DOE/PC/92521--T264

TECHNICAL REPORT
December 1, 1994 through February 28, 1995

Project Title: **PRODUCTION OF INORGANIC PELLET BINDERS FROM FLY-ASH**

DOE Cooperative Agreement Number: DE-FC22-92PC92521 (Year 3)
ICCI Project Number: 94-1/3.1A-1M
Principal Investigator: S. K. Kawatra, Department of Metallurgical and Materials Engineering, Michigan Technological University
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Project Manager: D. Banerjee, Illinois Clean Coal Institute

ABSTRACT

Fly-ash is produced by all coal-fired utilities, and it must be removed from the plant exhaust gases, collected, and disposed of. While much work has been done in the past to utilize fly-ash rather than disposing of it, we nevertheless do not find widespread examples of successful industrial utilization. This is because past work has tended to find uses only for high-quality, easily-utilized fly-ashes, which account for less than 25% of the fly-ash that is produced. The main factor which makes fly-ashes unusable is a high unburned carbon content. In this project, physical separation technologies are being used to remove this carbon, and to convert these unusable fly-ashes into usable products. The main application being studied for the processed fly-ash is as a binder for inorganic materials, such as iron-ore pellets. Work in the first quarter concentrated on obtaining samples of all of the materials to be used (fly-ash, and magnetite ore), training of personnel on pelletization procedures, obtaining and setting up pelletization apparatus in the MTU laboratories, and running pelletization experiments with bentonite binder to establish a baseline for comparison with the fly-ash binders to be made.

In the current quarter, experimentation has been proceeding to study the removal of carbon from fly-ashes, and to make and test pellets that use fly-ash as binder. Using froth flotation, the loss-on-ignition (a key indicator of the carbon content) of a fly-ash from the E. D. Edwards plant, in Bartonville, Illinois, was reduced from 7.92% to only 1.19% while recovering 80.94% of the total fly-ash weight to the low-carbon product. In pelletization tests, fly-ash was used in combination with calcium hydroxide as binder for magnetite ore pellets. This produced pellets with dry crushing strengths of up to 7.5 pounds force per pellet, which is considerably stronger than the crushing strength of only 1.9 pounds force per pellet with no binder added, and is comparable to the strengths achieved with pellets made using bentonite binder. A literature search has also been conducted to determine what binders other than bentonite have been studied, and the methods needed for testing and using these binders effectively.

"U. S. DOE Patent Clearance is **NOT** required prior to the publication of this document."

EXECUTIVE SUMMARY

All coal-fired power plants produce a great deal of ultrafine particulates in the form of "fly-ash" as a residue of coal combustion. The fly-ash is suspended in the exhaust gases, and since the particles have a mean size of less than 30 micrometers, they would present a serious dust problem if they were released. The fly-ash is removed from plant exhaust gases by electrostatic precipitation or similar processes, but once the fly-ash has been recovered, it must be dealt with in some way.

While much work has been done in the past to utilize fly-ashes in applications such as cement manufacture, only a small fraction of the fly-ash produced is actually used industrially. This is because most fly-ashes in their raw state contain impurities such as unburned carbon, which make them unusable for the applications that have been developed for this material in the past. The majority of the fly-ash produced must therefore still be landfilled.

In this project, a different approach from past research is being taken. Instead of searching for markets that can be adapted to take raw fly-ash (and will therefore have strict quality requirements on the fly-ash that can be used), methods are being developed for treating currently unusable fly-ashes to convert them into a useful product.

The goal of this project is to convert fly-ashes into a material that can be used as a binder for inorganic powders. Such a binder will be useful for several high-volume markets, such as production of iron ore pellets for blast-furnace feed. The conversion will be accomplished by first treating the fly-ash by physical separation techniques to remove unburned carbon and coarse particles, which are the components that make the majority of fly-ashes unusable in many applications. The separation will be accomplished by froth flotation. Following separation, the fly-ash will be used both alone and in combination with other low-cost materials as a binder for iron ore pellets.

