OHIO COAL DEVELOPMENT OFFICE
ANNUAL PROJECT ABSTRACT
AS OF DECEMBER 2004

1. PROJECT SPONSOR:
(entity name/mailing address)
University of Dayton Research Institute
300 College Park
Dayton, OH 45469

2. PROJECT MANAGER/TITLE:
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5. PROJECT TITLE: Surface Catalyzed Mercury Transformation Reactions

6. PROJECT TERM FROM: 1 Sept. 2004 **TO:** 30 Sept. 2005

7. PROJECT UPDATE xxx --OR-- **FINAL REPORT** _____

8. BUDGET:

CO-SPONSOR'S NAME	**COST-SHARE**
OCDO	$73,440
University of Dayton	$23,632
_____	$_____
_____	$_____
TOTAL PROJECT VALUE:	$97,072

ABSTRACT

The main goal of this project is to understand how fly ash surface affects speciation, partitioning, and reactions of mercury under the full range of combustor cool zone conditions. We have developed an experimental approach designed to sequentially determine the conditions under which surface assisted mercury transformation occurs, and specific parameter variations that can affect these transformation rates. Our experimental approach is based on our experience in a similar gas-surface reaction system; fly ash catalyzed organic pollutant (e.g., dioxin, furan) formations, where fly ash acts as a carbon source and as a catalyst. Fly ash is a complex surface, and in order to understand the fly ash mercury interactions in the combustor cool zone we have to design experiments that will allow us to divide overall surface-assisted mercury transformation processes into several manageable reaction systems. Therefore, in this proposed study we will use a model fly ash in a well-defined reaction system to first study formation of mercuric oxide and then mercuric chloride and then impact of various metals and flue gas components on formation of mercuric oxide and chloride. The composition of model fly ash would be based on the average composition of Ohio coal fly ashes. In this proposed study, experiments will be conducted using both fixed bed and entrained flow reactor systems. All experiments will be conducted using 6% O_2 in a helium mix as a reaction gas, and other reactants (HCl, SO_2, CO, H_2O) will be added as required. In each experiment the reactor

effluents will be split into three streams. One stream will be used for mercury speciation, the second stream will be used for chlorine speciation, and the third stream will be cryogenically trapped to be analyzed later using chromatographic and other stand alone techniques. After each experiment, model/real fly ash particles will be analyzed for mercury, chlorine, and specific metal species. The data generated in the proposed project will not only provide the information to develop better mercury control strategies, but will also provide fundamental data for mercury atmospheric transport and deposition models. We will also be studying the chlorine speciation and the impact of HCl, SO_2, and CO on mercury transformation reactions. The information generated in this proposed study should be broadly applicable to a variety of combustion sources.

9. OVERVIEW OF PROJECT & OBJECTIVES:

The main goal of this study is to investigate the mechanism of surface-assisted mercury transformation reactions in the combustor cool zone. To achieve this goal, we will investigate the interaction between $Hg^0(g)$ and fly ash particles under various reaction conditions. For this purpose, the five specific objectives have been established. During the first year the research will be focused on accomplishing the first two objectives listed below.

I. Investigate the role of fly ash metal constituents on mercury transformation reactions.
II. Determine the impact of CO, SO_2 and HCl concentration on mercury transformation reactions.
III. Investigate the interactions between fly ash carbon and fly ash metallic species and determine its impact on mercury adsorption.
IV. Investigate the role of CaO and $Ca(OH)_2$ in mercury adsorption and their interactions with post-combustion chlorine species.
V. Investigate impact of specific metallic species (Al_2O_3, Fe_2O_3, MgO, etc.) on chlorine speciation and its impact on overall mercury transformation.

Even though we know fly ash is responsible for catalyzing mercury transformation reaction and also adsorbing mercury, it is very difficult to elucidate the mechanism of any of these mercury transformation processes on fly ash. Fly ash is a unique and complex surface, as it constitutes carbon that can adsorb or catalyze and several metallic species that can catalyze. This situation is further complicated by the fact that fly ash particle composition and size distribution are different for different types of coals and different combustors. In order to simplify this complex reaction system, we will use model fly ash in a well-defined reaction atmosphere to first study the formation of mercuric oxide and then mercuric chloride and then the impact of various metals and flue gas components on the formation of mercuric oxide and chloride. This will provide information that can be used to estimate the extent of mercury transformation based on fly ash and flue gas composition. The other advantage of using model fly ash is that we will have a well-characterized surface with a known composition. This will be immensely helpful, because at present we are unable to distinguish mercuric chloride and oxide and therefore we need to know as many other variables as possible.

10. WORK TO DATE & CONCLUSIONS:

Based on the suggestion of the advisory committee it was decided that before starting experiments with model fly ash a preliminary data on mercury transformation reactions should be obtained using the real Ohio coal fly ashes (Task 4). The results from this experimental task will help determine the range of catalytic activity of Ohio coal fly ashes in mercury transformation reactions. To accomplish this task ,four different coal fly ashes were obtained from AEP. These AEP fly ashes have been characterized and the experiments are under way to test their catalytic activity in mercury transformation reactions.

11. PLANS FOR COMING YEAR:

In the coming year we will evaluate the catalytic activity of the four Ohio Coal fly ashes with respect to mercury oxidation and chlorination. The obtained catalytic activity will then be

correlated with fly ash composition.

12. HIGHLIGHTS/ACCOMPLISHMENTS:

The project was initiated in September 2004 and as of yet there are no highlights to report.

13. ARTICLES/PRESENTATIONS:

A presentation was given at the *2004 Ohio Air Quality & Coal Research Symposium*. The title of the presentation was "Surface Catalyzed Mercury Transformation Reactions." The talk was given by Sukh Sidhu.