non-mechanical device using semi-transparent plastic material that offered an inexpensive, reliable powder dispensing solution. Powder is dispensed reliably and accurately. The flow rate is easily varied from a high rate to a trickle for accurate dispensing.

First, the size of sample organic particles is prepared of less than 150 microns. The particles were conducted in the experiment twice. The results were compared for reliability. The highest number of particles appeared between the particle diameter of 0~25 microns for the particle size of less than 150 microns. For the particle size of less than 150 microns, the first experiment showed the mean diameter of 17.73 microns while the second experiment showed diameter of 17.81 microns. For the particles with the size of less than 150 microns, the first result showed the mean of velocity of 0.23m/s while the second experiment showed the velocity of 0.36 m/s.

Second, the experiment was conducted with humid particles and fog particles. To generate humid particles, the humidifier was used. A small tygon tubing was connected to the humidifier to lead the particle flow to the intersection of the laser beam. The test results of the particle diameter indicated that, the mean diameter of humid particles is between 6.17 microns and 6.69 microns when the humid particle flow is low. When the humid particle flow is high, the mean diameter is between 6.67 microns and 7.19 microns. The test results of the particle mean velocity indicated that the mean velocity is between 1.34 m/sec and 1.46 m/sec at low humid particle flow. When the humid particle flow is high, the mean velocity is between 1.57m/sec and 1.79 m/sec.

The tested fog particle diameter is 5.77 microns. Compared with the humid particle diameter, the mean diameter of fog particles is smaller to the humid particles. The mean velocity of fog particles is 3.76 m/sec. Recently, seacoal powder with the size of 74 microns (mesh 200) is used to explore its characteristics.

FUTURE WORK

- Data measurements for coal powder using PDPA system will be continued.
- The particle characteristics including mean diameter and mean velocity of the different particles will be explored.
- The statistical method will be used to analyze the factors effecting the mean diameter and mean velocity of the coal particle.
- Mie theory will be applied to analyze the particle characteristics.

LIST OF PAPERS PUBLISHED, U.S. PATENT/PAPTENT APPLICATION(S), CONFERENCE PRESENTATIONS, AWARDS RECEIVED AS A RESULT OF SUPPORTED RESEARCH, STUDENTS SUPPORTED UNDER THIS GRANT:

1. Y. Huang, S. Lee, "The Advanced Instrumentation/Analysis on the Particle Characteristics Using Laser-Based Phase Doppler Particle Analyzer(PDPA)"(This paper is accepted to be presented at 14th Undergraduate & Graduate Research Symposium, April 19, 2007)
2. S. Zhu; S. Lee; "Prediction of Combustion Efficiency of Chicken Litter Using an Artificial Neral Network Approach", Journal of Fuel, Vol 86, Issue 86/56, PP. 877-886, 2007.

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