In the previous quarter, initial testwork was conducted in the research laboratories of a commercial producer of iron ore pellets. In these tests, several batches of pellets were produced using conventional Bentonite binder. These pellets were tested by compression and by "wet-knock" (repeated dropping from a fixed height until failure) to determine their strength. This provided a baseline for comparison of the fly-ash based binder with conventional binders. A laboratory-scale pelletizing drum was provided by the iron ore pellet producer, for use in the Michigan Tech research laboratories. This testwork and equipment was provided by the company as a portion of their cost-share for the research. A portion of the magnetite/bentonite mixture used in these experiments was "aged" by sealing it into a closed container for two months, and was then used to make pellets in the second quarter to determine whether extended reaction times before pelletizing have an effect on the finished pellet properties.

In the current quarter, fly-ash provided by the Central Illinois Light Co. from their E. D. Edwards plant was treated by froth flotation to remove unburned carbon. This treated fly-ash was used for the subsequent pelletization experiments, along with fly-ash samples from the Upper Peninsula Power Co. (UPPCO) which had been collected and prepared previously. Froth flotation is a process that separates particles based on their wettability by water. By proper selection of reagents, the wettabilities of various types of particles

can be controlled so that, if air is bubbled through a suspension of the particles in water, the less-wettable particles will attach to the air bubbles and be carried to the surface while the more-wettable particles will remain in suspension. Since the carbon in fly-ash has an affinity for hydrocarbon oils, these oils can be used as "collectors" for the carbon, selectively coating its surface and reducing its wettability.

Flotation was carried out using a mixture of #2 Fuel Oil and a froth conditioner manufactured by Dow Chemical Co. as the carbon collector, and using a polyglycol frother to stabilize the froth. Removal of carbon from the fly-ash was nearly complete, as shown in Table 1.

Table 1: Removal of carbon from E. D. Edwards fly-ash by froth flotation at various reagent dosages, as determined by Loss-on-Ignition measurements. Reagent dosages are expressed as kilograms per metric ton of fly-ash (kg/mt).

	% of Feed Weight	% Loss-on-Ignition (Unburned carbon)	% Carbon Removal
Raw Ash		7.92+/-0.02	
Collector: 0.39 kg/mt Frother: 0.16 kg/mt	80.94	1.19+/-0.06	87.84
Collector: 0.18 kg/mt Frother: 0.15 kg/mt	82.35	2.16+/-0.05	77.54
Collector: 0.37 kg/mt Frother: 0.23 kg/mt	78.27	1.26+/-0.15	87.54

The % Carbon Removal was calculated from the Loss-on-Ignition values using the following equation:

$$\%\ \text{Carbon Removal} = \frac{(\text{Feed \% LOI}) \times 100 - (\text{Product \% LOI}) \times (\text{Product \% Wt.})}{(\text{Feed \% LOI}) \times 100} \times 100$$

Pelletizing tests were carried out using the "aged" magnetite/bentonite mixture from the first quarter, and also using fly-ash (in combination with calcium hydroxide) as a binder for magnetite. Pellets between 1/2 and 7/16 inches were produced with a laboratory-scale pelletizing drum, and their characteristics were measured. A summary of the results is given in Table 2. The best fly-ash results are with the Edwards ash added dry, which gives strengths comparable to pellets made with bentonite binder.

Table 2: Comparison of dry strengths of magnetite pellets made using fly-ash based binders. The "aged" bentonite was the same bentonite/magnetite mix as was used in the previous quarter, but was allowed to stand in a sealed container for two months before being used to make pellets. The aging appears to have increased the effectiveness of the bentonite as a binder. Fly-ash binders were 2 parts fly-ash:1 part calcium hydroxide, and the amount of binder added was 1% of the magnetite weight. The "wet" binder was mixed with 4 parts water to make a fluid slurry before adding it to the magnetite, while the "dry" binder was added without any additional water. Values are averages for 20 individual pellets, and the +/- values are one standard deviation.

