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INTRODUCTION

This project is divided into four tasks. We developed our Management Plan in Task 1. Task 2, Evaluation of Mechanisms in FGD Sorbent and Ash Interactions, focuses on characteristics of binary mixtures of these distinct powders. Task 3, Evaluation of Mechanisms in Conditioning Agents and Ash, is designed to examine effects of various conditioning agents on fine ash particles to determine mechanisms by which these agents alter physical properties of ash. We began Tasks 2 and 3 with an extensive literature search and assembly of existing theories. We completed this phase of the project with publication of two special Topical Reports. During the past quarter we continued our analyses of the samples in our database. We will be continuing these laboratory analyses through the next three quarters. Pilot-scale evaluations will follow these laboratory investigations. We will include the results of laboratory and pilot-scale work performed under Tasks 2 and 3 in a Flue Gas Conditioning Model that we will issue under Task 4. The Final Report for the project will also be prepared under Task 4.

Task 2 and Task 3 each include several groups of experiments. Each experiment has a title and a corresponding number. We described these experiments and tests that are included under each experiment in our fourth Quarterly Report (April - June 1992). In our literature reviews reported in Topical Reports 1 and 2, we emphasized the roles adsorbed water can have in controlling bulk properties of powders. The experiments we are performing are designed to define the extent to which water affects key properties of ashes, powders, and mixtures of sorbents and ashes. We have included selected data from prior quarterly reports in this report for the sake of completeness, and for comparisons with newly-acquired data. In several places in this report samples are referred to by their identification (SID) numbers. Table 1 provides a brief description of all the samples we have used in this project along with their SID numbers. (The second set of leached ashes are discussed under Experiment 3.4.)

Table 1
Identification of Samples

	SID	Description of Sample
SORBENTS	2870	Muskingum base line ESP hopper ash
	2871	DITF dry $\text{Ca}(\text{OH})_2$ injection
AND	2872	DITF $\text{Ca}(\text{OH})_2$ slurry injection
	2873	DITF $\text{Ca}(\text{OH})_2$ slurry injection with CaCl_2 addition
BASE LINE	2884	Kintigh base line ESP hopper ash
	2885	spray dryer ash (High Sulfur Test Center)
ASHES	2883	Edgewater furnace $\text{Ca}(\text{OH})_2$ injection
DUST CAKE	2101	Scholz dust cake ash
	2029	Monticello dust cake ash
ASHES	2515	Harrington dust cake ash
	1994	AFBC dust cake ash
LEACHED	2101-W	leached Scholz dust cake ash (first set)
	2029-W	leached Monticello dust cake ash (first set)
	2515-W	leached Harrington dust cake ash (first set)
DUST CAKE	1994-W	leached AFBC dust cake ash (first set)
	2101-L	leached Scholz dust cake ash (second set)
ASHES	2029-L	leached Monticello dust cake ash (second set)
	2515-L	leached Harrington dust cake ash (second set)
	1994-L	leached AFBC dust cake ash (second set)
POWDERS	1856	glass beads
	3063	silicon dioxide (Cabosil L-90)
	3064	silicon dioxide (Cabosil M-5)
	3065	silicon dioxide (Cabosil EH-5)
	3238	aluminosilicate (Neutralite)
	2769	silicon dioxide (Kenite 900)
	2874	alumina powder

SUMMARY

We performed a wide variety of laboratory analyses during the past quarter. As with most of the work we performed during the previous quarter, our recent efforts were primarily directed toward the determination of the effects of adsorbed water on the cohesivity and tensile strength of powders. We also continued our analyses of dust cake ashes that have had the soluble compounds leached from their particle surfaces by repeated washings with water. Our analyses of leached and unleached dust cake ashes continued to provide some interesting insights into effects that compounds adsorbed on surfaces of ash particles can have on bulk ash behavior.

