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THE COMBUSTION CHARACTERISTICS OF
PONDEROSA PINE BARK

TECHNICAL PROGRESS REPORT NO. 7

DAVID C. JUNGE, PH.D.
OREGON STATE UNIVERSITY
CORVALLIS, OREGON 97331

PERIOD: SEPTEMBER 16, 1977 TO
SEPTEMBER 15, 1978

DATE OF REPORT: DECEMBER 1978

PREPARED FOR THE U.S. DEPARTMENT OF ENERGY: CONTRACT EY-76-C-06-2227
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ABSTRACT

Significant quantities of wood residue fuels are presently being used in industrial steam generating facilities. Recent studies indicate that substantial additional quantities of wood residue fuels are available for energy generation in the form of steam and/or electricity. A limited data base on the combustion characteristics of wood residue fuels has resulted in the installation and operation of inefficient combustion systems for these fuels.

This investigation of the combustion characteristics of wood residue fuels was undertaken to provide a data base which could be used to optimize the combustion of such fuels. Optimization of the combustion process in industrial boilers serves to improve combustion efficiency and to reduce air pollutant emissions generated in the combustion process.

This report presents data on the combustion characteristics of Ponderosa Pine bark.

The data were obtained in a pilot scale combustion test facility at Oregon State University. Other technical reports present data on the combustion characteristics of:

- Douglas Fir Bark
- Douglas Fir Planer Shavings
- Red Alder Sawdust
- Red Alder Bark

- Hemlock Bark
- Eastern White Pine Bark

An Executive Summary Report is also available which compares the combustion characteristics of the various fuel species.

SUMMARY AND CONCLUSIONS

The following conclusions are drawn based on the experiments conducted for this species of wood residue fuel used in industrial spreader-stoker boilers:

- 1) Optimum combustion conditions occur when an overall level of 50% excess air is used;
- 2) The combustion air should be distributed approximately 40% undergrate and 60% overfire to achieve minimum air pollutant emissions and maximum combustion efficiency. Care must be taken to avoid burning out the grates with this combustion mode;
- 3) The temperature of the combustion air has a definite effect on combustion efficiency and air pollutant emissions. As the temperature increases, efficiency goes down and pollutants increase. Therefore, low inlet air temperatures are desirable, at least at the grate. Ideally, it would be best to supply low temperature (ambient) air at the grate and to use the highest possible temperature air for overfire air so as to maintain high thermal efficiency of the boiler and keep air pollutant emissions to a minimum level.
- 4) The combustible content of the boiler emissions is relatively high for this species (typically greater than 85%). It ranges from 65% to 96%. Under optimal combustion conditions, it ranges from 88% to 96% with a mean value of 90%. Therefore, it would be beneficial to recycle this ash in a separate combustion chamber system to recover its heating value. However, reinjection of the ash to the boiler is not recommended because it will result in increased air pollutant emissions.
- 5) The mass mean size of the ash typically ranges from 0.89 mm to 1.95 mm. Under optimum combustion conditions, it ranges from 1.06 mm to 1.40 mm with a mean value of 1.31 mm.

- 6) The mass mean density of the ash typically ranges from 0.06 to 0.19 g/cm³. Under optimum combustion conditions, it ranges from 0.06 to 0.12 g/cm³ with a mean value of 0.06 g/cm³.
- 7) Careful control of combustion conditions can reduce pollutant emissions by approximately 80%.

1. INTRODUCTION

In the wood products industry, large quantities of wood residue are used for fuel, principally to generate process steam by direct combustion in boilers. In the United States there are approximately 1700 industrial wood fired boilers in operation.

With increasing fossil fuel costs there is added incentive to utilize wood residue fuels. However, present technology affecting the design and operation of wood fired boilers is limited. As a result, a large percentage of both new and older boiler facilities are experiencing difficulty in operating efficiently and in meeting the environmental restrictions.

The technology "gap" focuses on the complete combustion of the wood fuel. It is desirable to completely burn all of the combustible components of the fuel in order to maximize the combustion efficiency and minimize the fuel requirements. Complete combustion will reduce emissions of air pollutant materials and reduce requirements for "tail end" control devices to meet stringent air pollution regulations.

There are specific questions pertinent to the design and operation of wood fired boilers which have not been satisfactorily answered. For example:

- 1) What is the optimum level of excess air (air to fuel ratio) to maximize the combustion process?
- 2) What is the influence of preheating combustion air on completion of the combustion process. (The effect of preheated air on thermal efficiency is well documented, but its effect on combustion efficiency is not documented).
- 3) What is the best method of distributing air in the combustion chamber?
- 4) What is the optimum size of wood fuel required to bring about complete combustion?
- 5) What is the influence of fuel moisture on the completion of the combustion reaction? (The effect of fuel moisture on thermal efficiency can be calculated but its effect on completion of

the combustion reaction has not been documented.)

- 6) What is the relationship of fuel feed rate to the completion of the combustion reaction?
- 7) For given combustion conditions, what is the rate of carryover of unburned fuel and inorganic ash out of the boiler and into the primary collector system? This questions pertains to the design requirements of primary collector systems.
- 8) What are the physical characteristics of wood fuel fly ash in terms of size distribution, density distribution, and combustible content for specific combustion conditions? This questions also pertains to the design requirements of primary collector systems.
- 9) What are the optimum combustion parameters for reducing opacity from the wood fired boiler exhaust gases?

The answers to these questions must take into account the design of the wood burning boilers system. There are four general design categories of boiler systems:

- 1) Spreader-stokers
- 2) Dutch ovens
- 3) Suspension burning systems
- 4) Fluidized bed combustion systems

Since the early 1950's, the majority of boilers constructed in this country have been of the spreader-stoker design. It is estimated that over 50% of the currently operating boilers are spreader-stokers. Therefore, the spreader-stoker design was emphasized in the research effort reported herein.

2. PURPOSE AND SCOPE OF THE PROJECT

The purpose of this research effort is to develop a design data base for the combustion of wood residue fuels. Each of the important variables in the combustion process is taken into consideration including the following:

- 1) Species of fuel
- 2) Size of fuel
- 3) Moisture content of fuel
- 4) Feed rate of fuel
- 5) Inlet air temperature
- 6) Air to fuel ratio - level of excess air
- 7) Distribution of the combustion air above and below the grate.

When the data base is complete it will allow engineers, designers, and boiler operators to more effectively utilize wood residue fuels for energy with improved combustion efficiency and reduced air pollutant emissions.

3. FINANCIAL SUPPORT

Support for this research effort has been provided principally by the Government of the United States as noted below:

1) Phases I & II	Energy Research and Development Administration: Division of Conservation Research and Technology.	\$100,000
2) Continuation	Department of Energy: Fossil Fuels Utilization Program	\$187,000
3) Oregon State University		\$ 7,350
4) International Paper Company		\$ 2,500
5) Oregon Department of Environmental Quality		\$ 2,000

4. PROJECT PARTICIPANTS

The principal investigator for the research effort is Dr. David C. Junge, Associate Professor of Mechanical Engineering (Senior Research Scientist). Dr. R. W. Boubel, F. Kayihan, J. G. Mingle have acted as supporting investigators. Dr. Kenneth Tuttle assisted during the period when he was a candidate for the degree of Doctor of Philosophy. Several undergraduate students have participated in the project as well as two full time technicians.

5. TIME FRAMEWORK OF THE PROJECT

The initial funding of the project began on April 1, 1976. The test facility was designed and constructed during the period of April 1, 1976 to January 31, 1977. Startup and debugging took place between February 1, 1977 and April 15, 1977. Initial data were collected on Douglas fir hogged bark from April 16, 1977 to June 30, 1977. Funding for the initial phases of the project concluded June 30, 1977.

The continuation work began September 16, 1977 with funding from the Dept. of Energy. Revisions to the test facility were accomplished between September 16, 1977 and December 31, 1977. Tests on a variety of species were conducted between January 1, 1978 and July 15, 1978. Funding for the continuation work is still in progress and is expected to continue through September 15, 1979.

The results reported in this document were obtained during the period January 1, 1978 to July 15, 1978.

6. DESCRIPTION OF THE TEST FACILITY

A test facility was designed and constructed to carry out this needed research program. It is located in Corvallis, Oregon at the Fairplay Research Center, a part of Oregon State University.

As indicated in Figure 1, the test facility is a small spreader stoker boiler designed to fire wood residue fuels (hogged fuel). The system includes:

- 1) A conveyor system to control and meter the fuel flow;
- 2) A mechanical "flinger" roll to distribute fuel uniformly across the grate;
- 3) A water wall lined combustion chamber with a fixed, pin-hole grate. The area of the grate is 10 square feet. The combustion zone extends approximately 11 feet above the grate. Steam is generated at atmospheric pressure with natural recirculation in the water walls;

- 4) A fin tube, forced air cooled, jacketed duct to carry combustion exhaust gases from the combustion zone to an air preheater;
- 5) A plate type, counter flow, tripple pass air preheater designed for up to 550 °F air exit;
- 6) A cyclone separator downstream from the air preheater to remove entrained particulate matter from the exhaust gas stream;
- 7) A forced draft fan to provide combustion air to the test facility;
- 8) A system of venturi orifice flow meters to measure the amount of air distributed above and below the grate;
- 9) A system of gate valves to control the flow of air above and below the grate
- 10) Instrumentation to measure independent and dependent variables of the test facility. (Instrumentation is discussed in greater detail in Section 7.)

A photograph of the test facility is shown in Figure 2. (P. 7)

The test facility is designed to combust fuel samples with heat release rates of up to 10×10^6 BTU's per hour. Typical tests are carried out with heat release rates of 6×10^6 BTU's per hour.

Fuel species, fuel size, and fuel moisture levels are not controlled by the test facility. These characteristics are determined with the purchase of the fuel from various suppliers.

SCHEMATIC ILLUSTRATION OF WOOD COMBUSTION TEST FACILITY

Figure 1: Wood Combustion Test Facility - Oregon State University

Figure 2: Photograph of the Experimental Test Facility - Oregon State University

7. DESCRIPTION OF THE INSTRUMENTATION

The instrumentation used in conjunction with the test facility is illustrated schematically in Figure 3. Specific comments are offered concerning particular aspects of the instruments:

- 1) Fuel Size Distribution: Fuel size was determined by a screen analysis on pre-dried fuel samples. Samples were placed in a laboratory oven at 106°C until their weight reached a constant level indicating uniform, oven dry moisture levels. The samples were then screened in a series of standard (Tyler) screens to determine the mass/size distribution.
- 2) Fuel Moisture Content: Moisture content was determined by collecting random samples of the fuel from the storage pile and conducting standard gravimetric analyses. Drying was carried out at 106°C until the samples reached constant weight.
- 3) Fuel Feed Rate: Feed rates were determined by calibrating the screw feed conveyor of the fuel feed system. Calibration was in terms of cubic feet of fuel delivered per hour for each specific fuel size and fuel moisture level. Calibration checks were made at regular intervals.

Note: This method of determining fuel feed rate proved to have limitations in accuracy. The desired information on fuel feed rate was in terms of dry pounds of fuel per hour. To obtain information in this form, it was necessary to determine the volumetric flow rate of the fuel (ft^3/hr), the moisture content of the fuel ($\# \text{H}_2\text{O} / \# \text{fuel}$), and the fuel density ($\# \text{fuel}/\text{ft}^3$). Each of these measurements had inherent inaccuracies. It was found that greater accuracy in determining the fuel flow rate was possible by accurately metering the combustion air and the level of excess air in the exhaust gas. Simple calculations could then be used to determine the fuel feed rate to the combustion chamber based on the combustion air supplied to the chamber.

- 4) Fuel Density: Density of the fuel was determined by collecting samples of the fuel from a sample point mid-way in the screw feed conveyor. Known volume samples were weighed to determine their density. Caution was used to insure uniform compaction of the fuel samples.
- 5) Air Temperature Measurements: Air temperatures through the test facility were determined using standard laboratory and industrial thermometers.
- 6) Gas Flow Rates: Gas (air) flow rates were determined by the use of standard ASTM sharp edge orifices which were calibrated at various temperatures using a standard pitot tube. Pitot traverses were done according to standard methods. Each orifice is equipped with a thermometer for simultaneous temperature measurement. Orifice pressure differentials were recorded for each test condition and gas flow rates were then found by the use of an orifice flow calibration chart.

The main air flow lines to the combustion chamber were equipped with venturi orifice flow meters rather than sharp edge orifice flow meters. This was done to provide greater accuracy in measuring these two critical air flows. The calibration and pressure differential measurement were done as described above.
- 7) Temperatures in the Combustion Chamber: Exhaust gas temperatures inside the combustion chamber were determined by the use of shielded platinum-rhodium thermocouples. The data from these thermocouples is highly suspect due to re-radiation problems at elevated temperatures.
- 8) Exhaust Gas Analyses: An exhaust gas sample line was installed at the inlet to the air preheater. The sample was cooled to approximately 70 °F to condense the water vapor and remove it. Filters were placed in the sample line to remove particulate matter. Continuous oxygen, carbon monoxide, and carbon dioxide analyzers were used to evaluate the flue gas constituents. Fyrite portable analyzers were used to make spot checks on the accuracy of the continuous analyzers.

- 9) Total Ash Carryover: Ash carryover rates were determined gravimetrically using a simple laboratory scale. The ash collected at the base of the cyclone separator was weighed in a tared container and the elapsed time for the collection of the weighed sample was noted. Calculations were then made to determine the rate of ash carryover in terms of pounds/hr.
- 10) Ash Characteristics - Size, Density, Combustible Content: The characteristics of the ash were determined in the laboratory. Size distribution was obtained using standard sieve screen analyses. The density was determined by placing ash samples in graduated cylinders to determine volume, and then weighing the known volume samples to determine density in pounds/cubic foot (or g/cc). Representative samples of the collected ash were used to determine the percent of the ash which was combustible. Tared containers with known amounts of sample were placed in a muffle furnace at 600 °C for 8 hours. The remaining ash was then reweighed to determine the percent of combustible material in the sample.
- 11) Opacity Measurements: Opacity was determined visually.

1. Fuel Species	13. Temperature @ Forced Draft Fan Exit
2. Fuel Size Distribution	14. Air Flow Rate @ Forced Draft Fan Exit
3. Fuel Moisture Content (% by weight - "as-is" basis)	15. Gas Sample Point For Flue Gas Analyses (O_2 , CO, CO_2)
4. Fuel Feed Rate	16. Ash Sample Point
5. Fuel Density	17. Opacity Measurement Point
6. Overfire Air Temperature	
7. Underfire Air Temperature	
8. Overfire Air Flow Rate	
9. Underfire Air Flow Rate	
10. Temperature 60" Above Grate	
11. Temperature @ Air Heater Inlet	
12. Temperature @ Air Heater Exit

Figure 3: Schematic Illustration of Instrumentation Used With the Combustion Test Facility

8. DESIGN OF THE EXPERIMENTS

The overall experimental program was designed to study the influence on the combustion of wood residue fuels of the normal combustion variables found in industrial processes. These variables include:

Fuel Related Variables

Species
Size
Moisture
Feed Rate

Combustion Air Related Variables

Inlet Air Temperature
Level of Excess Air
Distribution of Air Above
and Below The Grate

The principal dependent variable of concern in the experiments is the amount of unburned carbon and non-combustible ash carried out of the combustion chamber per unit of time. This parameter is a measure of the completeness of the combustion reaction in the test facility. High levels of combustible carbon carryover indicate poor combustion conditions. Low levels of carryover indicate better combustion conditions.

The experimental data reported in this document are for only one species: Ponderosa Pine bark. Experimental data for other species are reported in other technical reports. For experimental data in this report, the following parameters and ranges were used:

<u>Variables</u>	<u>Range of Variables</u>		
No. of Experimental Test Runs:	<u>43</u>		
Test Run Numbers:	<u>203</u>	To	<u>248</u>
Range - Fuel Size Used	<u>0.5</u>	To	<u>18.5</u> (mm)
Range - Fuel Moisture Levels Used:	<u>29.7</u>	To	<u>32.7</u> (%H ₂ O: "As-Is")
Range - Fuel Feed Rates Used:	<u>471</u>	To	<u>683</u> (Dry Pounds/Hr)
Range - Levels of Excess Air:	<u>24</u>	To	<u>100</u> (%)
Range - Levels of Inlet Air Temp:	<u>110</u>	To	<u>403</u> (°F)
Range - Levels of Air Distribution:	<u>12</u>	To	<u>83</u> (% Undergrate)

9. DATA COLLECTED

For each test run, data were collected for independent and dependent variables. The independent variables included the following:

- 1) Fuel Related
 - Species
 - Size Range
 - Moisture Content
 - Density
 - Feed Rate
- 2) Air Related
 - Temperatures at:
 - Forced Draft Fan Exit
 - Undergrate Air Duct
 - Overfire Air Duct
 - Air Flow Rates at:
 - Forced Draft Fan Exit
 - Undergrate Air Duct
 - Overfire Air Duct
 - Fuel Conveyor Air Duct
- 3) Weather Conditions

The dependent variables for which data were collected during each test run included the following:

- 1) Combustion Exhaust Gas Temperatures
 - 60" Above the Grate
 - At the Inlet to the Air Preheater
 - At the Exit of the Air Preheater
- 2) Ash Carryover Rate from the Discharge of the Cyclone
- 3) Ash Characteristics in Terms of Size Distribution, Combustible Content, and Density Distribution
- 4) Percent Excess Air as Determined by Oxygen Analyses
- 5) Opacity from the Exhaust Gases

For most but not all test conditions, two replications were made.