Binder	Dry crushing strength (pounds force)
None	1.9+/-0.2
Bentonite (0.66% wt., from previous quarter. Dry binder)	6.1+/-1.1
Bentonite (mixed with magnetite, aged 2 months. Dry binder)	9.8+/-1.5
UPPCO -400 mesh (wet binder)	4.8+/-0.8
UPPCO Decarbonized (wet binder)	3.9+/-0.7
Edwards -150 mesh Decarbonized (wet binder)	3.2+/-0.5
UPPCO -400 mesh (dry binder)	5.4+/-1.3
Edwards -150 mesh Decarbonized (dry binder)	7.5+/-1.7

OBJECTIVES

The objective of this project is to convert fly-ashes that are currently unusable into a marketable form, particularly into a binder for inorganic powders such as iron ore concentrate. The tasks which are scheduled to accomplish this in the current year are:

1. Sample collection and characterization, which will entail collection of samples of fly-ash from a number of Illinois power plants, and characterization of these samples by both physical and chemical analysis;
2. Carbon removal experiments, which will use froth flotation to remove unburned carbon and other contaminants that interfere with the utilization of fly-ash; and
3. Agglomeration experiments, where the fly-ash will be used as a binder component for production of iron ore pellets, and the properties of the pellets produced will be measured to determine how their quality compares with pellets produced using conventional binders.

INTRODUCTION AND BACKGROUND

All coal-fired power plants produce a great deal of ultrafine particulates in the form of "fly-ash" as a residue of coal combustion. The fly-ash is suspended in the exhaust gases, and since the particles have a mean size of approximately 30 micrometers, they would present a serious dust problem if they were released. The fly-ash is removed from plant exhaust gases by electrostatic precipitation or similar processes, but once the fly-ash has been recovered, it must be dealt with in some way. Handling and disposal of this fly-ash is a significant problem, and is one of the factors that tends to drive utilities to switch to fuels other than coal.

While much work has been done in the past to utilize fly-ashes in applications such as cement manufacture, only a small fraction of the fly-ash produced is actually used industrially. This is because most fly-ashes in their raw state contain impurities such as unburned carbon, which make them unusable for the applications that have been developed for this material in the past. The majority of the fly-ash produced must therefore still be landfilled.

In this project, a different approach from past research is being taken. Instead of searching for markets that can be adapted to take raw fly-ash (and will therefore have strict quality requirements on the fly-ash that can be used), methods are being developed for treating currently unusable fly-ashes to convert them into a useful product. The application being studied initially is the use of fly-ash as a binder for iron ore concentrate during the production of iron ore pellets. Successful use of treated fly-ash for this application will lead to use of the fly-ash based binder for numerous other applications, such as sand molds in foundries.

In the first quarter of this project, equipment and materials for making iron-ore pellets were obtained from the research laboratories of a nearby, cooperating iron ore producer, and project personnel were trained in the laboratory pelletizing procedures that are used by the industry. Several batches of pellets were made and tested using bentonite as binder, to provide a benchmark for comparison with pellets made using fly-ash based binders.

In the current quarter, fly-ashes from two sources were chemically analyzed, and the Illinois fly-ash was processed using size separation and froth flotation to make it more suitable for use as a binder. Experiments were then begun using these fly-ashes as binders for iron-ore pellets.

EXPERIMENTAL PROCEDURES

Sample Preparation and Analysis

Fly-ash was provided by the Central Illinois Light Co., which was collected from the ash-disposal pond at their E. D. Edwards plant. A second sample of ash was collected by the investigators from a conveniently-located plant operated by the Upper Peninsula Power Co. (UPPCO). Negotiations are underway with a number of plants which are either located in Illinois or burn Illinois coal to provide samples of their ashes for later studies.

The Edwards ash was collected wet, and had been mixed with the coarse bottom ash from the plant. It was necessary to dry the ash, and screen out the material coarser than 28 mesh so that it could be split into representative samples. The main sample was thoroughly mixed, and divided into subsamples by incremental sampling and by riffling. Two samples of 50 grams each were removed, and pulverized for chemical analysis. An additional sample was removed for size analysis.

The UPPCO ash was collected dry, and so it could be mixed and split without additional preparation. A 50 gram subsample was removed for chemical analysis, and an additional sample for size analysis.

Size analysis was carried out using a Leeds and Northrup Microtrac particle size analyzer, and the chemical analyses were carried out by a commercial fly-ash testing laboratory.

