MERCURY FLUX IN COAL UTILIZATION BY-PRODUCTS

NATALIE J. PEKNEY, Donald Martello, Karl Schroeder, and Evan Granite

National Energy Technology Laboratory, US DOE, Pittsburgh, PA

INTRODUCTION

- Examination of the fate of mercury in coal-based power plants, including stability of mercury in by-products, is aligned with the need to develop cost-effective control technologies to address the mercury regulations
- As mercury is increasingly removed from the flue gas due to the regulations, it will likely be captured in by-products
- Coal utilization by-products (CUBs) currently find use as gypsum for wallboard production, cement, soil amendments, and flowable fill among other uses
- All of these end products must be environmentally safe and therefore the effects of mercury release must be examined
- Mercury release mechanisms from CUBs under typical management practices would include leaching, vapor release, and microbiologically mediated release

INTRODUCTION

- Recent research has suggested that coal fly ash does not emit significant amounts of mercury through volatilization
- However, there have been relatively few studies of atmospheric release of mercury from CUBs, and the effects of increasing mercury concentrations in CUBs due to removal from flue gas are unknown
- Initial experiments to measure mercury flux from CUBs, presented here, involve a variety of CUB samples and were conducted under dark and dry conditions to eliminate effects on flux from light exposure and moisture content
- Future work will examine these effects

Project Objective: Measure the flux of mercury from coal utilization by-product (CUB) samples to determine the extent of mercury release or absorption under dark and dry conditions

EXPERIMENTAL APPROACH

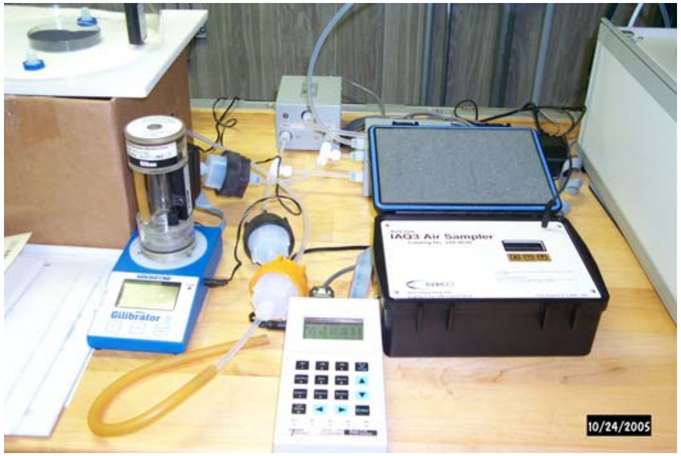
- The flux chamber consists of a Pyrex jar sitting on a Teflon plate on which the sample sits
- Temperature and relative humidity are continuously monitored inside the chamber
- Filtered ambient air is pulled through the chamber
- A Tekran measures mercury concentration of the air going into and coming out of the chamber in 10-minute intervals such that a flux measurement, *F*, can be calculated every 20 minutes