10. PROCEDURE FOR CONDUCT OF THE EXPERIMENTAL TEST RUNS

The procedure for conduct of the experimental test runs is outlined below:

- 1) Build a fire in the combustion zone and bring the test facility up to operating temperature. This generally requires 2 hours of operating time to bring the system into equilibrium.
- 2) Introduce fuel to the combustion zone where the fuel is of known and desired species, size distribution, moisture content, and fed at desired feed rates. Collect samples of the fuel to check moisture and density.
- 3) Establish the desired inlet air temperature by controlling the air flow through the air preheater and bypass lines. Establish the desired air flow rates through the overfire air lines and the underfire air duct. Check the level of excess air in the combustion zone as determined by the oxygen content of the exhaust gases. Re-adjust the overfire and underfire air flow rates to maintain desired levels of excess air and percentages of overfire and underfire air.
- 4) Begin data collection. Set the pre-tared ash collection bucket at the discharge of the cyclone collector and seal against leakage. Begin data collection from all temperature, gas flow, and pressure indicators and from the gas analysis equipment. Data points are noted at 10 minute intervals on all indicators except the flue gas analysis equipment which is continuous. Log weather conditions, opacity from the cyclone exit duct, and time of starting the test.
- 5) After sufficient running time (typically 20 to 30 minutes per test), terminate the test. Note time of finish of test run and remove the ash carryover buck from the cyclone bottom outlet. Measure the total weight of collected ash and obtain a sample of the collected ash for laboratory analyses on its characteristics.

- 6) Begin replication run of the test.
- 7) At the end of the replication run, re-adjust fuel and air flow parameters for the next test condition.

11. DATA ANALYSES

1. Fuel Size Analyses

The fuel size distribution is determined by drying a sample of the fuel at 106 °C for a minimum period of 24 hours or until the weight of the fuel sample reaches an equilibrium point. The dried samples are then screened using Tyler Standard screens indicated below:

Screen No.	(Inches)	(mm)
1	1.050	26.67
2	.742	18.85
3	.371	9.423
4	.185	4.760
5	.131	3.327
6	.079	2.000
7	.039	1.000
8	.020	.500
Pan		

The weight of each sample collected on each screen is determined and the mass-size distribution plotted on log-probability graph paper.

2. Fuel Moisture Analyses

Fuel moisture analyses were made by collecting a known weight of sample in a pre-tared container. The samples were then dried using the procedure indicated above in (1.) and re-weighed. Calculations were made to determine moisture content on a wet basis or "as-is" basis.

3. Fuel Density Analyses

Fuel density was determined by collecting a sample of the fuel as it was carried up the fuel feed conveyor (screw conveyor). The sample

was dropped from the conveyor into a container of 0.811 cubic feet volume. When the container was full to the top (with no mechanical compaction), the weight of the container and the fuel were determined. A simple calculation then produced the density of the fuel sample.

The density was important in determining the fuel feed rate to the combustion system in terms of pounds per hour. The feed conveyor was calibrated in terms of cubic feet of fuel delivered per hour.

4. Flue Gas Analyses

The flue gas analysis system consisted of a stainless steel gas sample line connected to the inlet side of the air preheater and to a sample gas cooling and filtration system. The cooling system allowed the entrained water in the exhaust gas to condense and be removed from the sample line. The filtration system removed entrained particulate matter to avoid plugging the gas analyzers.

Downstream from the cooling and filtration system, a sealed pump was installed to move the sample gas through the system. The exit line from the pump was connected to a sample gas header which carried the gas to the analysis instruments.

Two instruments were used to determine the flue gas constituents. An oxygen analyzer and a CO, CO₂ analyzer were used for continuous readings of the component gas percentages in the dry gas sample.

5. Ash Analyses

Laboratory analyses were conducted to determine the combustible and non-combustible content of the ash collected during the test runs. The standard ASTM test procedure was used in which the ash samples were heated to 600 °C until they reached constant weight. Initial and final weights were used to calculate the amount of combustible material in each sample. Standard screen analyses were used to determine the size distribution of the ash samples. Ash density analyses were made by determining the volume of sample collected on each of the filter screens.

6. Computer Analyses of the Data

A program was written (Fortran IV) to make the calculations pertinent to the requirements of the experimental program. The printout groups the related tests for easy comparison of test parameters and lists the independent and dependent variables.

12. EXPERIMENTAL RESULTS

The experimental test results are summarized on pages 18 and 19. The effects of the important parameters are noted on page 18 (Summary of Research Results). The characteristics of the ash are summarized on page 19 for the entire range of test parameters and for optimum combustion conditions.

The experimental data for each test condition is found in the Experimental Data Summary beginning on page 20. This section has the data in tabulated form.

Graphical representation of the data is found in the section beginning on page 33. Several forms of graphic analysis are offered to provide the reader with a greater understanding of the effects due to the combustion variables.

The raw fuel used in the experimental tests was analyzed and its analyses are indicated in tabular and graphic form beginning on page 56.

The ash analyses results are noted in both tabular and graphic form beginning on page 65. The combustible content of the ash samples as a function of their size distribution is noted in tabular and graphic form beginning on page 132.

13. CONCLUSIONS

The conclusions reached from this experimental work are summarized in the beginning of this report under Summary and Conclusions.

SUMMARY OF RESEARCH RESULTS

SUMMARY OF EFFECTS DUE TO:

1. FUEL SIZE: Not determined - only one fuel size used.
2. FUEL MOISTURE: Not determined - only one fuel moisture level used.
3. FUEL FEED RATE: Range studied (dry lbs/hr): 471 to 683
 Effects statistically significant within the range studied:
 Yes _____ No XXX
4. INLET AIR TEMPERATURE:
 Effects statistically significant within the range studied:
 Yes XXX No _____
 As air temperature increases, emissions increase XX decrease _____
 Reference: See pages 43, 44, 53, 54.
5. LEVELS OF EXCESS AIR: Test results indicate an interaction effect
 between level of excess air and distribution of air above and
 below the grate: Yes XXX No _____
 Optimum level of excess air for most test conditions: 50 (%)
 Reference: See pages 51 - 53.
6. DISTRIBUTION OF AIR ABOVE AND BELOW THE GRATE: Lb Air/Lb Dry Fuel
 Optimum rate of air flow through the grate: 3.0 - 4.0
 Range of air flow rates through the grate
 which were successfully tested: 1.0 to 9.9
 Overall optimum air distribution:
 Above the grate (overfire air): 57 (%) to 68 (%)
 Below the grate (underfire air): 32 (%) to 43 (%)
 Reference: See pages 42, 45-50.

SUMMARY OF ASH CHARACTERISTICS

	All Tests (Range)	Optimum Combustion Conditions (Mean)	(Range)
1. Rate of Total Carryover (lbs/hr)	<u>17.2</u> to <u>153.6</u>	<u>21.2</u>	<u>17.2</u> to <u>24.0</u>
2. Concentration of Total Particulate (gr/SCF - not corrected to 12% CO ₂)	<u>1.84</u> to <u>15.26</u>	<u>2.25</u>	<u>1.84</u> to <u>3.29</u>
3. Rate of Total Carryover (lb/lb dry fuel)	<u>3.47</u> to <u>23.31</u>	<u>4.15</u>	<u>3.47</u> to <u>4.70</u>
4. Rate of Combustible Carryover (lb/lb dry fuel)	<u>3.19</u> to <u>21.0</u>	<u>3.70</u>	<u>3.19</u> to <u>4.35</u>
5. Rate of Inorganic Carryover (lb/lb dry fuel)	<u>0.28</u> to <u>2.26</u>	<u>0.30</u>	<u>0.28</u> to <u>0.35</u>
6. Mass Mean Size (mm)	<u>0.89</u> to <u>1.95</u>	<u>1.31</u>	<u>1.06</u> to <u>1.40</u>
7. Mass Mean Density (g/cm ³)	<u>0.06</u> to <u>0.19</u>	<u>0.06</u>	<u>0.06</u> to <u>0.12</u>
8. Mean Combustible Content (%)	<u>64.8</u> to <u>95.8</u>	<u>90.3</u>	<u>88.4</u> to <u>95.8</u>
9. Combustible content as a function of ash size distribution.			

See pages 143, 144.

EXPERIMENTAL DATA SUMMARY SHEETS

EXPERIMENTAL DATA SUMMARY SHEET

TEST SERIES: 203 TO 248FUEL SPECIES: PONDEROSA PINE
BARK

----- FUEL CHARACTERISTICS -----

MASS MEAN SIZE (mm): 7.30 SIZE RANGE (mm): 0.5 TO 18.5MASS MEAN DENSITY (g/cm³): 0.185 DENSITY RANGE (g/cm³): .108 TO .239COMBUSTIBLE CONTENT (% OF DRY FUEL WEIGHT): 98.69

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----- OPERATING PARAMETERS -----						----- TEST RESULTS -----					
TEST FUEL NO.	FUEL FEED RATE (LBS/HR)	FUEL EXCESS H ₂ O AIR (%) (%)	UNDER GRATE AIR (%)	AIR TEMP. (°F)	LBS AIR LB FUEL @ GRATE	ASH RATE (LB/HR)	COMB. ASH (%)	MASS MEAN SIZE (mm)	MASS MEAN DENS. (g/cm ³)	OPACITY (%)	

203	659	32.4	43	83	403	7.59	117.6	84.2	1.80	0.07	10
204	"	"	39	83	385	7.16	153.6				"
205	567	"	76	82	390	9.73	69.6	92.6	1.95	0.07	5
206	"	"	76	82	410	9.75	84.0				"
207	683	"	100	83	432	9.48	99.6	64.8	0.89	0.19	"
208	"	29.7	100	82	410	9.62	87.6				"
209	471	"	25	50	362	4.67	28.0	93.4	1.60	0.07	6
210	471	"	25	50	347	4.74	28.5				6
211	520	"	55	52	365	5.76	44.7	92.6	1.53	0.06	5
212	"	"	60	52	362	5.77	38.2				5
213	"	"	77	52	368	6.66	42.6	89.7	1.60	0.08	"
214	"	"	76	52	367	6.67	40.2				"
217	543	"	22	31	364	2.62	24.0	90.4	1.20	0.06	10
218	"	"	23	30	361	2.61	22.5				10
219	511	"	45	30	363	3.33	19.8	88.4	1.06	0.07	5
221	495	32.7	68	31	367	4.13	17.2	91.8	1.40	0.06	"
222	"	"	68	31	367	4.12	19.3				"

EXPERIMENTAL DATA SUMMARY SHEET

TEST SERIES: 203 TO 248FUEL SPECIES: PONDEROSA PINE
BARK

----- FUEL CHARACTERISTICS -----

MASS MEAN SIZE (mm): 7.30 SIZE RANGE (mm): 0.5 TO 18.5MASS MEAN DENSITY (g/cm³): 0.185 DENSITY RANGE (g/cm³): 0.108 TO 0.239COMBUSTIBLE CONTENT (% OF DRY FUEL WEIGHT): 98.69

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| ----- OPERATING PARAMETERS ----- | | ----- TEST RESULTS ----- |

TEST NO.	FUEL FEED RATE (LBS/HR)	FUEL H ₂ O (%)	EXCESS AIR (%)	UNDER GRATE AIR (%)	AIR TEMP. (°F)	LBS AIR LB FUEL @ GRATE	ASH RATE (LB/HR)	COMB. ASH (%)	MASS MEAN SIZE (mm)	MASS MEAN DENS. (g/cm ³)	OPACITY (%)
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223	495	32.7	90	31	370	4.81	19.1	88.8	1.30	0.07	5
224	"	"	90	31	370	4.83	19.2				"
225	623	"	26	12	108	1.00	40.8	92.2	1.55	0.07	18
226	"	"	30	12	110	1.00	45.0				"
227	"	"	45	13	115	1.14	57.6	89.2	1.40	0.07	15
228	"	"	45	13	115	1.14	45.6				18
229	"	"	77	14	125	1.57	60.6	93.2	1.25	0.06	10
230	"	"	72	79	125	8.60	54.6				10
231	"	"	92	80	135	9.76	54.0				10
232	"	"	92	80	135	9.92	56.4				10
233	559	"	28	51	115	4.36	30.6	92.7	1.20	0.07	12
234	"	"	24	40	115	3.47	26.4				20
235	"	"	40	41	123	4.31	23.4	92.3	1.30	0.12	6
236	"	"	40	41	126	4.30	27.6				6
237	609	"	77	43	135	4.80	40.9	90.8	1.55	0.07	7
238	"	"	80	52	135	6.01	36.7				6
239	625	"	85	50	145	6.11	35.5	91.7	1.35	0.08	5

WOOD SPECIES: PINE BARK
 SIZE RANGE: 3/4" MINUS
 MOISTURE (%): 32.40
 DENSITY (LBS/CU.FT): 14.40

RUN NO:	203.	204.	205.	206.	207.
DATE:	5-10-78	5-10-78	5-10-78	5-10-78	5-11-78
CONVEYOR SETTING:	42.	42.	36.	36.	41.
FUEL FEED RATE:	659.	659.	567.	567.	683.
(DRY LBS/HR)					
HEAT INPUT RATE:	5927490.	5927490.	5099054.	5099054.	6146082.
(BTU/HR)					
HEAT RELEASE RATE:	592749.	592749.	509905.	509905.	614608.
(BTU/HR-SQFT)					
UNDERFIRE:	12-INCH	12-INCH	12-INCH	12-INCH	12-INCH
OVERFIRE:	6-INCH	6-INCH	6-INCH	6-INCH	6-INCH
PERCENT EX. AIR:	43.	39.	76.	76.	100.

TEMPERATURES (DEGREES F)

T2:	1342.	1360.	1273.	1327.	1378.
T3:	1155.	1157.	1045.	1057.	1155.
T4:	725.	738.	693.	697.	807.
FAN OUTLET:	59.	59.	62.	62.	62.
UNDERGRATE:	403.	385.	390.	410.	432.
OVERFIRE:	352.	340.	330.	347.	383.
AIR HEATER:	357.	358.	433.	430.	460.

PRESSURE DIFFERENTIALS (INCHES WATER)

MAIN ORIFICE:	.1	.1	.2	.2	.2
6" VENTURI:	.6	.6	1.0	1.0	1.5
12" VENTURI:	2.3	2.3	3.2	3.2	4.8
3" CONVEYOR:	3.0	3.0	3.0	3.0	3.0
ACROSS GRATE:	2.0	1.9	2.0	2.0	1.6

EXHAUST GAS ANALYSIS (PERCENT)

OXYGEN:	6.5	6.0	9.0	9.0	10.5
CARBON DIOXIDE:	13.5	14.0	0.5	10.5	9.8
CARBON MONOXIDE:	0.00	0.00	.07	.60	.30
OXIDES OF NITROGEN:	0.0	0.0	0.0	0.0	0.0

AIR FLOW RATES (ACFM)

MAIN:	1060.	1060.	1377.	1377.	1412.
UNDERGRATE:	1727.	1830.	2082.	2078.	2517.
OVERFIRE:	363.	379.	448.	447.	526.

AIR FLOW RATES (SCFM)

MAIN:	1005.	1005.	1298.	1298.	1331.
UNDERGRATE:	1040.	981.	1147.	1149.	1346.
OVERFIRE:	219.	203.	247.	247.	281.
UNDER + OVER:	1259.	1184.	1394.	1396.	1627.
CALC. BASED ON:	1208.	1174.	1279.	1279.	1752.
FUEL AND EX. AIR					
PERCENT UG:OF	83.:17.	83.:17.	82.:18.	82.:18.	83.:17.

CARRY OVER DATA

LBS/HR:	117.6	153.6	69.6	84.0	99.6
GR/SCF:	11.359	15.263	6.349	7.663	6.634
PERCENT ASH:	0.	0.	0.	0.	0.
PERCENT COMBUSTIBLE:	0.	0.	0.	0.	0.
LENGTH OF RUN(MIN):	5.	5.	5.	5.	5.
OPACITY:	10.	10.	5.	5.	5.

WEATHER:	CLOUDY	CLOUDY	CLOUDY	RAIN	CLOUDY
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SRU 1.546 UNITS.

RUN COMPLETE

BYE

WOOD SPECIES: PINE BARK
 SIZE RANGE: 3/4" MINUS
 MOISTURE (%): 29.70
 DENSITY (LBS/CU.FT): 14.70

RUN NO:	208.	209.	210.	211.	212.
DATE:	5-11-78	5-11-78	5-11-78	5-11-78	5-11-78
CONVEYOR SETTING:	41.	28.	28.	31.	31.
FUEL FEED RATE:	683.	471.	471.	520.	520.
(DRY LBS/HR)					
HEAT INPUT RATE:	6146082.	4240557.	4240557.	4680293.	4680293.
(BTU/HR)					
HEAT RELEASE RATE:	614608.	424056.	424056.	468029.	468029.
(BTU/HR-SQFT)					
UNDERFIRE:	12-INCH	12-INCH	12-INCH	12-INCH	12-INCH
OVERFIRE:	6-INCH	6-INCH	6-INCH	6-INCH	6-INCH
PERCENT EX. AIR:	100.	25.	25.	55.	60.

TEMPERATURES (DEGREES F)

T2:	1365.	1543.	1545.	1592.	1590.
T3:	1133.	953.	927.	958.	958.
T4:	820.	633.	618.	647.	645.
FAN OUTLET:	63.	62.	64.	66.	66.
UNDERGRATE:	410.	362.	347.	365.	362.
OVERFIRE:	363.	412.	398.	398.	394.
AIR HEATER:	450.	475.	448.	458.	455.

PRESSURE DIFFERENTIALS (INCHES WATER)

MAIN ORIFICE:	.2	0.0	0.0	.1	.1
6" VENTURI:	1.6	5.4	5.3	8.6	8.6
12" VENTURI:	4.9	.4	.4	.8	.8
3" CONVEYOR:	3.0	3.0	3.0	3.0	3.0
ACROSS GRATE:	1.7	1.3	1.1	1.2	1.1

EXHAUST GAS ANALYSIS (PERCENT)

OXYGEN:	10.5	4.5	4.5	7.5	7.6
CARBON DIOXIDE:	9.3	12.6	12.3	11.2	11.5
CARBON MONOXIDE:	.04	.08	.08	.05	.05
OXIDES OF NITROGEN:	0.0	0.0	0.0	0.0	0.0

AIR FLOW RATES (ACFM)

MAIN:	1446.	0.	0.	677.	677.
UNDERGRATE:	2525.	869.	856.	1161.	1159.
OVERFIRE:	537.	882.	864.	1064.	1063.

AIR FLOW RATES (SCFM)

MAIN:	1360.	0.	0.	633.	633.
UNDERGRATE:	1365.	457.	464.	622.	623.
OVERFIRE:	290.	464.	468.	570.	571.
UNDER + OVER:	1655.	921.	932.	1193.	1195.
CALC. BASED ON :	1752.	755.	755.	1034.	1067.
FUEL AND EX. AIR					
PERCENT UG:OF	82.:18.	50.:50.	50.:50.	52.:48.	52.:48.