Froth Flotation Experiments

Only the Edwards ash was treated by froth flotation in this quarter. Froth flotation of the Edwards fly-ash was carried out to remove the unburned carbon, using the following procedure:

1. For each test, a 200 gram sample was wet-screened with tap-water at 150 mesh to remove the coarse material. The -150 mesh fines were filtered, and used immediately as flotation feed.
2. The fines were added to a Denver flotation machine with a 1.2 liter flotation cell along with 500 ml of distilled water. The fines were then suspended by agitating with an impeller speed of 1200 RPM.
3. Collector was added at the desired dosage (the collector was a mixture of 80% #2 fuel oil, and 20% Dow M210 froth conditioner). The mixture was then agitated for 5 minutes to thoroughly mix the collector with the suspended fly-ash, and an additional 500 ml of distilled water was added to bring the level in the cell up to the operating depth.
4. Frother was added (the frother was Dow DF200, a polyglycol frother), and mixed in for 15 seconds.

5. The air flow was started, and flotation was carried out for 5 minutes. The final pH and temperature of the pulp were then measured, and the froth product was weighed.

6. The products from flotation were filtered, dried, weighed, and analyzed by thermogravimetric analysis to determine moisture, volatiles content, ash content, and fixed carbon according to ASTM Standard Method D 3172, "Standard Method for Proximate Analysis of Coal and Coke."

Pelletization Experiments

Pelletization experiments were carried out using 55 gallons of finely-ground magnetite ore provided by Cleveland Cliffs Iron Co. This magnetite contained 10% moisture by weight. The sample was carefully divided into charges of 4 kg each, which were immediately sealed into zip-lock bags to prevent loss of moisture. Each pelletization test uses one 4 kg charge of magnetite.

Both the UPPCO and Edwards ashes were used in pelletization experiments. The various UPPCO ashes had been prepared before the beginning of this project, while the Edwards ash was prepared in the current quarter. Fly-ashes were prepared for use as binder by screening (to remove coarse particles) and froth flotation (to remove unburned carbon), and binders were activated by mixing 2 parts (by weight) of fly-ash with 1 part of calcium hydroxide. For one series of tests, the fly-ash/calcium hydroxide mixture was made into a slurry with distilled water before adding it to the magnetite, and in a second series of tests, the mixture was added to the magnetite as a dry powder.

The pelletization procedure was as follows:

1. Approximately 4000 grams of magnetite containing 10% moisture was weighed to the nearest 0.1 g, and mixed thoroughly for 5 minutes with 1% by weight of the selected binder. After mixing, an 8 mesh screen was used to break up any lumps.

2. Pellets were formed in a pelletizing drum, rotating at 25 rpm. A small amount of material was added first to create pellet "seeds", and these were then moistened by a water spray while additional material was added to cause the seeds to grow into full-sized pellets. The pellets were removed from the drum periodically and screened to control the size.

3. The finished pellets were screened to between 1/2 inch and 7/16 inch for impact and crushing strength testing. The pellets were divided into two lots, with the first lot sealed into a closed container for wet-knock and wet-crushing tests. The second lot was dried at 105°C for a minimum of 1 hour to determine moisture content, and the dried pellets were used for dry-crushing tests.

4. Impact testing ("wet-knock") was carried out by repeatedly dropping pellets individually from a height of 18 inches onto a steel plate until they fractured, and recording the number of drops for fracture. Crushing strength was determined by gradually increasing the load on a pellet using an Instron compression tester, and recording the peak force needed to fracture the pellet. Impact testing was conducted only on fresh, wet pellets, while crushing strength was determined on both wet pellets and on pellets that have been dried at 105°C. Twenty pellets were used in

each test, to ensure that the results were statistically valid. A summary of the test methods is given in Table 3.

Table 3: Summary of the procedures used for testing iron-ore pellets, and the reasons for conducting the tests.

Test Method	Procedure	Use of Data
Wet-knock	A single freshly-made (undried) pellet is dropped repeatedly from a height of 18 inches onto a steel plate. The number of drops required for fracture is recorded. This is repeated for 20 pellets, and the results averaged.	Measures the ability of the pellet to remain intact during handling.
Wet-crush	A single freshly-made (undried) pellet is compressed using an Instron compression test machine. The load required to fracture the pellet is recorded. This is repeated for 20 pellets, and the results averaged.	Measures the ability of the wet pellets to retain their shape during handling
Dry-crush	Pellets are dried at 105°C for at least 1 hour, and single pellets are then compressed using an Instron compression test machine. The load required to fracture the pellet is recorded. This is repeated for 20 pellets, and the results averaged.	Measures the ability of dried pellets to survive handling during the firing process.