As suggested by our literature review, our data indicate that water adsorption depends on particle morphology and on surface chemistry. Our measurements of tensile strength show, that for many of the samples we have analyzed a relative minimum in tensile strength exists for samples conditioned and tested at about 30% relative humidity. In our examinations of the effects of water conditioning on sample cohesivity, we determined that in the absence of absorption of water into the interior of the particles, cohesivity usually increases sharply when environments having relative humidities above 75% are used to condition and test the samples. Plans are under way to condition selected samples with $(\text{NH}_4)_2\text{SO}_4$, NH_4HSO_4 , CaCl_2 , organosiloxane, and SO_3 . Pending approval, we will begin these conditioning experiments, and subsequent analyses of the conditioned samples, during the next quarter.

TASK 2: ANALYSES OF MIXTURES OF SORBENTS AND ASHES

E 2.1 Standard Characterization of Mixtures of Sorbents and Ashes

During the past quarter, we began analyses on a sample of ash from the furnace injection of $\text{Ca}(\text{OH})_2$ that we received from Ohio Edison's Edgewater facility (SID 2883). We were hoping to obtain a suitable sample of base line ash (without any sorbent addition), and a sample of furnace injection of lignosulfonate-modified $\text{Ca}(\text{OH})_2$ from Edgewater before including this furnace sorbent injection ash in our data base. Unfortunately, the personnel who conducted the Edgewater tests were unable to provide us with either of these two ashes. However, all of our prior work under Task 2 has indicated that each type of sorbent addition process completely changes the characteristics of the particulate matter to be collected. The chemical and physical characteristics of the mixtures of sorbents and ashes dominate the original characteristics of the base line ashes. Therefore we believe that, although we do not

have base line ash or ash from the furnace injection of lignosulfonate-modified Ca(OH)_2 from Edgewater for analysis, useful information can be obtained from the analyses of ash from the furnace injection of Ca(OH)_2 at the Edgewater facility.

SEM pictures of the Edgewater furnace sorbent injection ash are shown in Figure 1. As with the other mixtures of sorbents and ashes, this sample apparently contains a mixture of relatively smooth, spherical ash particles and irregularly-shaped sorbent particles. Cumulative and differential size distributions of this sample are presented in Figure 2. The specific surface area of this sample is $4.2 \text{ m}^2/\text{g}$, and its true density is 2.59 g/cm^3 . The chemical characteristics of this sample are included in Table 2.

Table 2
Chemical Characteristics of Ashes and Sorbent and Ash Mixtures, % wt.*

SID	2870	2871	2872	2873	2884	2885	2883
LiO_2	0.05	0.02	0.02	0.03	0.03	0.01	0.01
Na_2O	0.57	0.27	0.46	0.59	0.62	0.67	0.17
K_2O	1.9	0.83	0.87	0.97	1.6	0.48	0.63
MgO	1.3	0.9	1.1	1.0	0.8	0.6	1.0
CaO	2.1	48.6	38.5	31.5	3.0	36.5	46.9
Fe_2O_3	20.7	8.2	8.0	9.1	20.9	4.1	10.5
Al_2O_3	22.9	9.9	9.7	11.1	24.1	7.0	7.9
SiO_2	48.7	20.9	20.0	23.1	46.9	12.4	16.2
TiO_2	1.0	0.6	0.5	0.5	0.9	0.3	0.40
P_2O_5	0.20	0.09	0.11	0.10	0.46	0.19	0.08
SO_3	0.33	9.1	20.3	21.1	0.23	36.0	13.9
LOI	1.1	12.5	12.3	6.1	4.9	6.2	13.6
soluble SO_4 =	0.78	10.4	24.2	25.3	0.76	43.8	17.4
Equilibrium pH	5.8	11.3	11.7	11.0	9.1	10.5	11.3

* Equilibrium pH is a dimensionless quantity

Chemical analyses of these samples show the expected relationships between calcium and sulfur (SO_3 and soluble sulfate) contents. Processes that have better sorbent utilization yield solids having higher sulfur content. The spray dryer sample indicates the highest sorbent utilization and the dry Ca(OH)_2 injection at the DITF the lowest. DITF samples show that

a

b

c

d

Figure 1. SEM photographs of the sorbent and ash mixture produced by the injection of Ca(OH)_2 into the furnace at Edgewater (SID 2883). These photographs were taken at magnifications of a) 100X, b) 500X, c) 1000X, and d) 5000X.