CARRY OVER DATA

LBS/HR:	87.6	28.0	28.5	44.7	38.2
GR/SCF:	5.835	4.325	4.402	5.048	4.174
PERCENT ASH:	0.	0.	0.	0.	0.
PERCENT COMBUSTIBLE:	0.	0.	0.	0.	0.
LENGTH OF RUN(MIN):	5.	12.	12.	11.	11.
OPACITY:	5.	6.	6.	5.	5.

WEATHER:	CLOUDY	CLDY/RAIN	CLOUDY	CLOUDY	CLOUDY
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SRU 1.547 UNITS.

RUN COMPLETE.

WOOD SPECIES: PINE BARK
 SIZE RANGE: 3/4" MINUS
 MOISTURE (%): 29.70
 DENSITY (LBS/CU.FT): 14.70

RUN NO:	213.	214.	217.	218.	219.
DATE:	5-11-78	5-11-78	5-19-78	5-19-78	5-19-78
CONVEYOR SETTING:	31.	31.	33.	33.	31.
FUEL FEED RATE: (DRY LBS/HR)	520.	520.	543.	543.	511.
HEAT INPUT RATE: (BTU/HR)	4680293.	4680293.	4890769.	4890769.	4602485.
HEAT RELEASE RATE: (BTU/HR-SQFT)	468029.	468029.	489077.	489077.	460249.
UNDERFIRE:	12-INCH	12-INCH	6-INCH	6-INCH	6-INCH
OVERFIRE:	6-INCH	6-INCH	12-INCH	12-INCH	12-INCH
PERCENT EX. AIR:	77.	76.	22.	23.	45.

TEMPERATURES (DEGREES F)

T2:	1527.	1522.	1647.	1648.	1640.
T3:	932.	940.	1040.	1034.	1000.
T4:	648.	650.	692.	703.	703.
FAN OUTLET:	56.	66.	76.	77.	80.
UNDERGRATE:	368.	367.	364.	361.	363.
OVERFIRE:	399.	396.	354.	348.	370.
AIR HEATER:	442.	440.	480.	489.	485.

PRESSURE DIFFERENTIALS (INCHES WATER)

MAIN ORIFICES:	.1	.1	0.0	0.0	.0
6" VENTURI:	12.5	12.5	2.8	2.8	4.1
12" VENTURI:	1.1	1.1	.8	.9	1.3
3" CONVEYOR:	3.0	3.0	3.0	3.0	3.0
ACROSS GRATE:	1.2	1.2	1.0	1.0	1.0

EXHAUST GAS ANALYSIS (PERCENT)

OXYGEN:	9.2	9.1	4.0	4.1	6.6
CARBON DIOXIDE:	10.5	10.5	14.3	14.3	12.4
CARBON MONOXIDE:	.06	.06	.16	.16	.03
OXIDES OF NITROGEN:	0.0	0.0	0.0	0.0	0.0

AIR FLOW RATES (ACFM)

MAIN:	1060.	1060.	0.	0.	521.
UNDERGRATE:	1320.	1319.	566.	569.	681.
OVERFIRE:	1240.	1239.	1285.	1352.	1562.

AIR FLOW RATES (SCFM)

MAIN:	991.	998.	0.	0.	475.
UNDERGRATE:	720.	721.	296.	295.	354.
OVERFIRE:	677.	677.	672.	701.	813.
UNDER + OVER:	1397.	1398.	969.	996.	1168.
CALC. BASED ON :	1180.	1174.	850.	857.	951.
FUEL AND EX. AIR					
PERCENT UG:OF	52.148.	52.148.	31.169.	30.170.	30.170.

CARRY OVER DATA

LBS/HR:	42.6	40.2	24.0	22.5	19.8
GR/SCF:	4.210	3.991	3.293	3.062	2.429
PERCENT ASH:	0.	0.	0.	0.	0.
PERCENT COMBUSTIBLE:	0.	0.	0.	0.	0.
LENGTH OF RUN(MIN):	10.	13.	20.	20.	20.
OPACITY:	5.	5.	10.	10.	5.

WEATHER:	SUNNY	SUNNY	SUNNY	SUNNY	SUNNY
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SRU 1.590 UNTS.

RUN COMPLETE.

WOOD SPECIES: PINE BARK
 SIZE RANGE: 3/4" MINUS
 MOISTURE (%): 32.70
 DENSITY (LBS/CU.FT): 15.10

RUN NO:	221-	222-	223-	224-	225-
DATE:	5-19-78	5-19-78	5-19-78	5-19-78	5-23-78
CONVEYOR SETTING:	30-	30-	30-	30-	38-
FUEL FEED RATE: (DRY LBS/HR)	495-	495-	495-	495-	623-
HEAT INPUT RATE: (BTU/HR)	4458343-	4458343-	4458343-	4458343-	5611480-
HEAT RELEASE RATE: (BTU/HR-SQFT)	445834-	445834-	445834-	445834-	561148-
UNDERFIRE:	6-INCH	6-INCH	6-INCH	6-INCH	6-INCH
OVERFIRE:	12-INCH	12-INCH	12-INCH	12-INCH	12-INCH
PERCENT EX. AIR:	68-	68-	90-	90-	26-

TEMPERATURES (DEGREES F)

T2:	1593-	1600-	1495-	1497-	1500-
T3:	992-	990-	978-	980-	1057-
T4:	710-	707-	717-	719-	647-
FAN OUTLET:	83-	83-	85-	85-	58-
UNDERGRATE:	367-	367-	370-	370-	108-
OVERFIRE:	383-	383-	385-	382-	108-
AIR HEATER:	467-	460-	445-	437-	128-

PRESSURE DIFFERENTIALS (INCHES WATER)

MAIN ORIFICE:	.1	.1	.2	.2	.4
6" VENTURI:	5.9	5.8	7.9	7.9	.3
12" VENTURI:	1.8	1.8	2.5	2.5	.9
3" CONVEYOR:	3.0	3.0	3.0	3.0	3.0
ACROSS GRATE:	.8	.8	.8	.9	1.9

EXHAUST GAS ANALYSIS (PERCENT)

OXYGEN:	8.3	8.3	9.8	9.8	4.6
CARBON DIOXIDE:	11.0	11.0	8.9	8.9	12.5
CARBON MONOXIDE:	.05	.05	.05	.05	.15
OXIDES OF NITROGEN:	0.0	0.0	0.0	0.0	0.0

AIR FLOW RATES (ACFM)

MAIN:	1060-	1060-	1666-	1377-	1835-
UNDERGRATE:	802-	792-	910-	906-	155-
OVERFIRE:	1765-	1758-	1994-	1986-	1087-

AIR FLOW RATES (SCFM)

MAIN:	961-	960-	1505-	1245-	1743-
UNDERGRATE:	425-	424-	495-	497-	129-
OVERFIRE:	937-	940-	1084-	1089-	910-
UNDER + OVER:	1362-	1364-	1579-	1586-	1039-
CALC. BASED ON:	1067-	1067-	1207-	1207-	1008-
FUEL AND EX. AIR PERCENT UG:OF	31.169-	31.169-	31.169-	31.169-	12.188-

CARRY OVER DATA

LBS/HR:	17.2	19.3	19.1	19.2	40.8
GR/SCF:	1.878	2.113	1.842	1.856	4.724
PERCENT ASH:	0-	0-	0-	0-	0-
PERCENT COMBUSTIBLE:	0-	0-	0-	0-	0-
LENGTH OF RUN (MIN):	22-	18-	17-	20-	10-
OPACITY:	5-	5-	5-	5-	18-

WEATHER:	SUNNY	SUNNY	SUNNY	SUNNY	PART. SUN
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SRU 1.586 UNTS.

RUN COMPLETE.

WOOD SPECIES: PINE BARK
 SIZE RANGE: 3/4" MINUS
 MOISTURE (%): 32.70
 DENSITY (LBS/CU.FT): 15.10

RUN NO:	226.	227.	228.	229.	230.
DATE:	5-23-78	5-23-78	5-23-78	5-23-78	5-23-78
CONVEYOR SETTING:	38.	38.	38.	38.	38.
FUEL FEED RATE:	623.	623.	623.	623.	623.
(DRY LBS/HR)					
HEAT INPUT RATE:	5611480.	5611480.	5611480.	5611480.	5611480.
(BTU/HR)					
HEAT RELEASE RATE:	561148.	561148.	561148.	561148.	561148.
(BTU/HR-SQFT)					
UNDERFIRE:	6.INCH	6.INCH	6.INCH	6.INCH	12.INCH
OVERFIRE:	12.INCH	12.INCH	12.INCH	12.INCH	6.INCH
PERCENT EX. AIR:	30.	45.	45.	77.	72.

TEMPERATURES (DEGREES F)

T2:	1512.	1510.	1512.	1507.	1517.
T3:	1027.	1035.	1052.	1065.	1073.
T4:	665.	687.	698.	753.	758.
FAN OUTLET:	59.	60.	60.	56.	55.
UNDERGRATE:	110.	115.	115.	125.	125.
OVERFIRE:	110.	115.	115.	125.	125.
AIR HEATER:	130.	135.	135.	145.	145.

PRESSURE DIFFERENTIALS (INCHES WATER)

MAIN ORIFICE:	.4	.4	.4	.5	.5
6" VENTURI:	.3	.4	.4	.8	.8
12" VENTURI:	.9	1.2	1.2	1.9	1.9
3" CONVEYOR:	3.0	3.0	3.0	3.0	3.0
ACROSS GRATE:	1.7	1.8	2.1	2.1	1.9

EXHAUST GAS ANALYSIS (PERCENT)

OXYGEN:	5.0	6.6	6.6	9.1	8.7
CARBON DIOXIDE:	12.5	12.4	12.4	10.7	10.7
CARBON MONOXIDE:	.13	.10	.10	.10	.10
OXIDES OF NITROGEN:	0.0	0.0	0.0	0.0	0.0

AIR FLOW RATES (ACFM)

MAIN:	1835.	1965.	1939.	2130.	2157.
UNDERGRATE:	155.	1113.	178.	250.	1368.
OVERFIRE:	1089.	288.	1223.	1478.	360.

AIR FLOW RATES (SCFM)

MAIN:	1739.	1859.	1834.	2080.	2060.
UNDERGRATE:	129.		147.	203.	1113.
OVERFIRE:	908.		1011.	1202.	293.
UNDER + OVER:	1037.	1159.	1159.	1406.	1406.
CALC. BASED ON :	1040.	1159.	1159.	1415.	1375.
FUEL AND EX. AIR					
PERCENT UG:OF	12.:88.	13.:87	13.:87.	14.:86.	79.:21.

CARRY OVER DATA

LBS/HR:	45.0	57.6	45.6	60.6	54.6
GR/SCF:	5.050	5.796	4.588	4.995	4.631
PERCENT ASH:	0.	0.	0.	0.	0.
PERCENT COMBUSTIBLE:	0.	0.	0.	0.	0.
LENGTH OF RUN(MIN):	10.	10.	10.	10.	10.
OPACITY:	18.	15.	18.	10.	10.

WEATHER:	MSTLY SUN	RAIN	CLOUDY	CLDY/RAIN	RAIN
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SRU 1.492 UNTS.

RUN COMPLETE.

WOOD SPECIES: PINE BARK
 SIZE RANGE: 3/4" MINUS
 MOISTURE (%): 32.70
 DENSITY (LBS/CU-FT): 15.10

RUN NO:	231.	232.	233.	234.	235.
DATE:	5-23-78	5-23-78	5-23-78	5-23-78	5-23-78
CONVEYOR SETTING:	38.	38.	34.	34.	34.
FUEL FEED RATE:	623.	623.	559.	559.	559.
(DRY LBS/HR)					
HEAT INPUT RATE:	5611480.	5611480.	5034912.	5034912.	5034912.
(BTU/HR)					
HEAT RELEASE RATE:	561148.	561148.	503491.	503491.	503491.
(BTU/HR-SQFT)					
UNDERFIRE:	12-INCH	12-INCH	12-INCH	6-INCH	6-INCH
OVERFIRE:	6-INCH	6-INCH	6-INCH	12-INCH	12-INCH
PERCENT EX. AIR:	98.	92.	28.	24.	40.

TEMPERATURES (DEGREES F)

	231.	232.	233.	234.	235.
T2:	1502.	1473.	1535.	1537.	1580.
T3:	1048.	1053.	1042.	1058.	1038.
T4:	762.	768.	625.	633.	658.
FAN OUTLET:	56.	55.	58.	58.	58.
UNDERGRATE:	135.	135.	115.	115.	123.
OVERFIRE:	135.	135.	115.	115.	123.
AIR HEATER:	155.	155.	135.	135.	143.

PRESSURE DIFFERENTIALS (INCHES WATER)

	231.	232.	233.	234.	235.
MAIN ORIFICE:	.6	.6	.3	.3	.4
6" VENTURI:	1.0	1.0	3.2	3.3	5.3
12" VENTURI:	2.6	2.7	.3	.3	.5
3" CONVEYOR:	3.0	3.0	2.9	2.9	3.0
ACROSS GRATE:	2.3	0.0	1.1	1.1	1.3

EXHAUST GAS ANALYSIS (PERCENT)

	231.	232.	233.	234.	235.
OXYGEN:	10.0	10.0	4.8	4.3	6.2
CARBON DIOXIDE:	9.4	9.4	14.1	14.1	13.1
CARBON MONOXIDE:	.10	.14	.15	.28	.09
OXIDES OF NITROGEN:	0.0	0.0	0.0	0.0	0.0

AIR FLOW RATES (ACFM)

	231.	232.	233.	234.	235.
MAIN:	2398.	2418.	1752.	1780.	1965.
UNDERGRATE:	1580.	1605.	612.	487.	614.
OVERFIRE:	390.	390.	588.	720.	878.

AIR FLOW RATES (SCFM)

	231.	232.	233.	234.	235.
MAIN:	2288.	2309.	1664.	1691.	1865.
UNDERGRATE:	1264.	1284.	506.	403.	501.
OVERFIRE:	312.	312.	486.	596.	716.
UNDER + OVER:	1576.	1597.	993.	998.	1218.
CALC. BASED ON FUEL AND EX. AIR	1535.	1535.	918.	890.	1004.
PERCENT UG:OF	30.120.	30.120.	51.149.	40.160.	41.159.

CARRY OVER DATA

	231.	232.	233.	234.	235.
LBS/HR:	54.0	56.4	30.6	26.4	23.4
GR/SCF:	4.103	4.286	3.887	3.462	2.718
PERCENT ASH:	0.	2.	0.	0.	0.
PERCENT COMBUSTIBLE:	0.	0.	0.	0.	0.
LENGTH OF RUN(MIN):	8.	5.	10.	10.	10.
OPACITY:	10.	10.	12.	20.	6.
WEATHER:	RAIN	RAIN	RAIN	RAIN	CLOUDY

SRU 1.550 UNTS.

RUN COMPLETE.

WOOD SPECIES: PINE BARK
 SIZE RANGE: 3/4" MINUS
 MOISTURE (%): 32.70
 DENSITY (LBS/CU-FT): 15.10

RUN NO:	236.	237.	238.	239.	240.
DATE:	5-23-78	5-24-78	5-24-78	5-24-78	5-24-78
CONVEYOR SETTING:	34.	37.	37.	38.	38.
FUEL FEED RATE: (DRY LBS/HR)	559.	609.	609.	625.	625.
HEAT INPUT RATE: (BTU/HR)	5034912.	5483101.	5483101.	5627659.	5627659.
HEAT RELEASE RATE: (BTU/HR-SQFT)	503491.	548310.	548310.	562766.	562766.
UNDERFIRE:	6-INCH	6-INCH	12-INCH	12-INCH	12-INCH
OVERFIRE:	12-INCH	12-INCH	6-INCH	6-INCH	6-INCH
PERCENT EX. AIR:	40.	77.	80.	85.	85.

TEMPERATURES (DEGREES F)

T2:	1572.	1570.	1533.	1560.	1557.
T3:	1035.	998.	987.	1018.	1015.
T4:	657.	673.	672.	700.	707.
FAN OUTLET:	58.	56.	57.	58.	60.
UNDERGRATE:	126.	135.	135.	145.	148.
OVERFIRE:	126.	135.	135.	145.	148.
AIR HEATER:	146.	155.	155.	165.	168.

PRESSURE DIFFERENTIALS (INCHES WATER)

MAIN ORIFICE:	.4	.5	.5	.6	.6
6" VENTURI:	5.3	8.1	8.1	11.1	11.2
12" VENTURI:	.5	.7	.8	.9	.9
3" CONVEYOR:	3.0	3.0	3.0	3.0	3.0
ACROSS GRATE:	1.2	1.4	1.3	1.3	1.3

EXHAUST GAS ANALYSIS (PERCENT)

OXYGEN:	6.7	9.1	9.3	9.7	9.7
CARBON DIOXIDE:	13.2	10.6	10.6	10.2	10.2
CARBON MONOXIDE:	.09	.10	.10	.10	.10
OXIDES OF NITROGEN:	0.0	0.0	0.0	0.0	0.0

AIR FLOW RATES (ACFM)

MAIN:	1965.	2203.	2203.	2334.	2313.
UNDERGRATE:	616.	759.	950.	1008.	1010.
OVERFIRE:	880.	1007.	869.	999.	1005.

AIR FLOW RATES (SCFM)

MAIN:	1865.	2099.	2095.	2218.	2190.
UNDERGRATE:	500.	607.	760.	793.	791.
OVERFIRE:	714.	805.	695.	787.	787.
UNDER + OVER:	1214.	1413.	1455.	1580.	1579.
CALC. BASED ON :	1004.	1383.	1406.	1484.	1484.
FUEL AND EX. AIR					
PERCENT UG:OF	41.:59.	43.:57.	52.:48.	50.:50.	50.:50.

CARRY OVER DATA

LBS/HR:	27.6	40.9	36.7	35.5	36.0
GR/SCF:	3.206	3.451	3.042	2.788	2.831
PERCENT ASH:	0.	0.	0.	0.	0.
PERCENT COMBUSTIBLE:	0.	0.	0.	0.	0.
LENGTH OF RUN(MIN):	10.	11.	9.	11.	10.
OPACITY:	6.	7.	6.	5.	5.