RESULTS AND DISCUSSION

Particle size distributions for the two fly-ashes are given in Table 4, along with particle size distributions for the magnetite used for making iron ore pellets, and for a western bentonite such as is commonly used as an iron-ore binder in current practice. The Edwards ash contained a great deal of coarse material as a result of being mixed with the bottom-ash from the boiler, and so it was much coarser than the UPPCO ash. It is likely that the finest fly-ash particles, on the order of the size of the bentonite particles, will be most effective as binder, since smaller particles have a higher surface area than larger particles and will therefore be more chemically reactive. At a minimum, it would probably be best to size the fly-ashes so that they are as fine as the magnetite, which will provide for more intimate mixing between the fly-ash and magnetite particles.

Chemical analyses of the UPPCO and Edwards ashes are given in Table 5. Both ashes were analyzed raw, with a minimum of processing (the UPPCO ash was analyzed as it was received from the plant, and the Edwards ash was dried, and screened at 28 mesh to remove the very coarse material that it contained). The Edwards ash was higher in carbon, sulfur, sodium, potassium, and calcium, and lower in phosphorus than the UPPCO ash. Otherwise, the two ashes are chemically fairly similar, and both are low enough in calcium that they would be classified as class "F" fly-ash.

Table 4: Particle size analyses for the two fly-ashes, as determined by laser diffraction.

Size, Micrometers	Edwards ash, Cumulative % Passing	UPPCO ash, Cumulative % Passing	Empire Magnetite Cumulative % Passing	Western Bentonite, Cumulative % Passing
352.00	100.00	100.00	100.00	100.00
248.90	96.26	99.94	100.00	100.00
176.00	89.74	97.89	100.00	100.00
124.45	81.79	94.05	100.00	100.00
88.00	73.38	88.85	100.00	100.00
62.23	64.33	81.51	99.65	100.00
44.00	55.14	73.12	96.96	99.42
31.11	46.43	63.50	88.32	98.08
22.00	39.34	54.36	73.18	96.98
15.56	32.28	43.66	51.77	95.13
11.00	25.45	32.12	32.67	91.26
7.78	20.14	22.71	21.57	85.36
5.50	15.04	14.83	13.67	75.08
3.89	9.69	7.59	6.91	56.54
2.75	6.68	5.01	3.49	37.86
1.94	3.93	3.48	1.44	21.19
1.38	1.87	1.73	0.45	10.90
0.97	0.38	0.38	0.00	3.39

Flotation Results

Results from flotation of the Edwards ash are given in Table 6, and a results summary is given in Table 1 of the Executive Summary. Flotation was carried out at three different dosages of collector and frother, and the best combination of low carbon content and high recovery to the low-carbon product was obtained with a collector dosage of 0.39 kg/mt, and a frother dosage of 0.16 kg/mt.

Pelletization Results

Pelletization experiments were carried out using the binders indicated in Table 7. Binders were made using calcium hydroxide to activate the fly-ash to make a material with cementing properties. The UPPCO -400 mesh fly-ash was selected to determine whether limiting the fly-ash to the finest particle sizes would result in higher-quality pellets than at coarser sizes. The UPPCO ashes were prepared in an earlier project, funded by the Center for Clean Industrial and Treatment Technologies, but had not been previously used in

Table 5: Chemical analyses of raw ash samples collected for this project. These values are for the raw, unprocessed ashes.

	Edwards ash	UPPCO ash
SiO_2	45.35	50.16
Al_2O_3	23.58	27.69
Fe_2O_3	9.77	8.33
CaO	3.16	1.66
MgO	0.87	0.63
Na_2O	0.59	0.24
K_2O	2.16	1.92
TiO_2	1.20	1.52
MnO_2	0.07	0.01
P_2O_5	0.16	0.47
SrO	0.15	0.15
BaO	0.15	0.17
SO_3	0.62	0.25
Loss on Ignition	12.15	6.79
Moisture	0.34	0.34

Table 6: Proximate analyses of froth flotation products with the -150 mesh Edwards fly-ash. Percentages are calculated on a dry basis. The final pH of the flotation pulp was 8.7, due to the presence of alkaline components in the Edwards ash.