$$F = {(C_{outlet} - C_{inlet}) * Q}/{A}$$

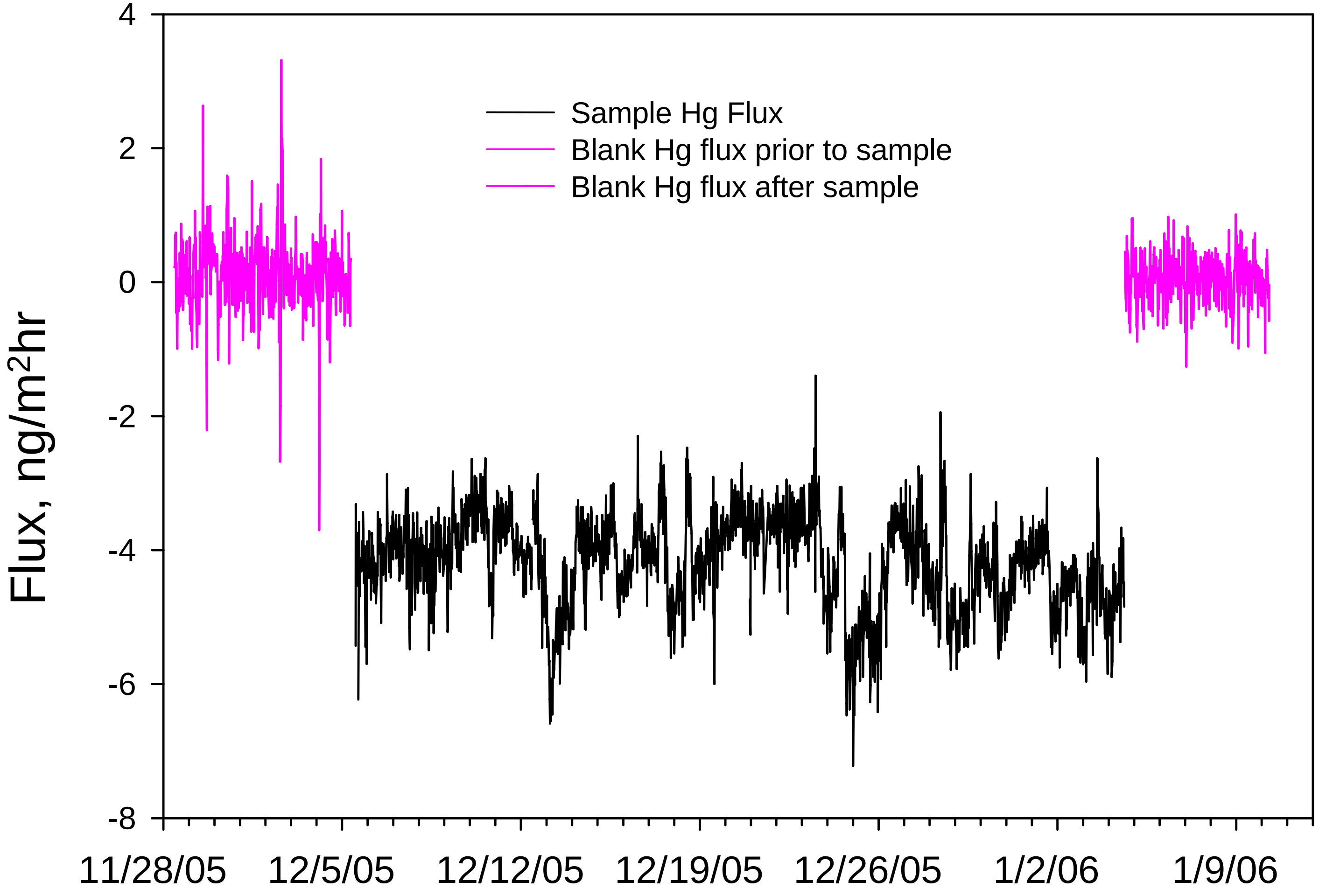
- Where C_{outlet} and C_{inlet} are the mercury concentrations of the air coming into and out of the chamber in ng/m^3, Q is the air flow rate in m^3/hr and A is the surface area of the sample in m^2


