TITLE: **CHEMISTRY OF MERCURY SPECIES AND THEIR CONTROL IN COAL COMBUSTION**

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I. ABSTRACT

OBJECTIVES:
The objective of the proposal is to examine the chemistry of mercury in controlled high temperature environments to help develop emission control methodologies. The focus is to establish the speciation of mercury at different temperatures in environments containing oxygen, chlorine and sulfur. This understanding would be used to develop control methodologies for capture of mercury in combustion environments. The focus would be to use the novel gas phase sorbent precursor methodology (Industrial Engr. and Chem. Res., vol. 35, 792-798, 1996) for trace species control. The major advantage using such a methodology is that mercury can be effectively transformed to an environmentally benign form (low leaching characteristics) at low sorbent to metal ratios and captured in existing particulate control devices.

WORK DONE TO DATE (AND ACCOMPLISHMENTS):

- System to perform controlled experiments on Hg speciation and capture designed. Trace concentrations of mercury introduced into reactor and speciation between gas and aerosol phase established. Furthermore, elemental and oxidized fractions determined as a function of residence time and temperature.
- Collaboration established with USEPA to develop better analytical capabilities for mercury speciation in combustion exhausts.
- Mercury oxidation to form the oxides is slow, and aerosol transformation occurs at a very slow rate in temperatures ranging from 300 to 1000 C. Process not practical for mercury removal from combustion systems.
- Used gas phase sorbent precursors to generate high surface area/mass ratio agglomerates of sorbent oxides for control of mercury emissions. Characterized agglomerates by real time aerosol size distribution measurements, by xray diffraction and TEM.
- Established mercury removal efficiencies. Mechanistic pathway of mercury capture established: mercury vapors transported to high surface area agglomerate, and is physically adsorbed. Bonding enhanced by using uv irradiation. Ultraviolet radiation results in photoxidation of mercury to mercury oxide on surface of titania sorbent. Mercury capture significantly improved by use of titania sorbent in conjunction with uv irradiation, in comparison to without uv irradiation.
- Established the capture efficiency of mercury using titania sorbents in simulated flue gas streams

containing varying amounts of sulfur dioxide. It was established that sulfur dioxide occupies some of the active sites and mercury efficiency reduces at the same sorbent loading. However, increase the sorbent loading could bring back the efficiency to previous values.

- Experiments also performed with different in situ generated sorbents such as silica and calcium oxide. Mercury capture efficiency with silica very low; approximately 35% with Ca based sorbents; compared to 98.6% with Ti based sorbents.
- Experiments performed using the corona as a uv light source. The use of coronas in existing ESPs (if successful) would not require the use of external uv irradiation. The submicrometer particle collection characteristics on combustion of Ohio coals also established.
- Studies to establish the sorbent evolution characteristics in combustor performed. In situ sorbent oxide formation process can be engineered to obtain high surface area oxides (100 to 1000 m^2/gm). Sintering studies on sorbent oxides performed.

II. LIST OF PUBLICATIONS ACKNOWLEDGING USDOE SUPPORT

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Biswas P. and Zachariah M.R. "In situ immobilization of lead species in combustion environments by injection of gas phase silica precursors", Environ. Sci. Technol., 31, 2455-2463, 1997.

Yang G. and Biswas P. "Study of the sintering of nanosized titania agglomerates in flames using in situ light scattering measurements", Aerosol Science and Technology, 27, 507-521, 1997.

Wu C.Y. and Biswas P. "Particle Growth by Condensation in a System with Limited Vapor", Aerosol Science and Technology, 28, 1-20, 1998.

Wu C.Y. and Biswas P. "Study of Numerical Diffusion in a Discrete Sectional Model and Its Application to Aerosol Dynamics Simulation" to appear, Aerosol Science and Technology, 1998.

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Wu C.Y., Lee T.G., Tyree G., Arar E., Biswas P. "Capture of mercury in combustion systems by in situ generated titania particles and uv irradiation", to appear, Environmental Engineering Science, vol 2, 1998.

STUDENTS: Chang-Yu Wu (Ph.D., 1996); G. Yang (Ph.D., 1998) Teddy Lee and Ye Zhuang (Ph.D. Candidates); Glendon Tyree and Melynda Hazelwood (Summer Interns)