Reagent Dosages	Product	% Wt.	% Ash	%LOI	% Volatiles	% Fixed Carbon
	Feed analysis		92.08+/-.02	7.92+/-.02	2.92+/-.25	5.00+/-.25
Collector: 0.39 kg/mt Frother: 0.16 kg/mt	Froth (high-carbon)	19.06	63.63+/-.07	36.37+/-.07	4.46+/-.18	31.90+/-.18
	Sinks (low-carbon)	80.94	98.81+/-.06	1.19+/-.06	1.23+/-.03	0.00+/-.03
Collector: 0.18 kg/mt Frother: 0.15 kg/mt	Froth (high-carbon)	17.65	64.84+/-.08	35.16+/-.08	4.61+/-.11	30.56+/-.11
	Sinks (low-carbon	82.35	97.84+/-.05	2.16+/-.05	2.10+/-.08	0.07+/-.08
Collector: 0.37 kg/mt Frother: 0.23 kg/mt	Froth (high-carbon)	21.73	68.42+/-.05	31.58+/-.05	4.31+/-.16	27.27+/-.16
	Sinks (low-carbon	78.27	98.74+/-.15	1.26+/-.15	1.31+/-.04	0.00+/-.05

pelletization experiments. Pelletization tests are still in progress, and additional binder mixtures will be used in the coming quarters.

It was found that if the fly-ash/calcium hydroxide binder was added dry, the dry crushing strengths were higher than they were when the binder was added wet. However, when the binders were added wet, the wet-knock values were higher than for the dry binder. The Edwards ash, added dry, produced dry crushing strengths comparable to those obtained in the previous quarter with bentonite binder.

A literature search of binder technology for iron-ore pellets has been carried out. This provided needed information on the use of organic binders, and on standardized techniques for evaluating the probable quality of a binder before the pellets are made. This will be of great use in selecting the binder mixtures to be used in future experiments.

CONCLUSIONS AND RECOMMENDATIONS

It has been shown that it is possible to produce iron-ore pellets, using a mixture of fly-ash and calcium hydroxide as binder, which have dry strengths comparable to pellets produced using conventional bentonite binder. It has also been demonstrated that a single stage of froth flotation can remove up to 87.84% of the carbon from the fly-ash under study, while recovering 80.94% of the total weight to the low-carbon product.

In the next quarter, pelletization experiments will be continued using fly-ashes that have been pre-treated in various ways and which are combined with various additives, to determine the optimum conditions for producing high-strength pellets using fly-ash binders. These studies will also be used to determine the reasons why the fly-ashes studied behave differently as iron-ore binders. This will require numerous chemical and particle size analyses of the treated ashes, to determine which factors are most important for a high-quality binder.

Table 7: Summary of characteristics of magnetite pellets made using fly-ash based binders. The "aged" bentonite was mixed with magnetite, and allowed to stand for 2 months in a sealed container before being used to make pellets. The binders incorporating fly-ash were made by mixing 2 parts fly-ash with 1 part calcium hydroxide, and the amount of binder added was 1% of the magnetite weight. The "wet" binder was mixed with 4 parts water to make a slurry before adding it to the magnetite, while the "dry" binder was added without any additional water. Each value given is the average of the values measured for 20 individual pellets, and the +/- values are one standard deviation. The % Moisture values were determined by drying the wet pellets at 105°C and measuring the weight loss, and represents the water that was not taken up by hydration of the binder.

Binder	Wet-Knock (# of drops)	Wet crushing strength (pounds force)	Dry crushing strength (pounds force)	% Moisture
None	5.5+/-1.2	1.7+/-0.3	1.9+/-0.2	10.8
Bentonite (from previous progress report) (dry binder)	5.9+/-0.9	2.7+/-0.3	6.1+/-1.1	9.9
Bentonite (aged 2 months before pelletizing) (dry binder)	5.9+/-1.1	2.1+/-0.4	9.8+/-1.5	9.3
Calcium Hydroxide (1.0% wt) (dry binder)	5.8+/-1.1	1.6+/-0.4	4.1+/-0.6	9.7
UPPCO -400 mesh (wet binder)	8.3+/-1.8	1.7+/-0.3	4.8+/-0.8	10.0
UPPCO Decarbonized (wet binder)	8.0+/-3.2	1.4+/-0.3	3.9+/-0.7	10.4
Edwards -150 mesh Decarbonized (wet binder)	6.5+/-1.6	1.5+/-0.3	3.2+/-0.5	9.9
UPPCO -400 mesh (dry binder)	3.9+/-0.8	1.6+/-0.3	5.4+/-1.3	9.2
Edwards -150 mesh Decarbonized (dry binder)	4.3+/-0.7	1.5+/-0.2	7.5+/-1.7	9.8