Figure 2. Cumulative and differential size distribution data measured with the Shimadzu Centrifugal Particle Size Analyzer for the Edgewater furnace sorbent injection ash (SID 2883). The MMD of this ash was determined to be 11 μm .

Ca(OH)_2 slurry with CaCl_2 has better utilization than slurry without the additive. The ranges of calcium content and sulfur content (especially soluble sulfate) in these samples give us a good opportunity to assess the effects of these variables on bulk particulate properties.

Data in Table 2 also show how the sorbent material dominates the chemistry of the sorbent and ash mixture. Changes in the calcium and silica contents from the base line ash to the sorbent and ash mixtures show that the sorbent represents more than half, and as much as three-fourths, of the mass of the mixtures. Furthermore, since we believe the soluble surface compounds control bulk properties of the particulate material, the role of the sorbent is even greater than it would be if the only consideration was its mass fraction of the solids.

We completed a series of resistivity measurements on the base line hopper ash from Plant Kintigh (SID 2884). These data are shown in Figure 3. As with other resistivity measurements we have performed, the effect of water adsorption on resistivity can be clearly seen at temperatures below 200 °C.

E 2.2 Characterization of Water Adsorption by Mixtures of Sorbents and Ashes

Under Task 2, Experiment 2.2 we performed measurements of water content on samples from Muskingum Station, the DITF, Plant Kintigh, Edgewater, and the HSTC. Prior to these determinations of water content, we conditioned weighed samples in sealed environments with controlled levels of relative humidity. This condition does not necessarily imitate the exposure the ash would have in a flue gas stream; however, the intent of this measurement was to quantify differences in adsorption of water among the ashes so that we could learn what properties of ashes govern adsorption mechanisms. Earlier measurements have convinced us that the most useful information can be gathered by baking the samples at 300°C (the maximum temperature available in the oven that is part of our Karl Fischer Device.) Table 3 presents a summary of the results of these Karl Fischer determinations of water content.

Figure 3. Resistivity of the Kintigh base line ESP hopper ash (SID 2884) as a function of temperature during descending-temperature resistivity determinations made in environments with three different moisture levels.

Table 3
Total Water Removed from Task 2 Samples Titrated in the Karl Fischer Device
after Baking at 300 °C, % wt.

SID	~Relative Humidity used to Condition Samples, %					
	1	11	22	50	75	82
2870	0.42	0.36		*0.59	0.33	
2871	1.3	1.6		*2.2	2.0	
2872	1.4	1.2		*3.2	> 2.9	
2873	1.6	2.3		*3.3	> 3.6	
2884	0.33	0.33		*0.42	0.61	
2885	2.1	2.5		> 3.5	> 4.5	
2883	0.53	0.42	0.81			1.5

* Time-resolved data not recorded; value expresses total water removed after 30 minute extraction. Total water that would eventually be removed with a longer extraction time may exceed this value.

The adsorption data show a relationship between the soluble sulfate content of the solids and their affinity for water. Figure 4 shows data from Table 2 and Table 3 that are evidence of the role of soluble surface compounds and the adsorption of water. The relationship is evident even at very low humidities, which permits us to apply this mechanism for adsorption to all flue gas environments. The data that seem to disagree with the trend presented in Figure 4 correspond to the Edgewater furnace sorbent injection ash (SID 2883). The relationship between $\text{SO}_4^{=}$ content and adsorbed water may be different for this sample because the sorbent was introduced into the furnace prior to conversion of SO_2 to SO_3 . We believe there is a cascade effect from the surface chemistry of the solids, to the reaction of the solids with flue gases, and to the affinity of the reacted solids with water. Ultimate properties of the bulk solids will depend on this sequence of reactions.