WEATHER:	CLDY/RAIN CLOUDY	CLOUDY	CLOUDY	CLOUDY
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SRU 1.601 UNTS.

RUN COMPLETE.

WOOD SPECIES: PINE BARK
 SIZE RANGE: 3/4" MINUS
 MOISTURE (%): 31.60
 DENSITY (LBS/CU.FT): 14.90

RUN NO:	241.	242.	243.	244.	245.
DATE:	5-24-78	5-24-78	5-24-78	5-24-78	5-24-78
CONVEYOR SETTING:	32.	32.	32.	32.	34.
FUEL FEED RATE: (DRY LBS/HR)	529.	529.	529.	529.	561.
HEAT INPUT RATE:	4760313.	4760313.	4760313.	4760313.	5049428.
(BTU/HR)					
HEAT RELEASE RATE:	476031.	476031.	476031.	476031.	504943.
(BTU/HR-SQFT)					
UNDERFIRE:	6-INCH	6-INCH	6-INCH	6-INCH	6-INCH
OVERFIRE:	12-INCH	12-INCH	12-INCH	12-INCH	12-INCH
PERCENT EX. AIR:	29.	26.	49.	58.	77.

TEMPERATURES (DEGREES F)

T2:	1592.	1608.	1680.	1647.	1610.
T3:	1065.	1077.	1035.	1007.	1002.
T4:	638.	642.	643.	643.	665.
FAN OUTLET:	60.	61.	64.	63.	62.
UNDERGRATE:	129.	130.	130.	130.	125.
OVERFIRE:	129.	130.	130.	130.	125.
AIR HEATER:	149.	150.	150.	150.	145.

PRESSURE DIFFERENTIALS (INCHES WATER)

MAIN ORIFICE:	.3	.3	.4	.4	.5
6" VENTURI:	1.8	1.8	2.6	2.6	3.8
12" VENTURI:	.5	.5	.8	.8	1.1
3" CONVEYOR:	3.0	3.0	3.0	3.0	3.0
ACROSS GRATE:	1.1	1.1	1.1	1.1	1.0

EXHAUST GAS ANALYSIS (PERCENT)

OXYGEN:	4.9	4.6	6.9	7.8	9.1
CARBON DIOXIDE:	13.8	13.8	12.4	11.8	11.5
CARBON MONOXIDE:	.20	.20	.05	.05	.06
OXIDES OF NITROGEN:	0.0	0.0	0.0	0.0	0.0

AIR FLOW RATES (ACFM)

MAIN:	1780.	1780.	2039.	2014.	2203.
UNDERGRATE:	369.	370.	440.	440.	525.
OVERFIRE:	882.	883.	1056.	1056.	1191.

AIR FLOW RATES (SCFM)

MAIN:	1684.	1680.	1915.	1896.	2077.
UNDERGRATE:	298.	298.	355.	355.	427.
OVERFIRE:	712.	712.	852.	852.	969.
UNDER + OVER:	1011.	1010.	1207.	1207.	1396.
CALC. BASED ON :	875.	855.	1011.	1072.	1274.
FUEL AND EX. AIR					
PERCENT UG:OF	30.:70.	30.:70.	29.:71.	29.:71.	31.:69.

CARRY OVER DATA

LBS/HR:	27.0	29.0	24.0	24.5	21.2
GR/SCF:	3.600	3.958	2.770	2.667	1.942
PERCENT ASH:	0.	0.	0.	0.	0.
PERCENT COMBUSTIBLE:	0.	0.	0.	0.	0.
LENGTH OF RUN(MIN):	12.	12.	11.	12.	15.
OPACITY:	6.	6.	5.	5.	5.

WEATHER:	CLOUDY	CLOUDY	CLOUDY	CLOUDY	CLOUDY
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SRU 1.601 UNTS.

RUN COMPLETE.

WOOD SPECIES: PINE BARK
 SIZE RANGE: 3/4" MINUS
 MOISTURE (%): 31.60
 DENSITY (LBS/CU-FT): 14.90

RUN NO:	246-	247-	248-	0-	0-
DATE:	5-24-78	5-24-78	5-24-78	11:11:11	11:11:11
CONVEYOR SETTING:	34-	34-	34-	0-	0-
FUEL FEED RATE: (DRY LBS/HR)	561-	561-	561-	0-	0-
HEAT INPUT RATE: (BTU/HR)	5049428-	5049428-	5049428-	0-	0-
HEAT RELEASE RATE: (BTU/HR-SQFT)	504943-	504943-	504943-	0-	0-
UNDERFIRE:	6-INCH	6-INCH	6-INCH	0-INCH	0-INCH
OVERFIRE:	12-INCH	12-INCH	12-INCH	0-INCH	0-INCH
PERCENT EX. AIR:	75-	90-	83-	0-	0-

TEMPERATURES (DEGREES F)

T2:	1595-	1497-	1568-	0-	0-
T3:	1013-	985-	1022-	0-	0-
T4:	650-	685-	698-	0-	0-
FAN OUTLET:	62-	62-	61-	0-	0-
UNDERGRATE:	125-	126-	124-	0-	0-
OVERFIRE:	125-	126-	124-	0-	0-
AIR HEATER:	145-	146-	144-	0-	0-

PRESSURE DIFFERENTIALS (INCHES WATER)

MAIN ORIFICE:	.5	.6	.6	0.0	0.0
6" VENTURI:	3.7	5.0	5.0	0.0	0.0
12" VENTURI:	1.1	1.6	1.6	0.0	0.0
3" CONVEYOR:	3.0	3.0	3.0	0.0	0.0
ACROSS GRATE:	1.1	1.0	1.0	0.0	0.0

EXHAUST GAS ANALYSIS (PERCENT)

OXYGEN:	8.9	9.9	9.5	0.0	0.0
CARBON DIOXIDE:	11.5	10.1	10.5	0.0	0.0
CARBON MONOXIDE:	.06	.08	.08	0.00	0.00
OXIDES OF NITROGEN:	0.0	0.0	0.0	0.0	0.0

AIR FLOW RATES (ACFM)

MAIN:	2203-	2418-	2398-	0-	0-
UNDERGRATE:	519-	599-	598-	0-	0-
OVERFIRE:	1191-	1382-	1380-	0-	0-

AIR FLOW RATES (SCFM)

MAIN:	2077-	2280-	2264-	0-	0-
UNDERGRATE:	422-	486-	487-	0-	0-
OVERFIRE:	969-	1122-	1124-	0-	0-
UNDER + OVER:	1390-	1608-	1611-	0-	0-
CALC. BASED ON :	1259-	1367-	1317-	0-	0-
FUEL AND EX. AIR					
PERCENT UG:OF	30.170-	30.170-	30.170-	0.1 0-	0.1 0-

CARRY OVER DATA

LBS/HR:	20.0	22.2	23.1	0.0	0.0
GR/SCF:	1.853	1.894	2.050	0.000	0.000
PERCENT ASH:	0-	0-	0-	0-	0-
PERCENT COMBUSTIBLE:	0-	0-	0-	0-	0-
LENGTH OF RUN(MIN):	21-	20-	21-	0-	0-
OPACITY:	5-	5-	5-	0-	0-
WEATHER:	CLOUDY	CLOUDY	CLOUDY		

SRU 1.429 UNITS.

RUN COMPLETE.

GRAPHS OF COLLECTED DATA

PLOT OF CARRYOVER RATE VS. LEVEL OF EXCESS AIR
AS MEASURED DOWNSTREAM FROM THE COMBUSTION PROCESS

TEST NOS.: 203-208
SPECIES: Pine Bark
SIZE: 3/4" Minus
MOISTURE: 32%

FUEL FEED RATE (DRY LBS/HR): 567
HEAT RELEASE RATE (BTU/HR): 5.9×10^5
INLET AIR TEMPERATURE (°F): 405
PERCENT UNDERGRATE AIR: 83

PLOT OF CARRYOVER RATE VS. LEVEL OF EXCESS AIR
AS MEASURED DOWNSTREAM FROM THE COMBUSTION PROCESS

TEST NOS.: 209-214
SPECIES: Pine Bark
SIZE: 3/4" Minus
MOISTURE: 30%

FUEL FEED RATE (DRY LBS/HR): 520
HEAT RELEASE RATE (BTU/HR): 4.2×10^5
INLET AIR TEMPERATURE (°F): 362
PERCENT UNDERGRATE AIR: 52

PLOT OF CARRYOVER RATE VS. LEVEL OF EXCESS AIR
AS MEASURED DOWNSTREAM FROM THE COMBUSTION PROCESS

TEST NOS.: 217-224
SPECIES: Pine Bark
SIZE: 3/4" Minus
MOISTURE: 33%

FUEL FEED RATE (DRY LBS/HR): 543
HEAT RELEASE RATE (BTU/HR): 4.8×10^5
INLET AIR TEMPERATURE (°F): 362
PERCENT UNDERGRATE AIR: 30

PLOT OF CARRYOVER RATE VS. LEVEL OF EXCESS AIR
AS MEASURED DOWNSTREAM FROM THE COMBUSTION PROCESS

TEST NOS.: 225-229
SPECIES: Pine Bark
SIZE: 3/4" Minus
MOISTURE: 33%

FUEL FEED RATE (DRY LBS/HR): 623
HEAT RELEASE RATE (BTU/HR): 5.6×10^5
INLET AIR TEMPERATURE (°F): 115
PERCENT UNDERGRATE AIR: 13

PLOT OF CARRYOVER RATE VS. LEVEL OF EXCESS AIR
AS MEASURED DOWNSTREAM FROM THE COMBUSTION PROCESS

TEST NOS.: 230-232
SPECIES: Pine Bark
SIZE: 3/4" Minus
MOISTURE: 33%

FUEL FEED RATE (DRY LBS/HR): 623
HEAT RELEASE RATE (BTU/HR): 5.6×10^5
INLET AIR TEMPERATURE (°F): 131
PERCENT UNDERGRATE AIR: 80

PLOT OF CARRYOVER RATE VS. LEVEL OF EXCESS AIR
AS MEASURED DOWNSTREAM FROM THE COMBUSTION PROCESS

TEST NOS.: 234-237
SPECIES: Pine Bark
SIZE: 3/4" Minus
MOISTURE: 33%

FUEL FEED RATE (DRY LBS/HR): 559
HEAT RELEASE RATE (BTU/HR): 5.0×10^5
INLET AIR TEMPERATURE (°F): 124
PERCENT UNDERGRATE AIR: 40

PLOT OF CARRYOVER RATE VS. LEVEL OF EXCESS AIR
AS MEASURED DOWNSTREAM FROM THE COMBUSTION PROCESS

TEST NOS.: 238-240
SPECIES: Pine Bark
SIZE: 3/4" Minus
MOISTURE: 32%

FUEL FEED RATE (DRY LBS/HR): 625
HEAT RELEASE RATE (BTU/HR): 5.6×10^5
INLET AIR TEMPERATURE (°F): 142
PERCENT UNDERGRATE AIR: 50

PLOT OF CARRYOVER RATE VS. LEVEL OF EXCESS AIR
AS MEASURED DOWNSTREAM FROM THE COMBUSTION PROCESS

TEST NOS.: 241-248
SPECIES: Pine Bark
SIZE: 3/4" Minus
MOISTURE: 32%

FUEL FEED RATE (DRY LBS/HR): 529
HEAT RELEASE RATE (BTU/HR): 4.8×10^5
INLET AIR TEMPERATURE (°F): 129
PERCENT UNDERGRATE AIR: 30

———— CARRYOVER VS. LB-AIR/LB-FUEL
- - - - MEAN PARTICLE SIZE VS. LB-AIR/LB-FUEL
——— % COMBUSTIBLE MATERIAL VS. LB-AIR/LB-FUEL

PINE BARK
RUNS: 201-225
AVERAGE TEMPERATURE - 365° F

———— CARRYOVER VS. LB-AIR/LB-FUEL
- - - MEAN PARTICLE SIZE VS. LB-AIR/LB-FUEL
- - - % COMBUSTIBLE MATERIAL VS. LB-AIR/LB-FUEL

PINE BARK
RUNS: 226-248
AVERAGE TEMPERATURE - 127° F.

SPECIES: PONDEROSA PINERUNS 229 TO 248TEMPERATURE: LOWAVERAGE MOISTURE CONTENT: 32%

PLOT OF THE COMPLETENESS OF THE COMBUSTION REACTION EXPRESSED AS THE LBS OF NON-COMBUSTED FUEL CARRIED OUT OF THE FURNACE/LB OF DRY FUEL ENTERING VERSUS THE AIR:FUEL RATIO AT THE GRATE

SPECIES: PONDEROSA PINERUNS 203 TO 224TEMPERATURE: HIGHAVERAGE MOISTURE CONTENT: 32 %

PLOT OF THE COMPLETENESS OF THE COMBUSTION REACTION EXPRESSED AS THE LBS OF NON-COMBUSTED FUEL CARRIED OUT OF THE FURNACE/LB OF DRY FUEL ENTERING VERSUS THE AIR:FUEL RATIO AT THE GRATE

SPECIES: PONDEROSA PINE BARK RUNS 225 TO 247TEMPERATURE: LOW AVERAGE MOISTURE CONTENT: 32 %

PLOT OF THE COMPLETENESS OF THE COMBUSTION REACTION EXPRESSED AS THE LBS OF NON-COMBUSTED FUEL CARRIED OUT OF THE FURNACE/LB OF DRY FUEL ENTERING VERSUS THE AIR:FUEL RATIO AT THE GRATE

SPECIES: PONDEROSA PINE BARK RUNS 203 TO 223TEMPERATURE: HIGH AVERAGE MOISTURE CONTENT: 32%

PLOT OF THE COMPLETENESS OF THE COMBUSTION REACTION EXPRESSED AS THE LBS OF NON-COMBUSTED FUEL CARRIED OUT OF THE FURNACE/LB OF DRY FUEL ENTERING VERSUS THE AIR:FUEL RATIO AT THE GRATE

SPECIES: PONDEROSA PINERUNS: 225 TO 247TEMPERATURE: LOW

AVERAGE MOISTURE CONTENT: _____ (%)

PLOT OF THE PERCENT OF REMOVAL OF INORGANIC ASH VS. AIR:FUEL AT THE GRATE

SPECIES: PONDEROSA PINERUNS: 203 TO 223TEMPERATURE: HIGH

AVERAGE MOISTURE CONTENT: _____ (%)

PLOT OF THE PERCENT OF REMOVAL OF INORGANIC ASH VS. AIR:FUEL AT THE GRATE

CARRYOVER VS. EXCESS AIR
VARYING UNDERGRATE VS. OVERFIRE AIR RATIO

Pine Bark

CARRYOVER RATE VS. EXCESS AIR
VARYING UNDERGRATE VS. OVERFIRE AIR RATIO

CARRYOVER RATE VS. EXCESS AIR
VARYING INLET AIR TEMPERATURES

Pine Bark

CARRYOVER RATE VS. EXCESS AIR
VARYING INLET AIR TEMPERATURES

Pine Bark

CARRYOVER RATE VS. EXCESS AIR
VARYING INLET AIR TEMPERATURES

Pine Bark

FUEL ANALYSIS DATA AND GRAPHS

DATA FORM - RAW FUEL ANALYSES

FUEL: PINE BARK

COMBUSTIBLE CONTENT ANALYSES

	SAMPLE NO. 1	SAMPLE NO. 2	SAMPLE NO. 3
INITIAL SAMPLE + CRUCIBLE WT (gm)	<u>34.31</u>	<u>33.48</u>	<u>34.12</u>
CRUCIBLE WT (gm)	<u>26.58</u>	<u>25.77</u>	<u>25.90</u>
SAMPLE WT (gm)	<u>7.73</u>	<u>7.71</u>	<u>8.22</u>
FINAL SAMPLE + CRUCIBLE WT (gm)	<u>26.67</u>	<u>25.88</u>	<u>26.01</u>
CRUCIBLE WT (gm)	<u>26.58</u>	<u>25.77</u>	<u>25.90</u>
ASH WT (gm)	<u>0.09</u> % <u>1.16</u>	<u>0.11</u> % <u>1.43</u>	<u>0.11</u> % <u>1.34</u>
COMBUSTIBLE CARBON WT (gm)	<u>7.64</u> % <u>98.84</u>	<u>7.60</u> % <u>98.57</u>	<u>8.11</u> % <u>98.66</u>

AVERAGE % INORGANIC ASH: 1.31AVERAGE % COMBUSTIBLE CARBON: 98.69

SIZE AND DENSITY ANALYSES

SIZE (mm)	SAMPLE + PAN (gm)	PAN TARE (gm)	SAMPLE WT (gm)	CUMULATIVE WT (gm)	CUMU- LATIVE %	VOLUME (cc)	DENSITY (gm/cc)
26.67							
18.85							
9.423	29.92	17.12	12.80	139.17		85	0.151
4.760	63.14	17.12	46.02	126.37	90.80	235	0.196
3.327	29.05	17.12	11.93	80.35	57.74	110	0.108
2.000	39.29	17.12	22.17	68.42	49.16	100	0.222
1.000	37.43	17.12	20.31	46.25	33.23	90	0.226
0.500	31.78	17.12	14.66	25.94	18.64	65	0.226
PAN	28.40	17.12	11.28	11.28	8.11	55	0.205

SIZE AND DENSITY ANALYSES

PINE BARK

SIZE (mm)	SAMPLE + PAN (gm)	PAN TARE (gm)	SAMPLE WT (gm)	CUMULATIVE WT (gm)	CUMU- LATIVE %	VOLUME (cc)	DENSITY (gm/cc)
26.67							
18.85							
9.423	38.44	17.12	21.32	141.59		105	0.203
4.760	58.17	17.12	41.05	120.27	84.94	200	0.205
3.327	37.75	17.12	20.63	79.22	55.95	95	0.146
2.000	38.60	17.12	21.48	58.59	41.38	90	0.239
1.000	33.65	17.12	16.53	37.11	26.21	70	0.236
0.500	28.55	17.12	11.43	20.58	14.53	55	0.208
PAN	26.27	17.12	9.15	9.15	6.46	47	0.195

SIZE AND DENSITY ANALYSES

PINE BARK

SIZE (mm)	SAMPLE + PAN (gm)	PAN TARE (gm)	SAMPLE WT (gm)	CUMULATIVE WT (gm)	CUMU- LATIVE %	VOLUME (cc)	DENSITY (gm/cc)
26.67							
18.85							
9.423	36.16	17.12	19.04	141.59		115	0.166
4.760	63.73	17.12	46.61	122.55	86.55	240	0.194
3.327	37.60	17.12	20.48	75.94	53.63	100	0.205
2.000	37.07	17.12	19.95	55.46	39.17	89	0.224
1.000	32.87	17.12	15.75	35.51	25.08	68	0.232
0.500	27.96	17.12	10.84	19.76	13.96	51	0.213
PAN	26.04	17.12	8.92	8.92	6.30	45	0.198

PLOT OF PARTICLE SIZE DISTRIBUTION

PINE BARK

RUN NUMBER: 1

PLOT OF PARTICLE DENSITY VERSUS GEOMETRIC MEAN SIZE

PINE BARK

RUN NUMBER: 1

▲ = Density of material collected in pan, i.e. particles less than 0.500mm.