DISCLAIMER STATEMENTS

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PROJECT MANAGEMENT REPORT
December 1, 1994 through February 28, 1995

Project Title: **PRODUCTION OF INORGANIC PELLET BINDERS FROM FLY ASH**

DOE Cooperative Agreement Number:	DE-FC22-92PC92521 (Year 3)
ICCI Project Number:	94-1/3.1A-1M
Principal Investigator:	S. K. Kawatra, Department of Metallurgical and Materials Engineering, Michigan Technological University
Other Investigators:	T. C. Eisele, Department of Metallurgical and Materials Engineering, Michigan Technological University
Project Manager:	D. Banerjee, Illinois Clean Coal Institute

COMMENTS

The project is in its second quarter. Work is proceeding on schedule. In some of the testwork being carried out, fly-ash samples are being used that were prepared in an earlier project, which was funded by the Center for Clean Industrial and Treatment Technologies (CenCITT). Preparation of these materials is therefore not being charged to the current project.

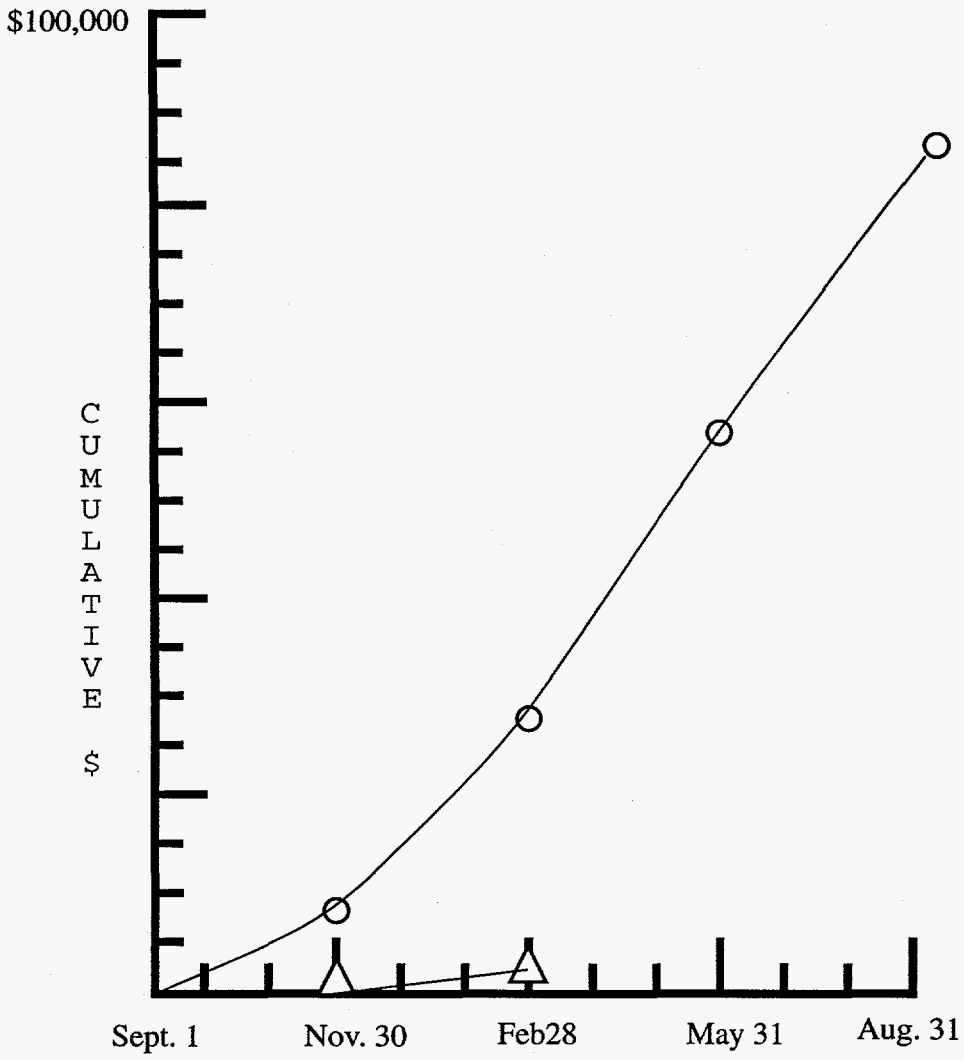
Projected and Estimated Expenditures by Quarter