E 2.3 Characterization of Water-Conditioned Sorbent and Ash Mixtures

Uncompacted bulk porosity and tensile strength determinations were performed on samples that had been conditioned at a variety of relative humidities. Results of these measurements are included in Tables 4 and 5.

Figure 4. Total water content of the Task 2 samples as a function of soluble sulfate content and the relative humidity used to condition the samples. An arrow (↑) next to a data point indicates that the total water content may be greater than the value indicated.

Table 4
Uncompacted Bulk Porosities of Selected Ashes
from Task 2 Studies as a Function of Relative Humidity, %

SID	~Relative Humidity used to Condition and Test Samples, %					
	7	27	53	75	83	93
2870	61	61		62		66
2871	87	87		86		87
2872	88	87		85		87
2873	87	87		87		89
2884	59		63	64	62	67
2885	83			84		85
2883	89					88

Table 5
Tensile Strengths of Ashes and Mixtures of Sorbents and Ashes
from Task 2 Studies as a Function of Relative Humidity, N/m²

SID	~Relative Humidity used to Condition and Test Samples, %				
	1	11	34	50	83
2870			1.1	1.6	> 30
2871	> 32	> 32	3.1	3.7	3.4
2872			> 28	> 9.5	15
2873			> 18	> 6.8	> 14
2884			0.6	0.6	0.5
2885	> 30	18	2.8	4.2	6.8
2883			31		> 23

Mixtures of ash and sorbents have higher tensile strengths than the base line fly ashes, except for the Muskingum base line ash at 83% RH. Unlike the two slurry injection ashes from the DITF (SID's 2872 and 2873), the tensile strengths of the High Sulfur Test Center spray dryer ash (SID 2885) and the DITF dry Ca(OH)₂ injection ash (SID 2871) are relatively low at higher humidities, and increase dramatically when the samples are conditioned and tested at low relative humidities. These differences in tensile strength are especially interesting because the uncompacted bulk porosity measurements of these four samples show no dependence on

relative humidity. Further tests are planned and must be completed before final conclusions can be drawn about the role of relative humidity on the tensile strengths of these samples. We hope to find relationships among adsorbed water content, tensile strength, and the history of the formation of the samples.

TASK 3: ANALYSES OF ASHES AND POWDERS

Task 3 studies involve analyses of a variety of powders, and leached and unleached dust cake ashes. In most of the discussions contained under Task 3, results of analyses performed on unleached dust cake ashes are being compared directly with similar analyses of leached dust cake ash samples. Although the leached dust cake ashes were produced and tested under Experiment 3.4, for convenience we have included most of the data describing the characteristics and behavior of leached dust cake ashes in tables which can be found in sections describing experiments E 3.1, E 3.2, and E 3.3.

E 3.1 Standard Characterization of Powders and Fly Ashes

During the past quarter we completed the planned measurements under Experiment 3.1. We measured the resistivity of three of the Task 3 samples: aluminosilicate powder (SID 3238), silicon dioxide (SID 2769), and alumina powder (SID 2874). The results of these measurements are presented in Figures 5, 6, and 7. In Figure 7, there is a relative maximum in the measured resistivity at about 180 °C, which at present we do not have sufficient information to explain.

E 3.2 Characterization of Water Adsorption by Powders and Fly Ashes

As in Experiment 2.2, we performed measurements of water content on powders and dust cake ashes using Karl Fischer titration. We conditioned weighed samples in sealed environments with controlled levels of relative humidity. Table 6 presents results of these Karl Fischer determinations of water content.

Figure 5. Resistivity of the aluminosilicate powder (SID 3238: Neutralite) as a function of temperature during descending-temperature resistivity determinations made in environments with three different moisture levels.

Figure 6. Resistivity of the silicon dioxide (SID 2769: Kenite 900) as a function of temperature during descending-temperature resistivity determinations made in environments with three different moisture levels.

Figure 7. Resistivity of the alumina powder (SID 2874) as a function of temperature during descending-temperature resistivity determinations made in environments with three different moisture levels.