PLOT OF PARTICLE SIZE DISTRIBUTION

PINE BARK

RUN NUMBER: 2

PLOT OF PARTICLE DENSITY VERSUS GEOMETRIC MEAN SIZE

PINE BARK

RUN NUMBER: 2

▲ = Density of material collected in pan, i.e. particles less than 0.500mm.

PLOT OF PARTICLE SIZE DISTRIBUTION

PINE BARK

RUN NUMBER: 3

PLOT OF PARTICLE DENSITY VERSUS GEOMETRIC MEAN SIZE

PINE BARK

RUN NUMBER: 3

▲ = Density of material collected in pan, i.e. particles less than 0.500mm.

ASH ANALYSIS DATA AND GRAPHS

DATA FORM - WOOD ASH ANALYSESRUN NO: 201

COMBUSTABLE CONTENT ANALYSES

	SAMPLE NO. 1	SAMPLE NO. 2
INITIAL SAMPLE + CRUCIBLE WT (gm)	<u>28.77</u>	<u>31.85</u>
CRUCIBLE WT (gm)	<u>27.28</u>	<u>30.30</u>
SAMPLE WT (gm)	<u>1.49</u>	<u>1.55</u>
FINAL SAMPLE + CRUCIBLE WT (gm)	<u>27.36</u>	<u>30.36</u>
CRUCIBLE WT (gm)	<u>27.28</u>	<u>30.30</u>
ASH WT (gm)	<u>0.08</u> % <u>5.37</u>	<u>0.06</u> % <u>3.87</u>
COMBUSTABLE CARBON WT (gm)	<u>1.41</u> % <u>94.63</u>	<u>1.49</u> % <u>96.13</u>

AVERAGE % INORGANIC ASH: 4.62AVERAGE % COMBUSTABLE CARBON: 95.38

SIZE AND DENSITY ANALYSES

SIZE (mm)	SAMPLE + PAN (gm)	PAN TARE (gm)	SAMPLE WT (gm)	CUMULATIVE WT (gm)	CUMULATIVE % %	VOLUME (cc)	DENSITY (gm/cc)
4.000	19.31	17.28	2.03	43.71		38	0.053
2.000	42.45	17.28	25.17	41.68	95.36	369	0.068
1.000	28.71	17.28	11.43	16.51	37.77	156	0.073
.500	20.04	17.28	2.76	5.08	11.62	33	0.084
.250	17.87	17.28	0.59	2.32	5.31	4.5	0.013
.125	17.68	17.28	0.40	1.73	3.96	2.8	0.014
.063	17.76	17.28	0.48	1.33	3.04	2.6	0.184
.045	17.81	17.28	0.53	0.85	1.94	4.5	0.118
PAN	17.60	17.28	0.32	0.32	0.73	2.4	0.133

DATA FORM - WOOD ASH ANALYSES

RUN NO: 203

COMBUSTABLE CONTENT ANALYSES

	SAMPLE NO. 1	SAMPLE NO. 2
INITIAL SAMPLE + CRUCIBLE WT (gm)	<u>30.70</u>	<u>31.78</u>
CRUCIBLE WT (gm)	<u>28.98</u>	<u>30.02</u>
SAMPLE WT (gm)	<u>1.72</u>	<u>1.76</u>
FINAL SAMPLE + CRUCIBLE WT (gm)	<u>29.26</u>	<u>30.29</u>
CRUCIBLE WT (gm)	<u>28.98</u>	<u>30.02</u>
ASH WT (gm)	<u>0.28</u> % <u>16.28</u>	<u>0.27</u> % <u>15.3</u>
COMBUSTABLE CARBON WT (gm)	<u>1.44</u> % <u>83.72</u>	<u>1.49</u> % <u>84.1</u>

AVERAGE % INORGANIC ASH: 15.81 AVERAGE % COMBUSTABLE CARBON: 84.19

SIZE AND DENSITY ANALYSES

SIZE (mm)	SAMPLE + PAN (gm)	PAN TARE (gm)	SAMPLE WT (gm)	CUMULATIVE WT (gm)	CUMULATIVE % %	VOLUME (cc)	DENSITY (gm/cc)
4.000	18.47	17.34	1.13	46.01		20	0.057
2.000	34.28	17.35	16.93	44.88	97.54	241	0.070
1.000	31.44	17.34	14.10	27.95	60.75	180	0.078
.500	24.20	17.35	6.85	13.85	30.10	86	0.080
.250	19.26	17.35	1.91	7.00	15.21	15	0.127
.125	19.06	17.35	1.71	5.09	11.06	6	0.285
.063	19.00	17.35	1.65	3.38	7.35	5.3	0.311
.045	18.01	17.35	0.66	1.73	3.76	2.8	0.236
PAN	18.42	17.35	1.07	1.07	2.33	5.2	0.206

DATA FORM - WOOD ASH ANALYSES

RUN NO: 205

COMBUSTABLE CONTENT ANALYSES

	SAMPLE NO. 1	SAMPLE NO. 2
INITIAL SAMPLE + CRUCIBLE WT (gm)	<u>27.48</u>	<u>29.42</u>
CRUCIBLE WT (gm)	<u>25.58</u>	<u>27.54</u>
SAMPLE WT (gm)	<u>1.90</u>	<u>1.88</u>
FINAL SAMPLE + CRUCIBLE WT (gm)	<u>25.73</u>	<u>27.67</u>
CRUCIBLE WT (gm)	<u>25.58</u>	<u>27.54</u>
ASH WT (gm)	<u>0.15</u> % <u>7.89</u>	<u>0.13</u> % <u>6.91</u>
COMBUSTABLE CARBON WT (gm)	<u>1.75</u> % <u>92.11</u>	<u>1.75</u> % <u>93.09</u>

AVERAGE % INORGANIC ASH: 7.40 AVERAGE % COMBUSTABLE CARBON: 92.60

SIZE AND DENSITY ANALYSES

SIZE (mm)	SAMPLE + PAN (gm)	PAN TARE (gm)	SAMPLE WT (gm)	CUMULATIVE WT (gm)	CUMULATIVE % %	VOLUME (cc)	DENSITY (gm/cc)
4.000	18.77	17.34	1.43	49.30		27.5	0.052
2.000	40.04	17.37	22.67	47.87	97.10	314	0.072
1.000	33.31	17.35	15.96	25.20	51.12	209	0.076
.500	22.20	17.39	4.81	9.24	18.74	60	0.080
.250	18.61	17.41	1.20	4.43	8.99	11	0.109
.125	18.54	17.34	1.20	3.23	6.55	4.5	0.267
.063	18.54	17.37	1.17	2.03	4.12	4.6	0.254
.045	17.84	17.36	0.48	0.86	1.74	2.4	0.200
PAN	17.74	17.36	0.38	0.38	0.77	2.4	0.158

DATA FORM - WOOD ASH ANALYSES

RUN NO: 207

COMBUSTABLE CONTENT ANALYSES

	SAMPLE NO. 1	SAMPLE NO. 2
INITIAL SAMPLE + CRUCIBLE WT (gm)	<u>29.40</u>	<u>30.65</u>
CRUCIBLE WT (gm)	<u>26.49</u>	<u>27.06</u>
SAMPLE WT (gm)	<u>2.91</u>	<u>3.59</u>
FINAL SAMPLE + CRUCIBLE WT (gm)	<u>27.48</u>	<u>28.37</u>
CRUCIBLE WT (gm)	<u>26.49</u>	<u>27.06</u>
ASH WT (gm)	<u>0.99</u> % <u>34.02</u>	<u>1.31</u> % <u>36.49</u>
COMBUSTABLE CARBON WT (gm)	<u>1.92</u> % <u>65.98</u>	<u>2.28</u> % <u>63.51</u>

AVERAGE % INORGANIC ASH: 35.26AVERAGE % COMBUSTABLE CARBON: 64.75

SIZE AND DENSITY ANALYSES

SIZE (mm)	SAMPLE + PAN (gm)	PAN TARE (gm)	SAMPLE WT (gm)	CUMULATIVE WT (gm)	CUMULATIVE %	VOLUME (cc)	DENSITY (gm/cc)
4.000	17.85	17.19	0.66	99.52		8	0.083
2.000	35.75	17.19	18.56	98.86	99.34	167	0.111
1.000	40.70	17.19	23.51	80.30	80.69	203	0.116
.500	56.18	17.19	38.99	56.79	57.06	168	0.232
.250	33.84	17.19	16.65	17.80	17.89	49	0.340
.125	17.94	17.19	0.75	1.15	1.16	1.6	0.469
.063	17.49	17.19	0.30	0.40	0.40	08	0.375
.045	17.27	17.19	0.08	0.10	0.10	0.6	0.133
PAN	17.21	17.19	0.02	0.02	0.02	-	-

DATA FORM - WOOD ASH ANALYSES

RUN NO: 209

COMBUSTABLE CONTENT ANALYSES

	SAMPLE NO. 1	SAMPLE NO. 2
INITIAL SAMPLE + CRUCIBLE WT (gm)	<u>29.86</u>	<u>29.57</u>
CRUCIBLE WT (gm)	<u>28.48</u>	<u>28.23</u>
SAMPLE WT (gm)	<u>1.38</u>	<u>1.34</u>
FINAL SAMPLE + CRUCIBLE WT (gm)	<u>28.57</u>	<u>28.32</u>
CRUCIBLE WT (gm)	<u>28.48</u>	<u>28.23</u>
ASH WT (gm)	<u>0.09</u> % <u>6.52</u>	<u>0.09</u> % <u>6.72</u>
COMBUSTABLE CARBON WT (gm)	<u>1.29</u> % <u>93.48</u>	<u>1.25</u> % <u>93.28</u>

AVERAGE % INORGANIC ASH: 6.62 AVERAGE % COMBUSTABLE CARBON: 93.38

SIZE AND DENSITY ANALYSES

SIZE (mm)	SAMPLE + PAN (gm)	PAN TARE (gm)	SAMPLE WT (gm)	CUMULATIVE WT (gm)	CUMULATIVE % %	VOLUME (cc)	DENSITY (gm/cc)
4.000	17.31	17.18	0.13	40.95		3	0.043
2.000	27.44	17.18	10.26	40.82	99.68	182	0.056
1.000	34.10	17.18	16.92	30.56	74.63	258	0.066
.500	26.03	17.18	8.85	13.64	33.31	110	0.080
.250	18.84	17.18	1.66	4.79	11.70	19	0.087
.125	18.03	17.18	0.85	3.13	7.64	6	0.142
.063	18.18	17.18	1.00	2.28	5.57	7	0.143
.045	18.44	17.18	1.26	1.28	3.13	10	0.126
PAN	17.20	17.18	0.02	0.02	0.04	-	-

DATA FORM - WOOD ASH ANALYSES

RUN NO: 211

COMBUSTABLE CONTENT ANALYSES

	SAMPLE NO. 1	SAMPLE NO. 2
INITIAL SAMPLE + CRUCIBLE WT (gm)	<u>31.03</u>	<u>28.96</u>
CRUCIBLE WT (gm)	<u>29.60</u>	<u>27.55</u>
SAMPLE WT (gm)	<u>1.43</u>	<u>1.41</u>
FINAL SAMPLE + CRUCIBLE WT (gm)	<u>29.70</u>	<u>27.66</u>
CRUCIBLE WT (gm)	<u>29.60</u>	<u>27.55</u>
ASH WT (gm)	<u>0.10</u> % <u>6.99</u>	<u>0.11</u> % <u>7.80</u>
COMBUSTABLE CARBON WT (gm)	<u>1.33</u> % <u>93.01</u>	<u>1.30</u> % <u>92.20</u>

AVERAGE % INORGANIC ASH: 7.40 AVERAGE % COMBUSTABLE CARBON: 92.61

SIZE AND DENSITY ANALYSES

SIZE (mm)	SAMPLE + PAN (gm)	PAN TARE (gm)	SAMPLE WT (gm)	CUMULATIVE WT (gm)	CUMULATIVE % %	VOLUME (cc)	DENSITY (gm/cc)
4.000	17.40	17.18	0.22	43.32		5	0.044
2.000	28.88	17.18	11.70	43.10	99.49	188	0.062
1.000	34.72	17.18	17.54	31.40	72.48	256	0.069
.500	25.14	17.18	7.96	13.86	31.99	104	0.077
.250	18.94	17.18	1.76	5.90	13.62	19	0.093
.125	18.38	17.18	1.20	4.14	9.56	6	0.200
.063	18.59	17.18	1.41	2.94	6.79	6	0.235
.045	18.36	17.18	1.18	1.53	3.53	7	0.169
PAN	17.53	17.18	0.35	0.35	0.81	2	0.175

DATA FORM - WOOD ASH ANALYSES

RUN NO: 213

COMBUSTABLE CONTENT ANALYSES

	SAMPLE NO. 1	SAMPLE NO. 2
INITIAL SAMPLE + CRUCIBLE WT (gm)	<u>30.13</u>	<u>29.75</u>
CRUCIBLE WT (gm)	<u>28.58</u>	<u>28.19</u>
SAMPLE WT (gm)	<u>1.55</u>	<u>1.56</u>
FINAL SAMPLE + CRUCIBLE WT (gm)	<u>28.75</u>	<u>28.34</u>
CRUCIBLE WT (gm)	<u>28.58</u>	<u>28.19</u>
ASH WT (gm)	<u>0.17</u> % <u>10.97</u>	<u>0.15</u> % <u>9.62</u>
COMBUSTABLE CARBON WT (gm)	<u>1.38</u> % <u>89.03</u>	<u>1.41</u> % <u>90.38</u>

AVERAGE % INORGANIC ASH: 10.30 AVERAGE % COMBUSTABLE CARBON: 89.71

SIZE AND DENSITY ANALYSES

SIZE (mm)	SAMPLE + PAN (gm)	PAN TARE (gm)	SAMPLE WT (gm)	CUMULATIVE WT (gm)	CUMULATIVE %	VOLUME (cc)	DENSITY (gm/cc)
4.000	17.46	17.18	0.28	48.21		5	0.056
2.000	30.93	17.18	13.75	47.93	99.42	190	0.072
1.000	36.09	17.18	18.91	34.18	70.90	246	0.077
.500	24.82	17.19	7.63	15.27	31.67	98	0.078
.250	19.01	17.18	1.83	7.64	15.85	17	0.108
.125	16.91	17.18	1.73	5.81	12.05	7	0.247
.063	19.14	17.18	1.96	4.08	8.46	8	0.245
.045	18.30	17.18	1.12	2.12	4.40	5	0.224
PAN	18.19	17.19	1.00	1.00	2.07	5	0.200

DATA FORM - WOOD ASH ANALYSES

RUN NO: 217

COMBUSTABLE CONTENT ANALYSES

	SAMPLE NO. 1	SAMPLE NO. 2
INITIAL SAMPLE + CRUCIBLE WT (gm)	<u>28.64</u>	<u>29.01</u>
CRUCIBLE WT (gm)	<u>27.29</u>	<u>27.55</u>
SAMPLE WT (gm)	<u>1.35</u>	<u>1.46</u>
FINAL SAMPLE + CRUCIBLE WT (gm)	<u>27.42</u>	<u>27.69</u>
CRUCIBLE WT (gm)	<u>27.29</u>	<u>27.55</u>
ASH WT (gm)	<u>0.13</u> % <u>9.63</u>	<u>0.14</u> % <u>9.59</u>
COMBUSTABLE CARBON WT (gm)	<u>1.22</u> % <u>90.37</u>	<u>1.32</u> % <u>90.41</u>

AVERAGE % INORGANIC ASH: 9.61AVERAGE % COMBUSTABLE CARBON: 90.39

SIZE AND DENSITY ANALYSES

SIZE (mm)	SAMPLE + PAN (gm)	PAN TARE (gm)	SAMPLE WT (gm)	CUMULATIVE WT (gm)	CUMULATIVE % %	VOLUME (cc)	DENSITY (gm/cc)
2.000	23.19	17.18	6.01	43.91		134	0.045
1.000	35.36	17.18	18.18	37.90	86.31	300	0.061
.500	28.58	17.18	11.40	19.72	44.91	150	0.076
.250	20.37	17.18	3.19	8.32	18.95	35	0.091
.125	18.76	17.19	1.57	5.13	11.68	13	0.121
.063	18.66	17.19	1.47	3.56	8.11	10	0.147
.045	18.40	17.19	1.21	2.09	4.76	9	0.134
PAN	18.07	17.19	0.88	0.88	2.00	7	0.126

DATA FORM - WOOD ASH ANALYSES

RUN NO: 219

COMBUSTABLE CONTENT ANALYSES

	SAMPLE NO. 1	SAMPLE NO. 2
INITIAL SAMPLE + CRUCIBLE WT (gm)	<u>30.87</u>	<u>28.29</u>
CRUCIBLE WT (gm)	<u>29.60</u>	<u>26.92</u>
SAMPLE WT (gm)	<u>1.27</u>	<u>1.32</u>
FINAL SAMPLE + CRUCIBLE WT (gm)	<u>29.75</u>	<u>27.07</u>
CRUCIBLE WT (gm)	<u>29.60</u>	<u>26.92</u>
ASH WT (gm)	<u>0.15</u> % <u>11.81</u>	<u>0.15</u> % <u>11.36</u>
COMBUSTABLE CARBON WT (gm)	<u>1.12</u> % <u>88.19</u>	<u>1.17</u> % <u>88.64</u>