Quarter	Types of Cost	Direct Labor	Fringe Benefits	Materials and Supplies	Travel	Major Equipment	Other Direct Costs	Indirect Costs	Total
Sept. 1, 1994 to Nov. 30, 1994	Projected	3988	1404	93	196			2670	8,350
	Estimated	0	0	0	0			0	0
Sept. 1, 1994 to Feb. 28, 1995	Projected	12614	4440	294	619			8445	26,412
	Estimated	0	0	32	0		300	156	488
Sept. 1, 1994 to May 31, 1995	Projected	26669	9388	622	1310			17854	55,843
	Estimated								
Sept. 1, 1994 to Aug. 31, 1995	Projected	40724	14335	950	2000			27264	85,273
	Estimated								

*Cumulative by Quarter

COSTS BY QUARTER

"Production of Inorganic Pellet Binders from Fly Ash"

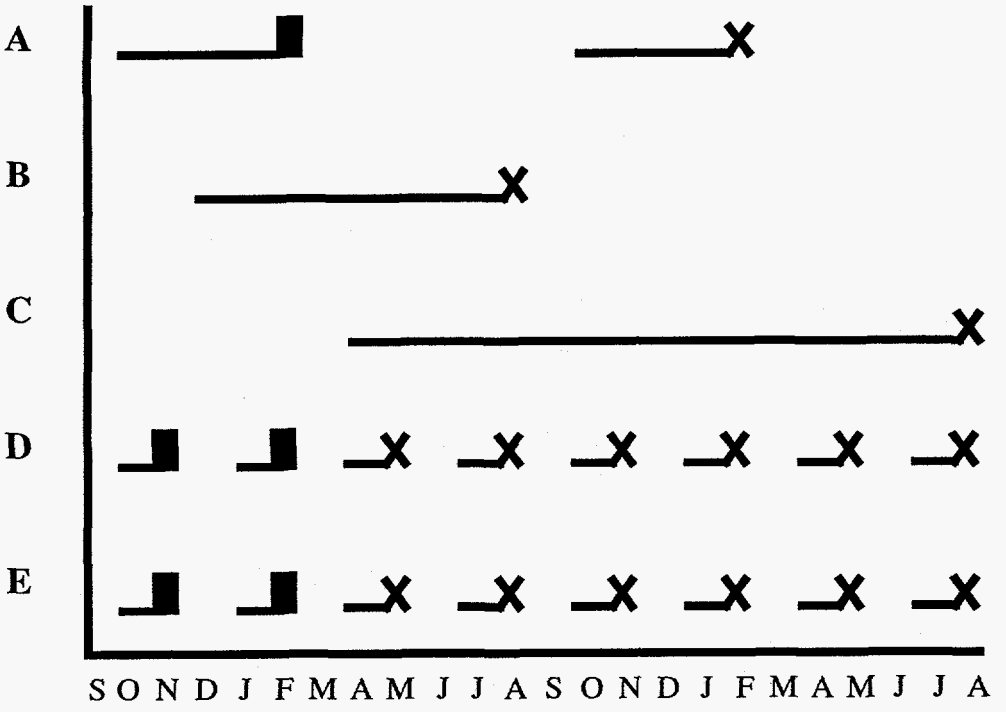


○ = Projected Expenditures _____

△ = Actual Expenditures _____

Total ICCI Award: $85,273 (first year)

SCHEDULE OF PROJECT MILESTONES



Begin
Sept. 1
1994

Milestones

A. Task 1: Sample Collection and Characterization (carried out in two stages)
B. Task 2: Carbon Removal Experiments
C. Task 3: Agglomeration Experiments
D. Technical Reports Prepared and Submitted
E. Project Management Reports Prepared and Submitted