Table 6
Total Water Removed from Task 3 Samples Titrated in the Karl Fischer Device
after Baking at 300°C, % wt.

SID	~Relative Humidity used to Condition Samples, %				
	1	11	33	50	75
2101	1.9	2.3		2.0	3.1
2029	0.15	0.16		0.18	0.25
2515	0.25	0.18		0.22	0.27
1994	1.5	1.9		2.6	2.7
2101-W	0.62	0.79		1.1	1.3
2029-W	0.12	0.17		0.26	0.33
2515-W	2.9	3.3		3.6	3.9
1994-W	1.3	2.8		3.5	4.2
1856	0.064	0.15		*0.20	0.22
3063	0.20	0.27	0.35	*0.63	1.4
3064	0.28	0.36	0.54		1.7
3065	0.60	1.4	1.9		2.6
3238	2.2	2.0		*2.7	2.0
2769	0.040	0.16		*0.20	0.41
2874	0.048	0.051		*0.10	0.16

* Time-resolved data not recorded; value expresses total water removed after 30 minute extraction. Total water that would eventually be removed with a longer extraction time may exceed this value.

In an attempt to isolate the effects of particle morphology on the adsorption of water, we determined the water contents of the three Cab-O-Sil fumed silica powders (SID's 3063, 3064, and 3065) after conditioning at different levels of relative humidity. Figure 8 presents these data normalized by the surface areas of the three powders. Adsorbed water content does correlate with specific surface area; however, there seem to other factor(s) involved as well.

E 3.3 Characterization of Water-Conditioned Powders and Fly Ashes

Uncompacted bulk porosities of ashes and powders that were conditioned and tested at a variety of relative humidities are summarized in Table 7. Except for the possible measurement

Figure 8. Total water removed from conditioned samples of fumed silica. The total amount of water reacted in the Karl Fischer Device has been normalized by the surface areas of the silica powders.

of the uncompact bulk porosity of the glass beads (SID 1856) at relative humidities between 53 and 75 %, the uncompact bulk porosity measurements planned under Experiments 3.3 and 3.4 are complete.

Table 7
Uncompact Bulk Porosities of Selected Ashes
from Task 3 Studies as a Function of Relative Humidity, %

SID	~Relative Humidity used to Condition and Test Samples, %					
	7	27	53	75	83	93
2101	77	76	78	82	84	87
2029	64	67	68	69	70	80
2515	74	76	75	76		78
1994	90	88	90	89		91
2101-W	73	72	72	72	73	80
2029-W	65	63	64	64	IA	80
2515-W	77	74	76	76	IA	80
1994-W	90	89	91	90		91
2101-L		72				
2029-L		64				
2515-L		79				
1994-L						
1856	44		50	70	73*	77*
3238	94					95
2769	91					92
2874	77			79		81

IA Insufficient ash available to fill cup

* powder got quite moist, forcing it through the screen created "gummy spindles"

The water adsorption and uncompact bulk porosity data measured for the leached and unleached dust cake ashes support the argument that a sufficient coating of water on particle surfaces causes significant increases in ash cohesivity due to the formation of liquid bridges that are formed between the particles. The cohesivity of neither the leached nor the unleached AFBC dust cake ash responds to water conditioning. As we have mentioned earlier, we believe this is due to the sequestering of water by the highly absorbent AFBC ash particles.

We believe that the rather sudden increases in uncompacted bulk porosity measured for the leached Scholz ash, and the leached and unleached Monticello and Harrington ashes between 75 and 93% RH are due to liquid bridges. The unleached Scholz ash experiences this same increase in uncompacted bulk porosity at a much lower relative humidity (~ 50%). This ash has a great deal of free sulfuric acid on its particle surfaces. The acid chemically bonds with initially adsorbed water, ultimately causing a higher degree of water to be bound, both chemically and physically, to the unleached Scholz ash than to the leached Scholz ash. Our Karl Fischer data demonstrate that the unleached Scholz ash needs a much lower partial pressure of water vapor to achieve similar total water content as the leached Scholz ash at 93% RH. In fact, the total water we measured for the unleached Scholz ash conditioned at 1% RH exceeded the total water measured for the leached Scholz ash conditioned at 93% RH. Because the technique we used to condition ashes at 1% RH may have permitted water that was initially adsorbed on the ash at relative humidities around 30% (due to exposure of the ash to air in the laboratory) to remain on the ash, this difference may not be quite as dramatic as the Karl Fischer data would suggest. However we do believe that free sulfuric acid on particle surfaces promotes water adsorption, chemical bonding, and increases in ash cohesivity.