AVERAGE % INORGANIC ASH: 11.59 AVERAGE % COMBUSTABLE CARBON: 88.42

SIZE AND DENSITY ANALYSES

SIZE (mm)	SAMPLE + PAN (gm)	PAN TARE (gm)	SAMPLE WT (gm)	CUMULATIVE WT (gm)	CUMULATIVE %	VOLUME (cc)	DENSITY (gm/cc)
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2.000	20.84	17.18	3.66	39.29		68	0.054
1.000	32.87	17.18	15.69	35.63	90.68	238	0.066
.500	28.68	17.18	11.50	19.94	50.75	148	0.078
.250	19.81	17.19	2.62	8.44	21.48	30	0.087
.125	18.73	17.19	1.54	5.82	14.81	10	0.154
.063	18.88	17.19	1.69	4.28	10.89	8	0.211
.045	18.11	17.19	0.92	2.59	6.59	5	0.184
PAN	18.86	17.19	1.67	1.67	4.25	10	0.167

DATA FORM - WOOD ASH ANALYSES

RUN NO: 221

COMBUSTABLE CONTENT ANALYSES

	SAMPLE NO. 1	SAMPLE NO. 2
INITIAL SAMPLE + CRUCIBLE WT (gm)	<u>29.15</u>	<u>27.64</u>
CRUCIBLE WT (gm)	<u>27.85</u>	<u>26.49</u>
SAMPLE WT (gm)	<u>1.30</u>	<u>1.15</u>
FINAL SAMPLE + CRUCIBLE WT (gm)	<u>27.95</u>	<u>26.59</u>
CRUCIBLE WT (gm)	<u>27.85</u>	<u>26.49</u>
ASH WT (gm)	<u>0.10</u> % <u>7.69</u>	<u>0.10</u> % <u>8.70</u>
COMBUSTABLE CARBON WT (gm)	<u>1.20</u> % <u>92.31</u>	<u>1.05</u> % <u>91.30</u>

AVERAGE % INORGANIC ASH: 8.20 AVERAGE % COMBUSTABLE CARBON: 91.81

SIZE AND DENSITY ANALYSES

SIZE (mm)	SAMPLE + PAN (gm)	PAN TARE (gm)	SAMPLE WT (gm)	CUMULATIVE WT (gm)	CUMULATIVE %	VOLUME (cc)	DENSITY (gm/cc)
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2.000	25.96	17.18	8.78	41.62		150	0.059
1.000	36.13	17.18	18.95	32.84	78.90	298	0.064
.500	24.70	17.19	7.51	13.89	33.37	104	0.072
.250	18.73	17.19	1.54	6.38	15.33	17	0.091
.125	18.37	17.19	1.18	4.84	11.63	7	0.169
.063	18.63	17.19	1.44	3.66	8.79	8	0.180
.045	18.12	17.19	0.93	2.22	5.33	5	0.186
PAN	18.48	17.19	1.29	1.29	3.10	8	0.161

DATA FORM - WOOD ASH ANALYSES

RUN NO: 223

COMBUSTABLE CONTENT ANALYSES

		SAMPLE NO. 1	SAMPLE NO. 2
INITIAL SAMPLE + CRUCIBLE WT (gm)		<u>28.19</u>	<u>30.00</u>
CRUCIBLE WT (gm)		<u>26.79</u>	<u>28.63</u>
SAMPLE WT (gm)		<u>1.40</u>	<u>1.37</u>
FINAL SAMPLE + CRUCIBLE WT (gm)		<u>26.95</u>	<u>28.78</u>
CRUCIBLE WT (gm)		<u>26.79</u>	<u>28.63</u>
ASH WT (gm)		<u>0.16</u> % <u>11.43</u>	<u>0.15</u> % <u>10.95</u>
COMBUSTABLE CARBON WT (gm)		<u>1.24</u> % <u>88.57</u>	<u>1.22</u> % <u>89.05</u>

AVERAGE % INORGANIC ASH: 11.19AVERAGE % COMBUSTABLE CARBON: 88.81

SIZE AND DENSITY ANALYSES

SIZE (mm)	SAMPLE + PAN (gm)	PAN TARE (gm)	SAMPLE WT (gm)	CUMULATIVE WT (gm)	CUMULATIVE % %	VOLUME (cc)	DENSITY (gm/cc)
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2.000	25.68	17.25	8.43	42.58		120	0.070
1.000	35.51	17.25	18.26	34.15	80.20	253	0.072
.500	25.39	17.25	8.14	15.89	37.32	103	0.079
.250	19.02	17.25	1.77	7.75	18.20	17	0.104
.125	19.01	17.25	1.76	5.98	14.04	8	0.220
.063	19.07	17.25	1.82	4.22	9.91	7	0.260
.045	18.14	17.25	0.89	2.40	5.64	4	0.223
PAN	18.76	17.25	1.51	1.51	3.55	7	0.216

DATA FORM - WOOD ASH ANALYSES

RUN NO: 225

COMBUSTABLE CONTENT ANALYSES

	SAMPLE NO. 1	SAMPLE NO. 2
INITIAL SAMPLE + CRUCIBLE WT (gm)	<u>30.33</u>	<u>29.98</u>
CRUCIBLE WT (gm)	<u>28.99</u>	<u>28.64</u>
SAMPLE WT (gm)	<u>1.34</u>	<u>1.34</u>
FINAL SAMPLE + CRUCIBLE WT (gm)	<u>29.10</u>	<u>28.74</u>
CRUCIBLE WT (gm)	<u>28.99</u>	<u>28.64</u>
ASH WT (gm)	<u>0.11</u> % <u>8.21</u>	<u>0.10</u> % <u>7.46</u>
COMBUSTABLE CARBON WT (gm)	<u>1.23</u> % <u>91.79</u>	<u>1.24</u> % <u>92.54</u>
AVERAGE % INORGANIC ASH: <u>7.84</u>	AVERAGE % COMBUSTABLE CARBON: <u>92.17</u>	

SIZE AND DENSITY ANALYSES

SIZE (mm)	SAMPLE + PAN (gm)	PAN TARE (gm)	SAMPLE WT (gm)	CUMULATIVE WT (gm)	CUMULATIVE % %	VOLUME (cc)	DENSITY (gm/cc)
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2.000	26.71	17.20	9.51	40.42		142	0.067
1.000	34.23	17.20	17.03	30.91	76.47	228	0.075
.500	25.86	17.20	8.66	13.88	34.34	108	0.080
.250	19.08	17.20	1.88	5.22	12.91	20	0.094
.125	18.25	17.20	1.05	3.34	8.26	5	0.210
.063	18.21	17.20	1.01	2.29	5.67	5	0.202
.045	17.80	17.20	0.60	1.28	3.17	4	0.150
PAN	17.88	17.20	0.68	0.68	1.68	4	0.170

DATA FORM - WOOD ASH ANALYSES

RUN NO: 227

COMBUSTABLE CONTENT ANALYSES

	SAMPLE NO. 1	SAMPLE NO. 2
INITIAL SAMPLE + CRUCIBLE WT (gm)	<u>30.32</u>	<u>32.01</u>
CRUCIBLE WT (gm)	<u>28.49</u>	<u>30.15</u>
SAMPLE WT (gm)	<u>1.83</u>	<u>1.86</u>
FINAL SAMPLE + CRUCIBLE WT (gm)	<u>28.68</u>	<u>30.36</u>
CRUCIBLE WT (gm)	<u>28.49</u>	<u>30.15</u>
ASH WT (gm)	<u>0.19</u> % <u>10.38</u>	<u>0.21</u> % <u>11.29</u>
COMBUSTABLE CARBON WT (gm)	<u>1.64</u> % <u>89.62</u>	<u>1.65</u> % <u>88.71</u>

AVERAGE % INORGANIC ASH: 10.84AVERAGE % COMBUSTABLE CARBON: 89.17

SIZE AND DENSITY ANALYSES

SIZE (mm)	SAMPLE + PAN (gm)	PAN TARE (gm)	SAMPLE WT (gm)	CUMULATIVE WT (gm)	CUMULATIVE %	VOLUME (cc)	DENSITY (gm/cc)
4.000	17.47	17.20	0.27	57.65		6	0.045
2.000	30.43	17.20	13.23	57.38	99.53	206	0.064
1.000	39.40	17.20	22.20	44.15	76.58	300	0.074
.500	28.84	17.20	11.64	21.95	38.07	148	0.079
.250	20.11	17.20	2.91	10.31	17.88	29	0.100
.125	19.30	17.20	2.10	7.40	12.84	10	0.210
.063	19.40	17.20	2.20	5.30	9.19	9	0.244
.045	18.23	17.20	1.03	3.10	5.38	5	0.206
PAN	19.27	17.20	2.07	2.07	3.59	11	0.188

DATA FORM - WOOD ASH ANALYSES

RUN NO: 229

COMBUSTABLE CONTENT ANALYSES

	SAMPLE NO. 1	SAMPLE NO. 2
INITIAL SAMPLE + CRUCIBLE WT (gm)	<u>29.66</u>	<u>29.98</u>
CRUCIBLE WT (gm)	<u>27.91</u>	<u>28.37</u>
SAMPLE WT (gm)	<u>1.75</u>	<u>1.61</u>
FINAL SAMPLE + CRUCIBLE WT (gm)	<u>28.03</u>	<u>28.48</u>
CRUCIBLE WT (gm)	<u>27.91</u>	<u>28.37</u>
ASH WT (gm)	<u>0.12</u> % <u>6.86</u>	<u>0.11</u> % <u>6.83</u>
COMBUSTABLE CARBON WT (gm)	<u>1.63</u> % <u>93.14</u>	<u>1.50</u> % <u>93.17</u>

AVERAGE % INORGANIC ASH: 6.85 AVERAGE % COMBUSTABLE CARBON: 93.16

SIZE AND DENSITY ANALYSES

SIZE (mm)	SAMPLE + PAN (gm)	PAN TARE (gm)	SAMPLE WT (gm)	CUMULATIVE WT (gm)	CUMULATIVE % %	VOLUME (cc)	DENSITY (gm/cc)
4.000	17.24	17.20	0.04	38.00		3	0.013
2.000	21.62	17.20	4.42	37.96	99.89	90	0.049
1.000	33.61	17.20	16.41	33.54	88.26	275	0.060
.500	27.59	17.20	10.39	17.13	45.08	141	0.074
.250	19.92	17.20	2.72	6.74	17.74	34	0.080
.125	18.49	17.20	1.29	4.02	10.58	11	0.117
.063	18.39	17.20	1.19	2.73	7.18	8	0.149
.045	18.26	17.20	1.06	1.54	4.05	9	0.118
PAN	17.68	17.20	0.48	0.48	1.26	4	0.120

DATA FORM - WOOD ASH ANALYSES

RUN NO: 233

COMBUSTABLE CONTENT ANALYSES

	SAMPLE NO. 1	SAMPLE NO. 2
INITIAL SAMPLE + CRUCIBLE WT (gm)	<u>29.39</u>	<u>28.47</u>
CRUCIBLE WT (gm)	<u>27.94</u>	<u>26.93</u>
SAMPLE WT (gm)	<u>1.45</u>	<u>1.54</u>
FINAL SAMPLE + CRUCIBLE WT (gm)	<u>28.04</u>	<u>27.05</u>
CRUCIBLE WT (gm)	<u>27.94</u>	<u>26.93</u>
ASH WT (gm)	<u>0.10</u> % <u>6.90</u>	<u>0.12</u> % <u>7.79</u>
COMBUSTABLE CARBON WT (gm)	<u>1.35</u> % <u>93.10</u>	<u>1.42</u> % <u>92.21</u>

AVERAGE % INORGANIC ASH: 7.35 AVERAGE % COMBUSTABLE CARBON: 92.66

SIZE AND DENSITY ANALYSES

SIZE (mm)	SAMPLE + PAN (gm)	PAN TARE (gm)	SAMPLE WT (gm)	CUMULATIVE WT (gm)	CUMULATIVE % %	VOLUME (cc)	DENSITY (gm/cc)
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2.000	23.09	17.19	5.9	46.21		109	0.054
1.000	37.21	17.19	20.02	40.31	87.23	321	0.062
.500	30.67	17.19	13.48	20.29	43.91	178	0.076
.250	19.96	17.19	2.77	6.81	14.74	31	0.089
.125	18.43	17.19	1.24	4.04	8.74	10	0.124
.063	18.45	17.19	1.26	2.80	6.06	9	0.140
.045	18.53	17.19	1.34	1.54	3.33	11	0.122
PAN	17.39	17.19	0.20	0.20	0.43	1	0.200

DATA FORM - WOOD ASH ANALYSES

RUN NO: 235

COMBUSTABLE CONTENT ANALYSES

	SAMPLE NO. 1	SAMPLE NO. 2
INITIAL SAMPLE + CRUCIBLE WT (gm)	<u>30.26</u>	<u>28.98</u>
CRUCIBLE WT (gm)	<u>28.82</u>	<u>27.44</u>
SAMPLE WT (gm)	<u>1.44</u>	<u>1.54</u>
FINAL SAMPLE + CRUCIBLE WT (gm)	<u>28.93</u>	<u>27.56</u>
CRUCIBLE WT (gm)	<u>28.82</u>	<u>27.44</u>
ASH WT (gm)	<u>0.11</u> % <u>7.64</u>	<u>0.12</u> % <u>7.79</u>
COMBUSTABLE CARBON WT (gm)	<u>1.33</u> % <u>92.36</u>	<u>1.42</u> % <u>92.21</u>

AVERAGE % INORGANIC ASH: 7.72 AVERAGE % COMBUSTABLE CARBON: 92.29

SIZE AND DENSITY ANALYSES

SIZE (mm)	SAMPLE + PAN (gm)	PAN TARE (gm)	SAMPLE WT (gm)	CUMULATIVE WT (gm)	CUMULATIVE % %	VOLUME (cc)	DENSITY (gm/cc)
4.000	17.30	17.19	0.11	48.27		2	0.055
2.000	25.44	17.19	8.25	48.16	99.77	131	0.063
1.000	38.96	17.19	21.77	39.91	82.68	320	0.068
.500	28.50	17.19	11.31	18.14	37.58	144	0.079
.250	19.60	17.19	2.41	6.83	14.15	25	0.096
.125	18.55	17.19	1.36	4.42	9.16	9	0.151
.063	18.43	17.19	1.24	3.06	6.34	8	0.155
.045	18.05	17.19	0.86	1.82	3.77	6	0.143
PAN	18.15	17.19	0.96	0.96	1.99	6	0.160

DATA FORM - WOOD ASH ANALYSES

RUN NO: 237

COMBUSTABLE CONTENT ANALYSES

	SAMPLE NO. 1	SAMPLE NO. 2
INITIAL SAMPLE + CRUCIBLE WT (gm)	<u>29.06</u>	<u>30.34</u>
CRUCIBLE WT (gm)	<u>27.06</u>	<u>28.42</u>
SAMPLE WT (gm)	<u>2.00</u>	<u>1.92</u>
FINAL SAMPLE + CRUCIBLE WT (gm)	<u>27.23</u>	<u>28.43</u>
CRUCIBLE WT (gm)	<u>27.06</u>	<u>28.24</u>
ASH WT (gm)	<u>0.17</u> % <u>8.50</u>	<u>0.19</u> % <u>9.90</u>
COMBUSTABLE CARBON WT (gm)	<u>1.83</u> % <u>91.50</u>	<u>1.73</u> % <u>90.10</u>

AVERAGE % INORGANIC ASH: 9.20 AVERAGE % COMBUSTABLE CARBON: 90.80

SIZE AND DENSITY ANALYSES

SIZE (mm)	SAMPLE + PAN (gm)	PAN TARE (gm)	SAMPLE WT (gm)	CUMULATIVE WT (gm)	CUMULATIVE % %	VOLUME (cc)	DENSITY (gm/cc)
4.000	17.34	17.19	0.15	57.23		3	0.050
2.000	31.24	17.19	14.05	57.08	99.74	207	0.068
1.000	39.93	17.19	22.74	43.03	75.19	295	0.077
.500	28.17	17.20	10.97	20.29	35.45	133	0.082
.250	19.79	17.20	2.59	9.32	16.29	25	0.104
.125	19.08	17.20	1.88	6.73	11.76	10	0.188
.063	19.09	17.20	1.89	4.85	8.47	9	0.210
.045	18.15	17.20	0.95	2.96	5.17	5	0.190
PAN	19.21	17.20	2.01	2.01	3.51	9	0.223

DATA FORM - WOOD ASH ANALYSES

RUN NO: 239

COMBUSTABLE CONTENT ANALYSES

		SAMPLE NO. 1	SAMPLE NO. 2
INITIAL SAMPLE + CRUCIBLE WT (gm)		<u>28.56</u>	<u>31.63</u>
CRUCIBLE WT (gm)		<u>26.80</u>	<u>29.88</u>
SAMPLE WT (gm)		<u>1.76</u>	<u>1.75</u>
FINAL SAMPLE + CRUCIBLE WT (gm)		<u>26.95</u>	<u>30.02</u>
CRUCIBLE WT (gm)		<u>26.80</u>	<u>29.88</u>
ASH WT (gm)		<u>0.15</u> % <u>8.52</u>	<u>0.14</u> % <u>8.00</u>
COMBUSTABLE CARBON WT (gm)		<u>1.61</u> % <u>91.48</u>	<u>1.61</u> % <u>92.00</u>
AVERAGE % INORGANIC ASH:	<u>8.26</u>	AVERAGE % COMBUSTABLE CARBON:	<u>91.74</u>

SIZE AND DENSITY ANALYSES

SIZE (mm)	SAMPLE + PAN (gm)	PAN TARE (gm)	SAMPLE WT (gm)	CUMULATIVE WT (gm)	CUMULATIVE %	VOLUME (cc)	DENSITY (gm/cc)
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2.000	29.21	17.20	12.01	52.75		179	0.067
1.000	39.33	17.20	22.13	40.74	77.23	300	0.074
.500	27.55	17.20	10.35	18.61	35.28	128	0.081
.250	19.51	17.20	2.31	8.26	15.66	25	0.092
.125	18.83	17.20	1.60	5.95	11.28	9	0.178
.063	18.83	17.20	1.63	4.35	8.25	8	0.204
.045	18.08	17.20	0.88	2.72	5.16	5	0.176
PAN	19.04	17.20	1.84	1.84	3.49	9	0.204