SKC
10/24/2005

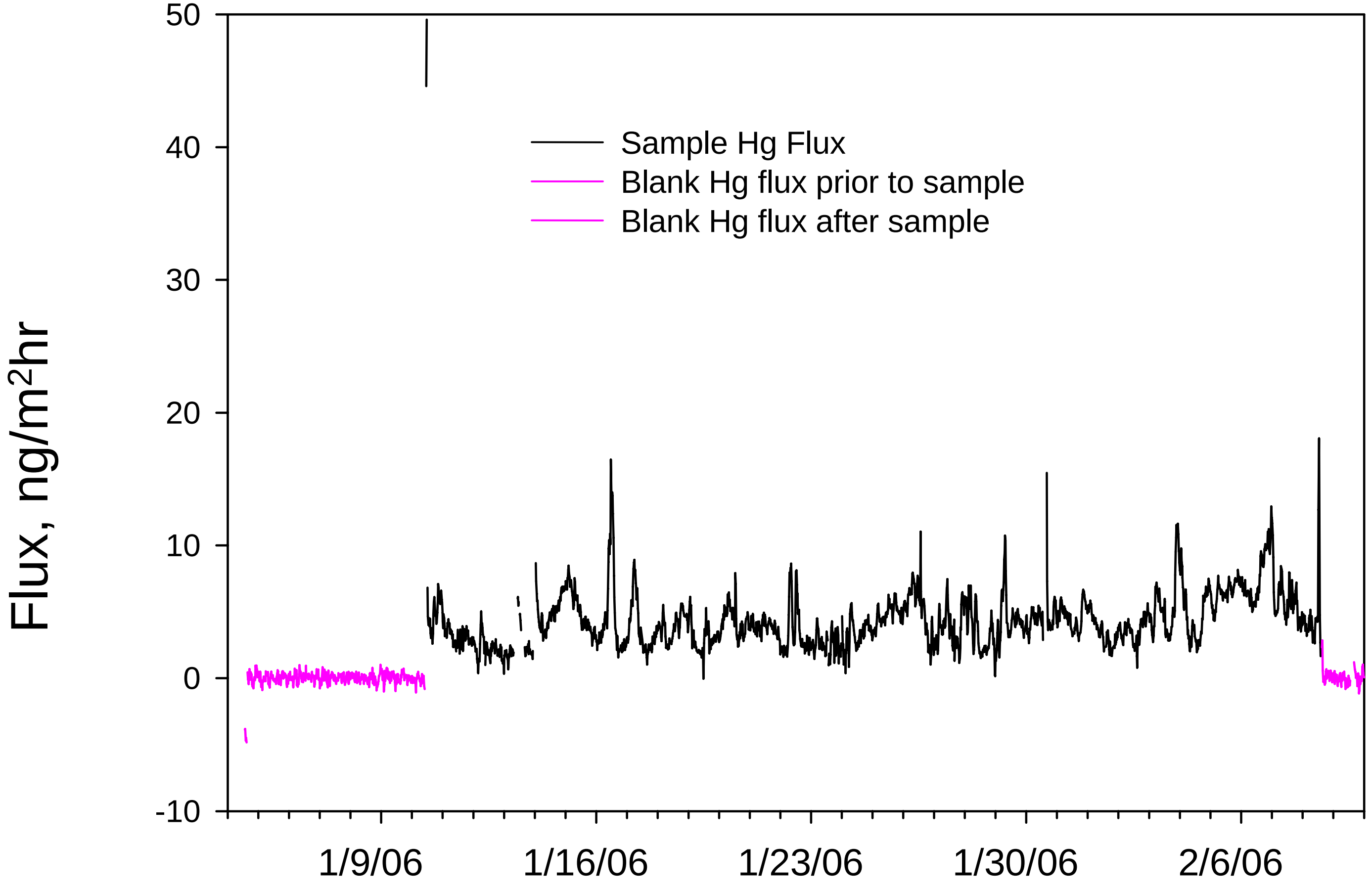

Tekran
MERCURY VAPOUR ANALYZER 2537A
10/24/2005