The uncompacted bulk porosities of the leached Scholz ash, and the leached and unleached Monticello and Harrington ashes converge to about 80% at 93% RH. This may be due to similarities in the morphology of the ash particles. The particles are mostly spherical, and their size distributions are fairly similar. Therefore, once the surfaces of the particles become coated with enough layers of water, the ash particles from these different samples interact in much the same way, and form an agglomerate with similar bulk porosity.

Table 8 presents a summary of tensile strength measurements performed under Experiments 3.3 and 3.4.

Table 8
Tensile Strengths of Ashes and Mixtures of Sorbents and Ashes
from Task 3 Studies as a Function of Relative Humidity, N/m²

SID	-Relative Humidity used to Condition and Test Samples, %					
	1	11	34	50	75	83
2101	11	4.7	1.5	5.1	5.4	28
2029		19	4.1	8.2	8.5	8.5
2515		> 32	19	15	> 26	30
1994			> 13	> 7.7		
2101-W	15	6.3	1.8	2.8		3.9
2029-W	> 30	15	3.1	3.2	3.6	3.8
2515-W	> 32		2.0	1.6		3.4
1994-W			> 14	> 9.5		
1856	7.9	3.6	0.6	0.8		32
3238	> 30	4.9	2.0	1.4		1.9
2769			> 6.6	> 4.4		
2874	3.3	1.5	0.8	0.8		1.2

A number of additional measurements of tensile strength are planned under Experiments 3.3 and 3.4. A selection of the data presented in Table 7 are shown in Figure 9. Although the trend is not present in all of the samples we have tested, there is often a minimum in tensile strength between 25 and 50 % RH. We believe that bonding due to the interaction of layers of adsorbed water (liquid bridges) can explain the increase in tensile strength with increasing relative humidity. However, we are not certain what causes some very dry powders and ashes to exhibit very high tensile strengths. We have speculated that during the preparation of the sample in the laboratory at about 30% RH, enough water is adsorbed on the surfaces of the particles to dissolve some of the salts present on the particle surfaces. During the subsequent drying in the sealed test chamber (to 11 or 1% RH) these dissolved salts may concentrate at contact points and strengthen the bonds between particles. We investigated this possibility by performing similar sets of tensile strength measurements on the simple powders in our data base (glass beads, alumina powder, and aluminosilicate). These powders also showed significant increases in tensile strength at low relative humidities. We are still searching for an explanation for this trend. Static charge may influence this behavior, but we cannot offer a verified mechanism at this time.

Figure 9. Tensile strengths of selected samples as a function of the relative humidity used to condition the samples. An arrow (↑) next to a data point indicates that the actual tensile strength is greater than the value shown.

E 3.4 Solvent Leaching Studies of Fly Ashes

During the past quarter, additional analyses were performed on leached dust cake ashes that we described in our earlier quarterly report (April - June 1992). We measured the true densities of the leached dust cake ashes. These data are presented in Table 9 along with values previously measured for the unleached dust cake ashes. Leaching apparently did not significantly change the density of the ash particles.