DATA FORM - WOOD ASH ANALYSES

RUN NO: 241

COMBUSTABLE CONTENT ANALYSES

	SAMPLE NO. 1	SAMPLE NO. 2
INITIAL SAMPLE + CRUCIBLE WT (gm)	<u>29.91</u>	<u>26.81</u>
CRUCIBLE WT (gm)	<u>28.63</u>	<u>25.60</u>
SAMPLE WT (gm)	<u>1.28</u>	<u>1.21</u>
FINAL SAMPLE + CRUCIBLE WT (gm)	<u>28.74</u>	<u>25.70</u>
CRUCIBLE WT (gm)	<u>28.63</u>	<u>25.60</u>
ASH WT (gm)	<u>0.11</u> % <u>8.59</u>	<u>0.10</u> % <u>8.26</u>
COMBUSTABLE CARBON WT (gm)	<u>1.17</u> % <u>91.41</u>	<u>1.11</u> % <u>91.74</u>

AVERAGE % INORGANIC ASH: 8.43AVERAGE % COMBUSTABLE CARBON: 91.58

SIZE AND DENSITY ANALYSES

SIZE (mm)	SAMPLE + PAN (gm)	PAN TARE (gm)	SAMPLE WT (gm)	CUMULATIVE WT (gm)	CUMULATIVE % %	VOLUME (cc)	DENSITY (gm/cc)
4.000	17.81	17.20	0.61	51.50		11	0.055
2.000	36.86	17.20	19.66	50.89	98.82	270	0.073
1.000	34.92	17.20	17.72	31.23	60.64	224	0.079
.500	24.46	17.20	7.26	13.51	26.23	90	0.081
.250	18.81	17.20	1.61	6.25	12.14	17	0.095
.125	18.45	17.20	1.25	4.64	9.01	6	0.208
.063	18.50	17.20	1.30	3.39	6.58	6	0.217
.045	17.76	17.20	0.56	2.09	4.06	3	0.197
PAN	18.73	17.20	1.53	1.53	2.97	9	0.170

DATA FORM - WOOD ASH ANALYSESRUN NO: 243

COMBUSTABLE CONTENT ANALYSES

	SAMPLE NO. 1	SAMPLE NO. 2
INITIAL SAMPLE + CRUCIBLE WT (gm)	<u>27.81</u>	<u>28.98</u>
CRUCIBLE WT (gm)	<u>25.28</u>	<u>26.51</u>
SAMPLE WT (gm)	<u>2.53</u>	<u>2.47</u>
FINAL SAMPLE + CRUCIBLE WT (gm)	<u>25.38</u>	<u>26.62</u>
CRUCIBLE WT (gm)	<u>25.28</u>	<u>26.51</u>
ASH WT (gm)	<u>0.10</u> % <u>3.95</u>	<u>0.11</u> % <u>4.45</u>
COMBUSTABLE CARBON WT (gm)	<u>2.43</u> % <u>96.05</u>	<u>2.36</u> % <u>95.55</u>
AVERAGE % INORGANIC ASH: <u>4.20</u>	AVERAGE % COMBUSTABLE CARBON: <u>95.80</u>	

SIZE AND DENSITY ANALYSES

SIZE (mm)	SAMPLE + PAN (gm)	PAN TARE (gm)	SAMPLE WT (gm)	CUMULATIVE WT (gm)	CUMULATIVE % %	VOLUME (cc)	DENSITY (gm/cc)
2.000	23.06	17.19	5.87	40.08		119	0.049
1.000	35.52	17.19	18.33	34.21	85.35	302	0.061
.500	27.32	17.19	10.13	15.88	39.62	135	0.075
.250	19.17	17.19	1.98	5.75	14.35	21	0.094
.125	18.34	17.19	1.15	3.77	9.41	8	0.144
.063	18.28	17.19	1.09	2.62	6.54	7	0.156
.045	17.93	17.19	0.74	1.53	3.82	6	0.123
PAN	17.98	17.19	0.79	0.79	1.97	6	0.132

DATA FORM - WOOD ASH ANALYSES

RUN NO: 245

COMBUSTABLE CONTENT ANALYSES

	SAMPLE NO. 1	SAMPLE NO. 2
INITIAL SAMPLE + CRUCIBLE WT (gm)	<u>31.22</u>	<u>28.48</u>
CRUCIBLE WT (gm)	<u>29.60</u>	<u>26.92</u>
SAMPLE WT (gm)	<u>1.62</u>	<u>1.56</u>
FINAL SAMPLE + CRUCIBLE WT (gm)	<u>29.77</u>	<u>27.08</u>
CRUCIBLE WT (gm)	<u>29.60</u>	<u>26.92</u>
ASH WT (gm)	<u>0.17</u> % <u>10.49</u>	<u>0.16</u> % <u>10.26</u>
COMBUSTABLE CARBON WT (gm)	<u>1.45</u> % <u>89.51</u>	<u>1.40</u> % <u>89.74</u>

AVERAGE % INORGANIC ASH: 10.38 AVERAGE % COMBUSTABLE CARBON: 89.63

SIZE AND DENSITY ANALYSES

SIZE (mm)	SAMPLE + PAN (gm)	PAN TARE (gm)	SAMPLE WT (gm)	CUMULATIVE WT (gm)	CUMULATIVE % %	VOLUME (cc)	DENSITY (gm/cc)
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2.000	20.71	17.19	3.52	48.22		59	0.060
1.000	38.23	17.19	21.04	44.70	92.70	297	0.071
.500	31.44	17.19	14.25	23.66	49.07	177	0.081
.250	20.13	17.19	2.94	9.41	19.51	32	0.092
.125	19.08	17.19	1.89	6.47	13.42	11	0.172
.063	18.97	17.19	1.78	4.58	9.50	9	0.198
.045	18.00	17.19	0.81	2.80	5.81	4	0.203
PAN	19.18	17.19	1.99	1.99	4.13	11	0.181

DATA FORM - WOOD ASH ANALYSES

RUN NO: 247

COMBUSTABLE CONTENT ANALYSES

	SAMPLE NO. 1	SAMPLE NO. 2
INITIAL SAMPLE + CRUCIBLE WT (gm)	<u>27.06</u>	<u>30.13</u>
CRUCIBLE WT (gm)	<u>25.52</u>	<u>28.53</u>
SAMPLE WT (gm)	<u>1.54</u>	<u>1.60</u>
FINAL SAMPLE + CRUCIBLE WT (gm)	<u>25.70</u>	<u>28.73</u>
CRUCIBLE WT (gm)	<u>25.52</u>	<u>28.53</u>
ASH WT (gm)	<u>0.18</u> % <u>11.69</u>	<u>0.20</u> % <u>12.50</u>
COMBUSTABLE CARBON WT (gm)	<u>1.36</u> % <u>88.31</u>	<u>1.40</u> % <u>87.50</u>
AVERAGE % INORGANIC ASH: <u>12.10</u>	AVERAGE % COMBUSTABLE CARBON: <u>87.91</u>	

SIZE AND DENSITY ANALYSES

SIZE (mm)	SAMPLE + PAN (gm)	PAN TARE (gm)	SAMPLE WT (gm)	CUMULATIVE WT (gm)	CUMULATIVE % %	VOLUME (cc)	DENSITY (gm/cc)
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2.000	24.06	17.20	6.86	47.79		117	0.059
1.000	36.77	17.20	19.57	46.93	85.65	282	0.069
.500	28.30	17.20	11.10	21.36	44.70	142	0.078
.250	19.53	17.20	2.33	10.26	21.47	25	0.093
.125	19.20	17.20	2.00	7.93	16.59	11	0.181
.063	19.39	17.20	2.19	5.93	12.41	9	0.243
.045	18.18	17.20	0.98	3.74	7.83	5	0.196
PAN	19.96	17.20	2.76	2.76	5.78	13	0.212

PLOT OF PARTICLE SIZE DISTRIBUTION--COLLECTED ASH

PINE BARK

RUN NUMBER: 201

PLOT OF PARTICLE DENSITY VERSUS GEOMETRIC MEAN SIZE

PINE BARK

RUN NUMBER: 201

▲ = Density of material collected in pan, i.e. particles less than 0.045mm.

PLOT OF PARTICLE SIZE DISTRIBUTION--COLLECTED ASH

90

PINE BARK

RUN NUMBER: 203

PLOT OF PARTICLE DENSITY VERSUS GEOMETRIC MEAN SIZE

PINE BARK

RUN NUMBER: 203

▲ = Density of material collected in pan, i.e. particles less than 0.045 mm.

PLOT OF PARTICLE SIZE DISTRIBUTION--COLLECTED ASH

92

PINE BARK

RUN NUMBER: 205

PLOT OF PARTICLE DENSITY VERSUS GEOMETRIC MEAN SIZE

PINE BARK

RUN NUMBER: 205

▲ = Density of material collected in pan, i.e. particles less than 0.045 mm.

PLOT OF PARTICLE SIZE DISTRIBUTION--COLLECTED ASH

PINE BARK

RUN NUMBER: 207

PLOT OF PARTICLE DENSITY VERSUS GEOMETRIC MEAN SIZE

PINE BARK

RUN NUMBER: 207

▲ = Density of material collected in pan, i.e. particles less than 0.045 mm.

PLOT OF PARTICLE SIZE DISTRIBUTION--COLLECTED ASH

96

PINE BARK

RUN NUMBER: 209

PLOT OF PARTICLE DENSITY VERSUS GEOMETRIC MEAN SIZE

PINE BARK

RUN NUMBER: 209

▲ = Density of material collected in pan, i.e. particles less than 0.045mm.

PLOT OF PARTICLE SIZE DISTRIBUTION--COLLECTED ASH

PINE BARK

RUN NUMBER: 211

PLOT OF PARTICLE DENSITY VERSUS GEOMETRIC MEAN SIZE

PINE BARK

RUN NUMBER: 211

▲ = Density of material collected in pan, i.e. particles less than 0.045mm.

PLOT OF PARTICLE SIZE DISTRIBUTION--COLLECTED ASH

100

PINE BARK

RUN NUMBER: 213

PLOT OF PARTICLE DENSITY VERSUS GEOMETRIC MEAN SIZE

PINE BARK

RUN NUMBER: 213

▲ = Density of material collected in pan, i.e. particles less than 0.045 mm.

PLOT OF PARTICLE SIZE DISTRIBUTION--COLLECTED ASH

PINE BARK

RUN NUMBER: 217

PLOT OF PARTICLE DENSITY VERSUS GEOMETRIC MEAN SIZE

PINE BARK

RUN NUMBER: 217

▲ = Density of material collected in pan, i.e. particles less than 0.045mm.

PLOT OF PARTICLE SIZE DISTRIBUTION--COLLECTED ASH

PINE BARK

RUN NUMBER: 219

PLOT OF PARTICLE DENSITY VERSUS GEOMETRIC MEAN SIZE

PINE BARK

RUN NUMBER: 219

▲ = Density of material collected in pan, i.e. particles less than 0.045mm.

PLOT OF PARTICLE SIZE DISTRIBUTION--COLLECTED ASH

106

PINE BARK

RUN NUMBER: 221

PLOT OF PARTICLE DENSITY VERSUS GEOMETRIC MEAN SIZE

PINE BARK

RUN NUMBER: 221

▲ = Density of material collected in pan, i.e. particles less than 0.045 mm.

PLOT OF PARTICLE SIZE DISTRIBUTION--COLLECTED ASH

PINE BARK

RUN NUMBER: 223

PLOT OF PARTICLE DENSITY VERSUS GEOMETRIC MEAN SIZE

PINE BARK

RUN NUMBER: 223

▲ = Density of material collected in pan, i.e. particles less than 0.045mm.

PLOT OF PARTICLE SIZE DISTRIBUTION--COLLECTED ASH

110

PINE BARK

RUN NUMBER: 225

PLOT OF PARTICLE DENSITY VERSUS GEOMETRIC MEAN SIZE

PINE BARK

RUN NUMBER: 225

▲ = Density of material collected in pan, i.e. particles less than 0.045mm.

PLOT OF PARTICLE SIZE DISTRIBUTION--COLLECTED ASH

PINE BARK

RUN NUMBER: 227

PLOT OF PARTICLE DENSITY VERSUS GEOMETRIC MEAN SIZE

DINE BARK

RUN NUMBER: 227

▲ = Density of material collected in pan, i.e. particles less than 0.045mm.

PLOT OF PARTICLE SIZE DISTRIBUTION--COLLECTED ASH

PINE BARK

RUN NUMBER: 229

PLOT OF PARTICLE DENSITY VERSUS GEOMETRIC MEAN SIZE

PINE BARK

RUN NUMBER: 229

▲ = Density of material collected in pan, i.e. particles less than 0.045mm.

PLOT OF PARTICLE SIZE DISTRIBUTION--COLLECTED ASH

PINE BARK

RUN NUMBER: 233

PLOT OF PARTICLE DENSITY VERSUS GEOMETRIC MEAN SIZE

PINE BARK

RUN NUMBER: 233

▲ = Density of material collected in pan, i.e. particles less than 0.045mm.

PLOT OF PARTICLE SIZE DISTRIBUTION--COLLECTED ASH

118

PINE BARK

RUN NUMBER: 235

PLOT OF PARTICLE DENSITY VERSUS GEOMETRIC MEAN SIZE

PINE BARK

RUN NUMBER: 235

▲ = Density of material collected in pan, i.e. particles less than 0.045 mm.

PLOT OF PARTICLE SIZE DISTRIBUTION--COLLECTED ASH

PINE BARK

RUN NUMBER: 237

PLOT OF PARTICLE DENSITY VERSUS GEOMETRIC MEAN SIZE

PINE BARK

RUN NUMBER: 237

▲ = Density of material collected in pan, i.e. particles less than 0.045mm.

PLOT OF PARTICLE SIZE DISTRIBUTION--COLLECTED ASH

PINE BARK

RUN NUMBER: 239

PLOT OF PARTICLE DENSITY VERSUS GEOMETRIC MEAN SIZE

PINE BARK

RUN NUMBER: 239

▲ = Density of material collected in pan, i.e. particles less than 0.045 mm.

PLOT OF PARTICLE SIZE DISTRIBUTION--COLLECTED ASH

PINE BARK

RUN NUMBER: 241

PLOT OF PARTICLE DENSITY VERSUS GEOMETRIC MEAN SIZE

PINE BARK

RUN NUMBER: 241

▲ = Density of material collected in pan, i.e. particles less than 0.045 mm.

PLOT OF PARTICLE SIZE DISTRIBUTION--COLLECTED ASH

126

PINE BARK

RUN NUMBER: 243

PLOT OF PARTICLE DENSITY VERSUS GEOMETRIC MEAN SIZE

PINE BARK

RUN NUMBER: 243

▲ = Density of material collected in pan, i.e. particles less than 0.045 mm.

PLOT OF PARTICLE SIZE DISTRIBUTION--COLLECTED ASH

PINE BARK

RUN NUMBER: 245

PLOT OF PARTICLE DENSITY VERSUS GEOMETRIC MEAN SIZE

PINE BARK

RUN NUMBER: 245

▲ = Density of material collected in pan, i.e. particles less than 0.045 mm.

PLOT OF PARTICLE SIZE DISTRIBUTION--COLLECTED ASH

PINE BARK

RUN NUMBER: 247

PLOT OF PARTICLE DENSITY VERSUS GEOMETRIC MEAN SIZE

PINE BARK

RUN NUMBER: 247

▲ = Density of material collected in pan, i.e. particles less than 0.045 mm.