Gilibrator
IAQ3 Air Sampler
10/24/2005

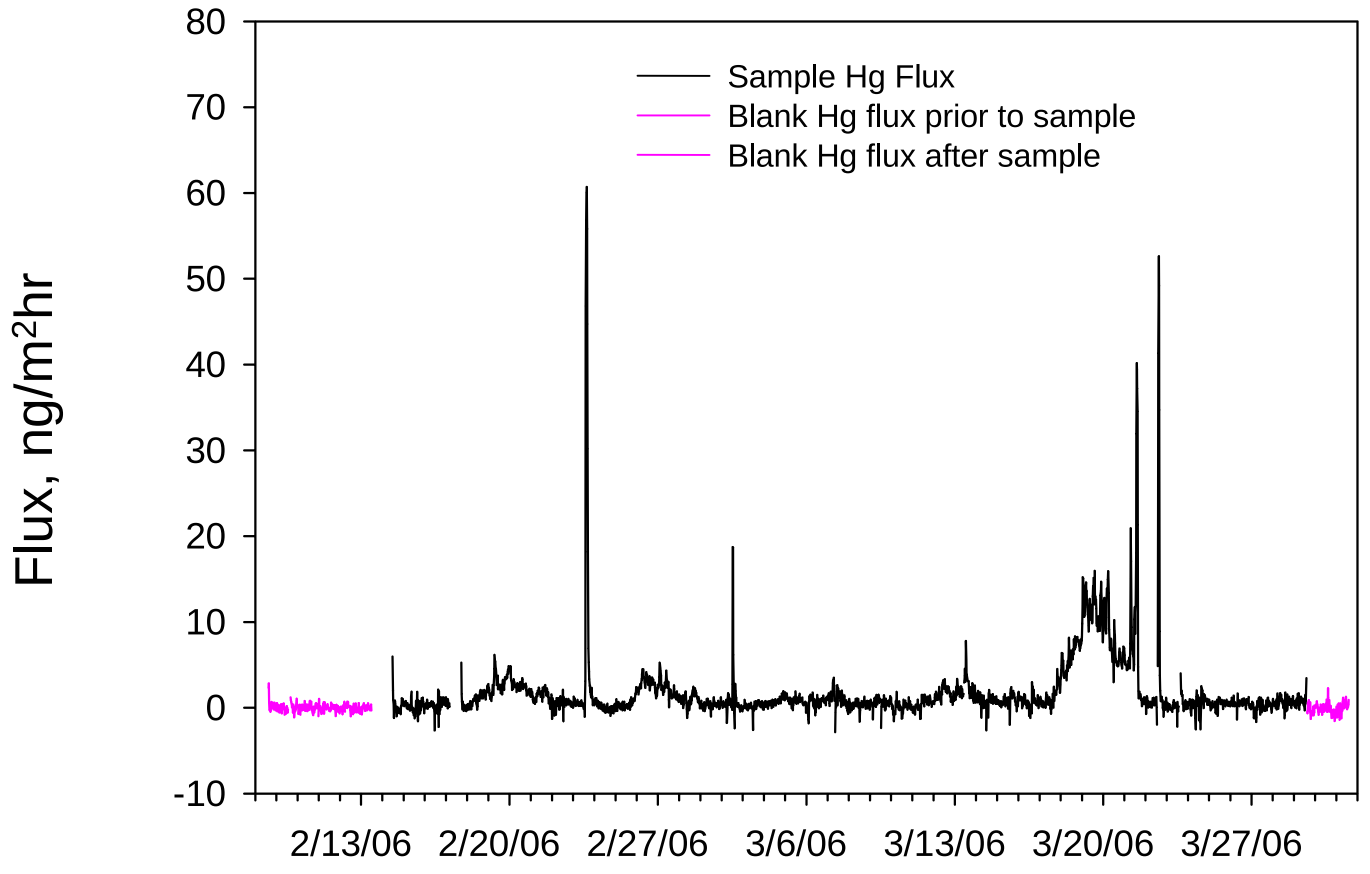
MERCURY FLUX FROM SAMPLE 1, BITUMINOUS