Table 9
True Densities of Dust Cake Ashes

SID	Description of Sample	true density, g/cm ³
2101	Scholz dust cake ash	2.44
2029	Monticello dust cake ash	2.47
2515	Harrington dust cake ash	2.66
1994	AFBC dust cake ash	2.65
2101-W	leached Scholz dust cake ash	2.52
2029-W	leached Monticello dust cake ash	2.47
2515-W	leached Harrington dust cake ash	2.59
1994-W	leached AFBC dust cake ash	2.70

We determined that the amounts of the four leached dust cake ashes (SID's 2101-W, 2029-W, 2515-W, and 1994-W) that we had on hand were not large enough to complete the permeability tests we had scheduled. We also are planning, pending our sponsor's approval, to use leached dust cake ashes in a new experiment under Task 3. Therefore we generated four additional samples of leached dust cake ash using the same technique that we used to generate samples 2101-W, 2029-W, 2515-W, and 1994-W. These new samples are identified as 2101-L, 2029-L, 2515-L, and 1994-L. We measured the drag-equivalent diameters, uncompacted bulk porosities, and relative gas flow resistances of three of these leached dust cake ashes and compared these data with corresponding data we measured for unleached dust cake ashes. These data are summarized in Table 10.

Table 10
Permeabilities and Uncompacted Bulk Porosities of Dust Cake Ashes
Measured at 28% Relative Humidity

SID	Sample Description	drag-equivalent diameter, μm	uncompacted bulk porosity, %	relative gas flow resistance, $\text{in. H}_2\text{O} \cdot \text{min} \cdot \text{ft} / \text{lb}$
2101	Scholz	2.6	76	2.1
2101-L	Scholz (leached)	2.3	72	4.1
2029	Monticello	3.5	67	3.3
2029-L	Monticello (leached)	3.3	64	4.9
2515	Harrington	2.3	76	2.5
2515-L	Harrington (leached)	1.6	79	3.5

Gas flow resistance is obtained by filtering air at a known flow rate through a simulated dust cake of known porosity in a laboratory test device while measuring the resistance to the air flow. When this measurement is made with the porosity of the simulated dust cake equal to the estimated characteristic dust cake porosity of the ash, the resultant gas flow resistance is defined as R , the relative gas flow resistance. The R value is the resistance that this simulated dust cake (with an areal loading of $1.0 \text{ lb}/\text{ft}^2$) exhibits for an air flow of $1.0 \text{ acfm}/\text{ft}^2$. For each of these dust cake ashes, leaching increased the relative gas flow resistance of the ash. For the Scholz and Monticello ashes, the increases in R were due to reductions in drag-equivalent diameter and uncompacted bulk porosity (which is used as an estimate of dust cake porosity). Reductions in drag-equivalent diameter are not too surprising for these ashes, since we noted increases in specific surface area due to leaching for the first set of leached samples. Drag-equivalent diameter usually decreases as specific surface area increases. (Drag-equivalent diameter is not a measurement of physical size, but rather a fitted parameter ranking the characteristic gas flow resistances of ashes at equal porosities. Increasing values of drag-equivalent diameter indicate a lower resistance to gas flow at a given porosity. Measurements of physical size (Bahco, Shimadzu and Coulter mean diameters) generally correlate with this expression; however, the drag-equivalent diameter best expresses the fineness of an ash as it relates to its effect on gas flow resistance.) The reduction in the drag-equivalent diameter of the Harrington ash was large enough to overcome a small increase in uncompacted bulk porosity.

PLANS FOR THE UPCOMING QUARTER

We will be continuing laboratory experiments under Task 3 on dust cake ashes and powders. We have submitted plans for Experiment 3.5 Determination of the Effects of the Deposition of Chemical Compounds on Particle Surfaces. Work on this experiment will proceed once approval of our sponsor has been obtained. Under Task 2, we will be performing a variety of analyses on ashes and mixtures of ashes and sorbents with emphasis on Karl Fischer titration, tensile strength measurements, resistivity measurements, and further uncompacted bulk porosity determinations.

FUNDAMENTAL MECHANISMS IN FLUE GAS CONDITIONING

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Approved by

A handwritten signature in black ink, appearing to read 'D. H. Pontius', is written over a horizontal line.

Duane H. Pontius Head, Particulate Science Division

END

DATE
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5 / 20 / 93