COMBUSTIBLE CONTENT VS. SIZE OF ASH

DATA FORM - WOOD ASH ANALYSESRUN NO: 225FUEL: PINE BARK

COMBUSTABLE CONTENT ANALYSES

	SAMPLE NO. 1	SAMPLE NO. 2
INITIAL SAMPLE + CRUCIBLE WT (gm)	_____	_____
CRUCIBLE WT (gm)	_____	_____
SAMPLE WT (gm)	_____	_____
FINAL SAMPLE + CRUCIBLE WT (gm)	_____	_____
CRUCIBLE WT (gm)	_____	_____
ASH WT (gm)	_____ %	_____ %
COMBUSTABLE CARBON WT (gm)	_____ %	_____ %

AVERAGE % INORGANIC ASH: _____ AVERAGE % COMBUSTABLE CARBON: _____

SIZE AND DENSITY ANALYSES

SIZE (mm)	SAMPLE + PAN (gm)	PAN TARE (gm)	SAMPLE WT (gm)	CUMULATIVE WT (gm)	CUMULATIVE % %	VOLUME (cc)	DENSITY (gm/cc)
--------------	-------------------------	---------------------	----------------------	--------------------------	----------------------	----------------	--------------------

2.000	26.74	17.12	9.62	40.06		139	0.069
1.000	33.58	17.12	16.46	30.44	75.99	210	0.078
.500	26.08	17.12	8.96	13.98	34.90	109	0.082
.250	19.10	17.12	1.98	5.02	12.53	21	0.094
.125	18.26	17.12	1.14	3.04	7.59	5	0.228
.063	18.13	17.12	1.01	1.90	4.74	4	0.253
.045	17.70	17.12	0.58	0.89	2.22	3	0.193
PAN	17.43	17.12	0.31	0.31	0.77	2	0.155

DATA FORM - WOOD ASH ANALYSES

RUN NO. 225COMBUSTIBLE CONTENT ANALYSESFUEL PINE BARKSIZE (mm) 2.000

	<u>SAMPLE NO. 1</u>	<u>SAMPLE NO. 2</u>
INITIAL SAMPLE + CRUCIBLE WT (gm)	<u>29.26</u>	<u>28.11</u>
CRUCIBLE WT (gm)	<u>28.09</u>	<u>26.96</u>
SAMPLE WT (gm)	<u>1.17</u>	<u>1.15</u>
FINAL SAMPLE + CRUCIBLE WT (gm)	<u>28.11</u>	<u>26.99</u>
CRUCIBLE WT (gm)	<u>28.09</u>	<u>26.96</u>
ASH WT (gm)	<u>0.02</u> % <u>1.71</u>	<u>0.03</u> % <u>2.61</u>
COMBUSTIBLE CARBON WT (gm)	<u>1.15</u> % <u>98.29</u>	<u>1.12</u> % <u>97.39</u>
AVERAGE % INORGANIC ASH <u>2.16</u>	AVERAGE % COMBUSTIBLE CARBON <u>97.84</u>	

RUN NO. 225COMBUSTIBLE CONTENT ANALYSESFUEL PINE BARKSIZE (mm) 1.000

	<u>SAMPLE NO. 1</u>	<u>SAMPLE NO. 2</u>
INITIAL SAMPLE + CRUCIBLE WT (gm)	<u>29.78</u>	<u>29.76</u>
CRUCIBLE WT (gm)	<u>27.72</u>	<u>27.69</u>
SAMPLE WT (gm)	<u>2.06</u>	<u>2.07</u>
FINAL SAMPLE + CRUCIBLE WT (gm)	<u>27.78</u>	<u>27.74</u>
CRUCIBLE WT (gm)	<u>27.72</u>	<u>27.69</u>
ASH WT (gm)	<u>0.06</u> % <u>2.91</u>	<u>0.05</u> % <u>2.42</u>
COMBUSTIBLE CARBON WT (gm)	<u>2.00</u> % <u>97.09</u>	<u>2.02</u> % <u>97.58</u>
AVERAGE % INORGANIC ASH <u>2.67</u>	AVERAGE % COMBUSTIBLE CARBON <u>97.34</u>	

DATA FORM - WOOD ASH ANALYSES

RUN NO. 225COMBUSTIBLE CONTENT ANALYSESFUEL PINE BARKSIZE (mm) 0.500

		<u>SAMPLE NO. 1</u>		<u>SAMPLE NO. 2</u>
INITIAL SAMPLE + CRUCIBLE WT	(gm)	<u>28.91</u>		<u>28.15</u>
CRUCIBLE WT	(gm)	<u>27.79</u>		<u>27.02</u>
SAMPLE WT	(gm)	<u>1.12</u>		<u>1.13</u>
FINAL SAMPLE + CRUCIBLE WT	(gm)	<u>27.83</u>		<u>27.06</u>
CRUCIBLE WT	(gm)	<u>27.79</u>		<u>27.02</u>
ASH WT	(gm)	<u>0.04</u>	% <u>3.57</u>	<u>0.04</u> % <u>3.54</u>
COMBUSTIBLE CARBON WT	(gm)	<u>1.08</u>	% <u>96.43</u>	<u>1.09</u> % <u>96.46</u>
AVERAGE % INORGANIC ASH	<u>3.57</u>	AVERAGE % COMBUSTIBLE CARBON		<u>96.45</u>

RUN NO. 225COMBUSTIBLE CONTENT ANALYSESFUEL PINE BARKSIZE (mm) 0.250

		SAMPLE NO. 1		SAMPLE NO. 2
INITIAL SAMPLE + CRUCIBLE WT	(gm)	<u>27.80</u>		<u>27.22</u>
CRUCIBLE WT	(gm)	<u>26.93</u>		<u>26.32</u>
SAMPLE WT	(gm)	<u>0.87</u>		<u>0.90</u>
FINAL SAMPLE + CRUCIBLE WT	(gm)	<u>27.08</u>		<u>26.47</u>
CRUCIBLE WT	(gm)	<u>26.93</u>		<u>26.32</u>
ASH WT	(gm)	<u>0.15</u>	% <u>17.24</u>	<u>0.15</u> % <u>16.67</u>
COMBUSTIBLE CARBON WT	(gm)	<u>0.72</u>	% <u>82.76</u>	<u>0.75</u> % <u>83.33</u>
AVERAGE % INORGANIC ASH	<u>16.96</u>	AVERAGE % COMBUSTIBLE CARBON		<u>83.05</u>

DATA FORM - WOOD ASH ANALYSES

RUN NO. 225COMBUSTIBLE CONTENT ANALYSESFUEL PINE BARKSIZE (mm) 0.125

SAMPLE NO. 1

SAMPLE NO. 2

INITIAL SAMPLE + CRUCIBLE WT (gm)	<u>27.01</u>	<u>27.14</u>
CRUCIBLE WT (gm)	<u>26.53</u>	<u>26.63</u>
SAMPLE WT (gm)	<u>0.48</u>	<u>0.51</u>
FINAL SAMPLE + CRUCIBLE WT (gm)	<u>26.81</u>	<u>26.94</u>
CRUCIBLE WT (gm)	<u>26.53</u>	<u>26.63</u>
ASH WT (gm)	<u>0.28</u> % <u>58.33</u>	<u>0.31</u> % <u>60.78</u>
COMBUSTIBLE CARBON WT (gm)	<u>0.20</u> % <u>41.67</u>	<u>0.20</u> % <u>39.22</u>
AVERAGE % INORGANIC ASH	<u>59.56</u>	AVERAGE % COMBUSTIBLE CARBON <u>40.45</u>

RUN NO. 225COMBUSTIBLE CONTENT ANALYSESFUEL PINE BARKSIZE (mm) 0.063

SAMPLE NO. 1

SAMPLE NO. 2

INITIAL SAMPLE + CRUCIBLE WT (gm)	<u>27.32</u>	<u>26.29</u>
CRUCIBLE WT (gm)	<u>26.86</u>	<u>25.85</u>
SAMPLE WT (gm)	<u>0.46</u>	<u>0.44</u>
FINAL SAMPLE + CRUCIBLE WT (gm)	<u>27.16</u>	<u>26.12</u>
CRUCIBLE WT (gm)	<u>26.86</u>	<u>25.85</u>
ASH WT (gm)	<u>0.30</u> % <u>65.22</u>	<u>0.27</u> % <u>61.36</u>
COMBUSTIBLE CARBON WT (gm)	<u>0.16</u> % <u>34.78</u>	<u>0.17</u> % <u>38.64</u>
AVERAGE % INORGANIC ASH	<u>63.29</u>	AVERAGE % COMBUSTIBLE CARBON <u>36.71</u>

DATA FORM - WOOD ASH ANALYSES

RUN NO. 225COMBUSTIBLE CONTENT ANALYSESFUEL PINE BARKSIZE (mm) 0.045

	SAMPLE NO. 1	SAMPLE NO. 2
INITIAL SAMPLE + CRUCIBLE WT (gm)	<u>27.67</u>	<u>26.67</u>
CRUCIBLE WT (gm)	<u>27.46</u>	<u>26.47</u>
SAMPLE WT (gm)	<u>0.21</u>	<u>0.20</u>
FINAL SAMPLE + CRUCIBLE WT (gm)	<u>27.57</u>	<u>26.58</u>
CRUCIBLE WT (gm)	<u>27.46</u>	<u>26.47</u>
ASH WT (gm)	<u>0.11</u> % <u>52.38</u>	<u>0.11</u> % <u>55.00</u>
COMBUSTIBLE CARBON WT (gm)	<u>0.10</u> % <u>47.62</u>	<u>0.09</u> % <u>45.00</u>
AVERAGE % INORGANIC ASH	<u>53.69</u>	AVERAGE % COMBUSTIBLE CARBON <u>46.31</u>

RUN NO. 225COMBUSTIBLE CONTENT ANALYSESFUEL PINE BARKSIZE (mm) PAN

	SAMPLE NO. 1	SAMPLE NO. 2
INITIAL SAMPLE + CRUCIBLE WT (gm)	<u>26.61</u>	<u>NO SAMPLE</u>
CRUCIBLE WT (gm)	<u>26.33</u>	<u>26.72</u>
SAMPLE WT (gm)	<u>0.28</u>	
FINAL SAMPLE + CRUCIBLE WT (gm)	<u>26.47</u>	
CRUCIBLE WT (gm)	<u>26.33</u>	
ASH WT (gm)	<u>0.14</u> % <u>50.00</u>	%
COMBUSTIBLE CARBON WT (gm)	<u>0.14</u> % <u>50.00</u>	%
AVERAGE % INORGANIC ASH	<u>50.00</u>	AVERAGE % COMBUSTIBLE CARBON <u>50.00</u>

DATA FORM - WOOD ASH ANALYSES

RUN NO: 247FUEL: PINE BARK

COMBUSTABLE CONTENT ANALYSES

		SAMPLE NO. 1	SAMPLE NO. 2
INITIAL SAMPLE + CRUCIBLE WT (gm)		_____	_____
CRUCIBLE WT (gm)		_____	_____
SAMPLE WT (gm)		_____	_____
FINAL SAMPLE + CRUCIBLE WT (gm)		_____	_____
CRUCIBLE WT (gm)		_____	_____
ASH WT (gm)		_____ %	_____ %
COMBUSTABLE CARBON WT (gm)		_____ %	_____ %
AVERAGE % INORGANIC ASH: _____		AVERAGE % COMBUSTABLE CARBON: _____	

SIZE AND DENSITY ANALYSES

SIZE (mm)	SAMPLE + PAN (gm)	PAN TARE (gm)	SAMPLE WT (gm)	CUMULATIVE WT (gm)	CUMULATIVE % %	VOLUME (cc)	DENSITY (gm/cc)
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2.000	22.64	17.12	5.52	47.80		90	0.061
1.000	38.17	17.12	21.05	42.28	88.45	295	0.071
.500	28.31	17.12	11.19	21.23	44.41	149	0.075
.250	19.57	17.12	2.45	10.04	21.00	27	0.091
.125	19.19	17.12	2.07	7.59	15.88	10	0.207
.063	19.34	17.12	2.22	5.52	11.55	8	0.278
.045	18.28	17.12	1.16	3.30	6.90	5	0.232
PAN	19.26	17.12	2.14	2.14	4.48	10	0.214

DATA FORM - WOOD ASH ANALYSES

RUN NO. 247COMBUSTIBLE CONTENT ANALYSESFUEL PINE BARKSIZE (mm) 2.000

	SAMPLE NO. 1		SAMPLE NO. 2
INITIAL SAMPLE + CRUCIBLE WT (gm)	<u>27.54</u>		<u>27.75</u>
CRUCIBLE WT (gm)	<u>26.22</u>		<u>26.43</u>
SAMPLE WT (gm)	<u>1.32</u>		<u>1.32</u>
FINAL SAMPLE + CRUCIBLE WT (gm)	<u>26.24</u>		<u>26.45</u>
CRUCIBLE WT (gm)	<u>26.22</u>		<u>26.43</u>
ASH WT (gm)	<u>0.02</u>	% <u>1.52</u>	<u>0.02</u> % <u>1.52</u>
COMBUSTIBLE CARBON WT (gm)	<u>1.30</u>	% <u>98.48</u>	<u>1.30</u> % <u>98.48</u>
AVERAGE % INORGANIC ASH	<u>1.52</u>	AVERAGE % COMBUSTIBLE CARBON	<u>98.48</u>

RUN NO. 247COMBUSTIBLE CONTENT ANALYSESFUEL PINE BARKSIZE (mm) 1.000

	SAMPLE NO. 1		SAMPLE NO. 2
INITIAL SAMPLE + CRUCIBLE WT (gm)	<u>27.50</u>		<u>27.69</u>
CRUCIBLE WT (gm)	<u>26.18</u>		<u>26.40</u>
SAMPLE WT (gm)	<u>1.32</u>		<u>1.29</u>
FINAL SAMPLE + CRUCIBLE WT (gm)	<u>26.21</u>		<u>26.42</u>
CRUCIBLE WT (gm)	<u>26.18</u>		<u>26.40</u>
ASH WT (gm)	<u>0.03</u>	% <u>2.27</u>	<u>0.02</u> % <u>1.55</u>
COMBUSTIBLE CARBON WT (gm)	<u>1.29</u>	% <u>97.73</u>	<u>1.27</u> % <u>98.45</u>
AVERAGE % INORGANIC ASH	<u>1.91</u>	AVERAGE % COMBUSTIBLE CARBON	<u>98.09</u>

DATA FORM - WOOD ASH ANALYSES

RUN NO. 247COMBUSTIBLE CONTENT ANALYSESFUEL PINE BARKSIZE (mm) 0.500

SAMPLE NO. 1

SAMPLE NO. 2

INITIAL SAMPLE + CRUCIBLE WT (gm)	<u>27.40</u>	<u>26.64</u>
CRUCIBLE WT (gm)	<u>26.03</u>	<u>25.20</u>
SAMPLE WT (gm)	<u>1.37</u>	<u>1.44</u>
FINAL SAMPLE + CRUCIBLE WT (gm)	<u>26.07</u>	<u>25.23</u>
CRUCIBLE WT (gm)	<u>26.03</u>	<u>25.20</u>
ASH WT (gm)	<u>0.04</u> % <u>2.92</u>	<u>0.03</u> % <u>2.08</u>
COMBUSTIBLE CARBON WT (gm)	<u>1.33</u> % <u>97.08</u>	<u>1.41</u> % <u>97.92</u>

AVERAGE % INORGANIC ASH 2.50 AVERAGE % COMBUSTIBLE CARBON 97.50

RUN NO. 247COMBUSTIBLE CONTENT ANALYSESFUEL PINE BARKSIZE (mm) 0.250

SAMPLE NO. 1

SAMPLE NO. 2

INITIAL SAMPLE + CRUCIBLE WT (gm)	<u>27.16</u>	<u>27.74</u>
CRUCIBLE WT (gm)	<u>26.04</u>	<u>26.61</u>
SAMPLE WT (gm)	<u>1.12</u>	<u>1.13</u>
FINAL SAMPLE + CRUCIBLE WT (gm)	<u>26.24</u>	<u>26.82</u>
CRUCIBLE WT (gm)	<u>26.04</u>	<u>26.61</u>
ASH WT (gm)	<u>0.20</u> % <u>17.86</u>	<u>0.21</u> % <u>18.58</u>
COMBUSTIBLE CARBON WT (gm)	<u>0.92</u> % <u>82.14</u>	<u>0.92</u> % <u>81.42</u>

AVERAGE % INORGANIC ASH 18.22 AVERAGE % COMBUSTIBLE CARBON 81.78

DATA FORM - WOOD ASH ANALYSES

RUN NO. 247COMBUSTIBLE CONTENT ANALYSESFUEL PINE BARKSIZE (mm) 0.125

	SAMPLE NO. 1	SAMPLE NO. 2
INITIAL SAMPLE + CRUCIBLE WT (gm)	<u>26.85</u>	<u>26.70</u>
CRUCIBLE WT (gm)	<u>25.95</u>	<u>25.75</u>
SAMPLE WT (gm)	<u>0.90</u>	<u>0.95</u>
FINAL SAMPLE + CRUCIBLE WT (gm)	<u>26.51</u>	<u>26.34</u>
CRUCIBLE WT (gm)	<u>25.95</u>	<u>25.75</u>
ASH WT (gm)	<u>0.56</u> % <u>62.22</u>	<u>0.59</u> % <u>62.11</u>
COMBUSTIBLE CARBON WT (gm)	<u>0.34</u> % <u>37.78</u>	<u>0.36</u> % <u>37.89</u>
AVERAGE % INORGANIC ASH	<u>62.17</u>	AVERAGE % COMBUSTIBLE CARBON <u>37.84</u>

RUN NO. 247COMBUSTIBLE CONTENT ANALYSESFUEL PINE BARKSIZE (mm) 0.063

	SAMPLE NO. 1	SAMPLE NO. 2
INITIAL SAMPLE + CRUCIBLE WT (gm)	<u>27.34</u>	<u>28.21</u>
CRUCIBLE WT (gm)	<u>26.39</u>	<u>27.21</u>
SAMPLE WT (gm)	<u>0.95</u>	<u>1.00</u>
FINAL SAMPLE + CRUCIBLE WT (gm)	<u>27.02</u>	<u>27.88</u>
CRUCIBLE WT (gm)	<u>26.39</u>	<u>27.21</u>
ASH WT (gm)	<u>0.63</u> % <u>66.32</u>	<u>0.67</u> % <u>67.00</u>
COMBUSTIBLE CARBON WT (gm)	<u>0.32</u> % <u>33.68</u>	<u>0.33</u> % <u>33.00</u>
AVERAGE % INORGANIC ASH	<u>66.66</u>	AVERAGE % COMBUSTIBLE CARBON <u>33.34</u>

DATA FORM - WOOD ASH ANALYSES

RUN NO. 247COMBUSTIBLE CONTENT ANALYSESFUEL PINE BARKSIZE (mm) 0.045

SAMPLE NO. 1

SAMPLE NO. 2

INITIAL SAMPLE + CRUCIBLE WT (gm)	<u>27.67</u>	<u>NO SAMPLE</u>
CRUCIBLE WT (gm)	<u>26.79</u>	<u>25.67</u>
SAMPLE WT (gm)	<u>0.88</u>	
FINAL SAMPLE + CRUCIBLE WT (gm)	<u>27.32</u>	
CRUCIBLE WT (gm)	<u>26.79</u>	
ASH WT (gm)	<u>0.53</u>	% <u>60.23</u>
COMBUSTIBLE CARBON WT (gm)	<u>0.35</u>	% <u>39.77</u>

AVERAGE % INORGANIC ASH 60.23 AVERAGE % COMBUSTIBLE CARBON 39.77

RUN NO. 247COMBUSTIBLE CONTENT ANALYSESFUEL PINE BARKSIZE (mm) PAN

SAMPLE NO. 1

SAMPLE NO. 2

INITIAL SAMPLE + CRUCIBLE WT (gm)	<u>27.56</u>	<u>27.31</u>
CRUCIBLE WT (gm)	<u>26.60</u>	<u>26.43</u>
SAMPLE WT (gm)	<u>0.96</u>	<u>0.88</u>
FINAL SAMPLE + CRUCIBLE WT (gm)	<u>27.16</u>	<u>26.94</u>
CRUCIBLE WT (gm)	<u>26.60</u>	<u>26.43</u>
ASH WT (gm)	<u>0.56</u>	% <u>58.33</u>
COMBUSTIBLE CARBON WT (gm)	<u>0.40</u>	% <u>41.67</u>

AVERAGE % INORGANIC ASH 58.14 AVERAGE % COMBUSTIBLE CARBON 41.86