COAL FLY ASH



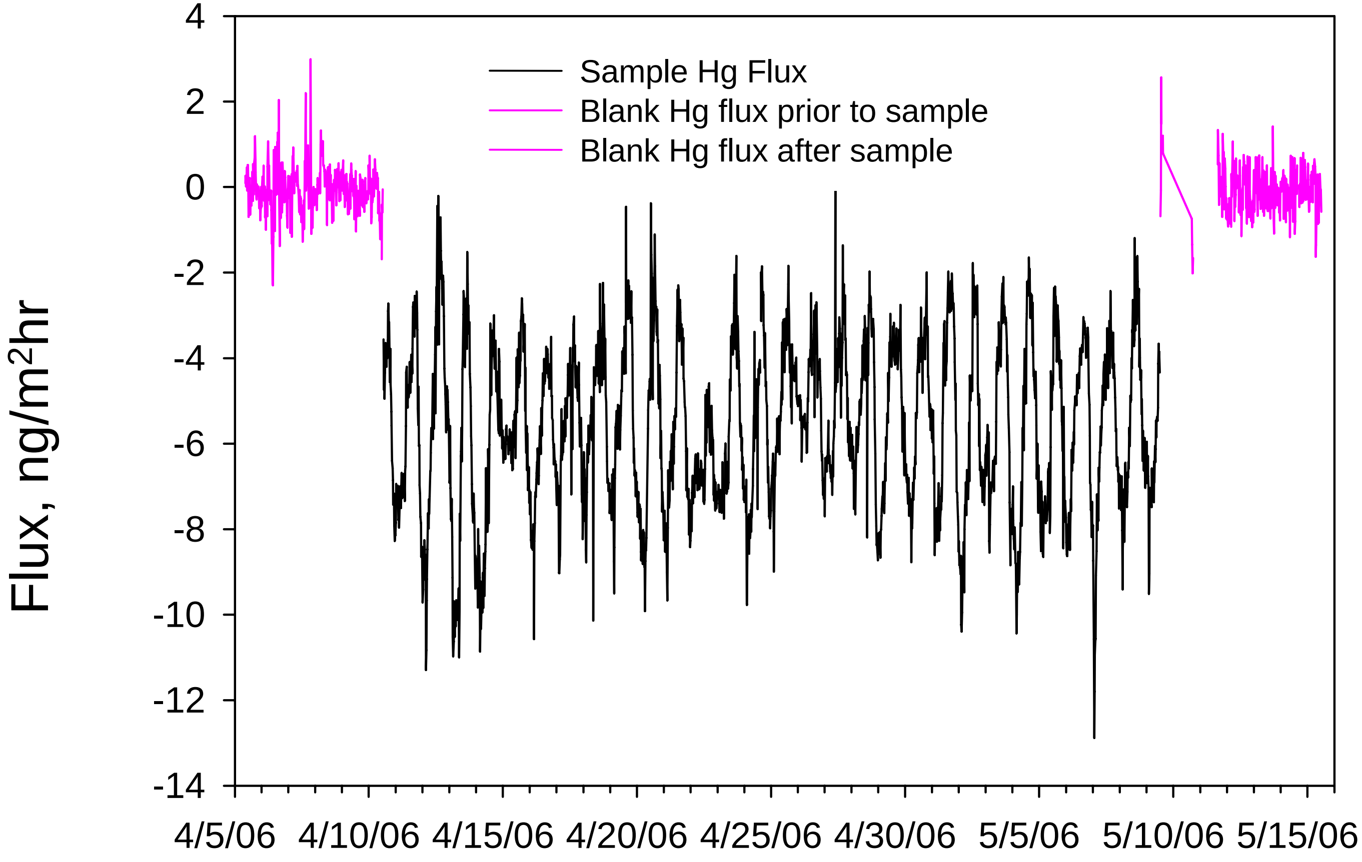
MERCURY FLUX FROM SAMPLE 2 – PRB COAL FLY ASH



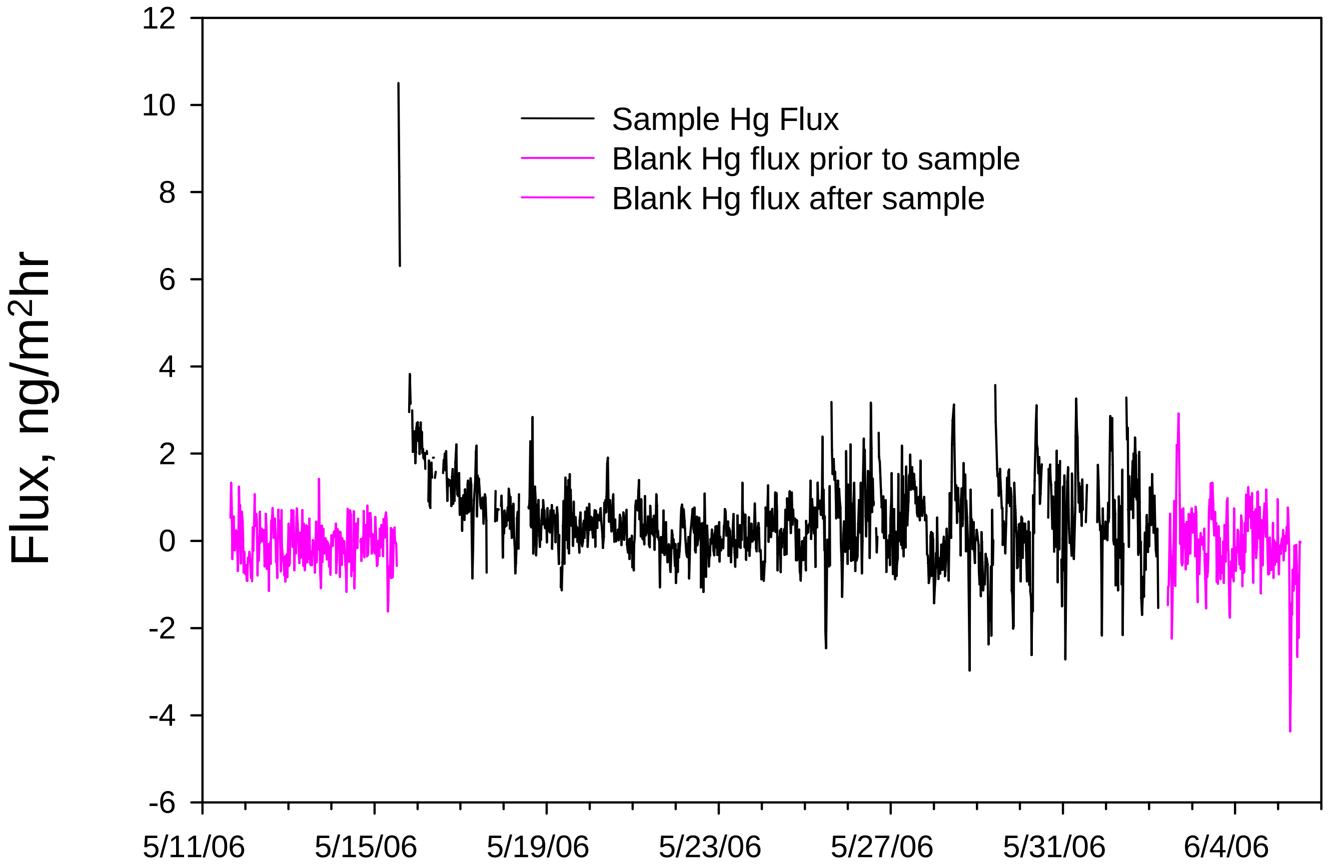
MERCURY FLUX FROM SAMPLE 3 – PRB/BITUMINOUS BLEND COAL FLY ASH



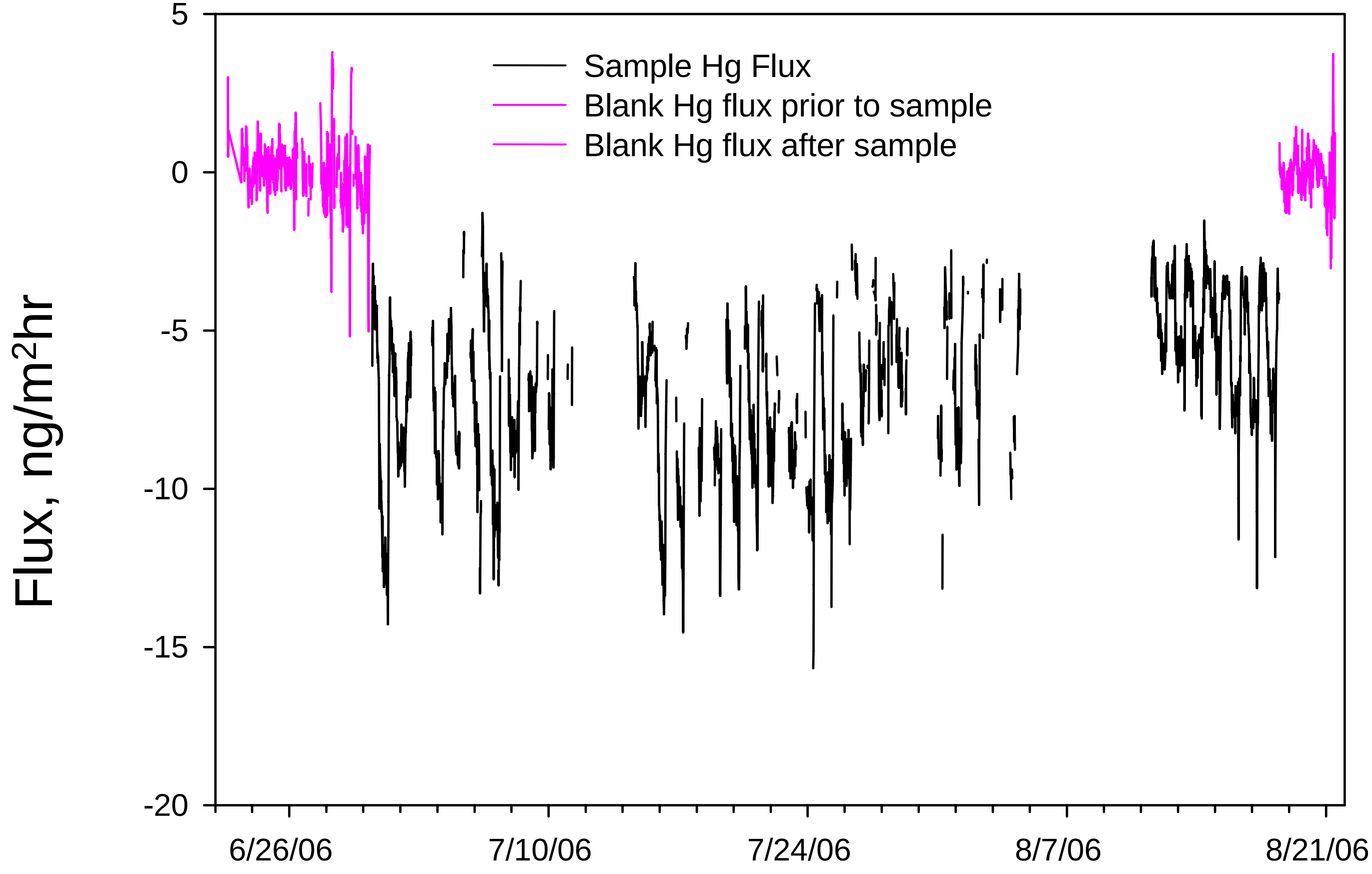
MERCURY FLUX FROM SAMPLE 4 – PRB/BITUMINOUS BLEND COAL FLY ASH



MERCURY FLUX FROM SAMPLE 5 – ND LIGNITE COAL FLY ASH



MERCURY FLUX FROM SAMPLE 6 – ND LIGNITE COAL FLY ASH



SUMMARY OF RESULTS

Sample Number	Type of Coal	Initial Hg Content (µg/kg)*	Final Hg Content (µg/kg)*	**Average Hg Flux (ng/m^2hr)***	Carbon Content (%)
1	Bituminous	1554(13.6)	1584(16.7)	**-4.19(0.70)**	6.955
2	PRB	251(12.1)	268(5.92)	**4.36(2.4)**	0.095
3	PRB/Bituminous Blend, no Hg controls	180(2.39)	191(4.00)	**1.78(4.2)**	1.89
4	PRB/Bituminous Blend after ACI	1127(38.9)	1020(76.4)	**-5.62(1.9)**	3.32
5	ND Lignite, no Hg controls	2.46(0.419)	4.55(1.39)	**0.50(1.0)**	0.97
6	ND Lignite, after ACI	420(7.84)	415(4)	**-6.82(2.6)**	1.21

*Standard deviation given in parenthesis.

- Samples 1 & 2 are from the DOE-NETL fly ash inventory
- Samples 3-6 are paired samples from the DOE-NETL Phase 2 Program. Samples 3 & 4 are paired with 3 representing no mercury controls and 4 representing conditions after mercury controls (activated carbon injection). Samples 5 & 6 are paired with 5 representing no mercury controls and 6 representing conditions after mercury controls (activated carbon injection).

CONCLUSIONS

- Some samples released mercury while others absorbed mercury, but all levels of release or absorption are quite low
- Phase 2 samples show differences from baseline (no mercury controls) to controlled (ACI) conditions
  - Samples 3 & 4: small amount of mercury released from baseline sample, while controlled sample absorbs mercury with a diurnal pattern similar to that of temperature inside the chamber
  - Samples 5 & 6: neither absorption nor release for baseline sample, while controlled sample absorbs mercury with a diurnal pattern similar to that of temperature inside the chamber
- Mercury release/absorption did not appear to be related to initial mercury content
- Temperature influenced mercury flux for some samples
- Samples with higher carbon content tended to absorb mercury
- Future experiments will vary light exposure and moisture content of the sample to determine effects of these conditions on the mercury flux

Disclaimer

Reference in this report to any specific commercial product, process, or service is to facilitate understanding and does not necessarily imply its endorsement or favoring by the United States Department of Energy.