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BACKGROUND INFORMATION FOR ESTABLISHMENT OF NATIONAL STANDARDS OF PERFORMANCE FOR NEW SOURCES

COAL CLEANING INDUSTRY

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1.0 INTRODUCTION

Coal is recovered from natural deposits in combination with greater or lesser amounts of rock, overburden, pyrites, and other materials which detract from the heating value of the coal and contribute air pollutants when the coal is burned. Coal cleaning processes are those which separate the unwanted material from the coal to meet product specifications. These products can be considered in three broad categories; utility, industrial and metallurgical (Table 1).

Electric utilities are the major users of coal in the United States. Specifications on coal sulfur content have gained increasing attention in past years. Ash content is generally limited to about 16%, which can be attained with no cleaning in many cases. Electric utilities commonly store coal in large stockpiles which are exposed to the weather. The coal is pulverized at the power plant immediately prior to use. Since the coal is stored in exposed stockpiles, the moisture content of the coal is not normally a significant specification.

Industrial coal users generally place specifications on both the size and moisture content of the coal to prevent handling problems in the feed system of stoker fired boilers. Excessive fines or high moisture content cause clogging of coal feed systems.[1]

TABLE 1

End Use of Coal, 1969

Total Production	560,505,000 tons
Electric Utilities	56%
Industrial	16%
Coke Plants	18%
Export	7%
All Others	3%

Source: 1969 Bureau of Mines Minerals Yearbook

Metallurgical coal has the tightest specifications of any of the three categories. It is not uncommon for specifications to call for a maximum of 5% ash, 1% sulfur, and 5% surface moisture. The top size of the coal is in the range of one inch and extreme fines are acceptable in the coal feed to coke ovens.

The majority of coal supplied for industrial and metallurgical use is cleaned, while a much lower percentage of the utility coal is processed in coal cleaning plants. This is reflected in the coal utilization data compiled by the U.S. Bureau of Mines. In 1969, 60% of the total coal production was processed in coal cleaning plants. Coal recovered from underground mines generally contains a moderate to high amount of rock and overburden, which is mined with the coal. Of the 347,000,000 tons of coal recovered from underground mines in 1969, 72% was processed in cleaning plants. Strip mines are commonly thick deposits of coal, and the overburden can be removed almost completely. Only 42% of the 197,000,000 tons of coal mined by stripping in 1969 was processed in coal cleaning plants. The majority of the coal mined by stripping was utilized as electric utility fuel. Auger mining is another surface operation which recovers coal with very little rock or other refuse. Of the 16,000,000 tons of coal recovered by auger mining in 1969, only 15% was processed in cleaning plants. Most of this coal went to utility end use and many of the auger mine operators are too small to own a cleaning plant.

The percentage of coal production processed through mechanical cleaning plants in the last ten years has been relatively constant at 60-65% (Table 2). The efficiency of coal cleaning has increased, however, with the percentage of refuse to raw coal rising gradually to the 1969 value of 23.1%.

The reduction of surface moisture necessary to meet specifications for industrial and metallurgical coal often requires that thermal drying be included as a final step in the coal preparation operation. Over the past eight years, a relatively constant 12% of the total coal production has been treated by thermal drying.

Coal preparation operations are almost universally carried out at the mine site. Preparation plants are located in areas which are remote from centers of population, almost without exception. Until recent years there has been very little pressure for environmental control at these installations and air pollution emissions have been high. West Virginia has more preparation plants than any other state. On September 1, 1968, Regulation V of the West Virginia Air Pollution Control Commission, "To Prevent and Control Air Pollution from the Operation of Coal Preparation Plants and Coal Handling Operations," became effective. This specific regulation, with the general process industry regulations enacted in the states of Pennsylvania and Illinois, contributed to a

TABLE 2

Growth of Coal Cleaning

	1929	1939	1949	1959	1961	1963	1965	1967	1969
Total Coal Production, millions of tons	535	395	438	412	403	459	512	545	560
Percent Cleaned	6.9	20.1	35.1	65.5	65.7	63.1	64.9	63.2	59.7
Percent Thermally Dried				8.7	9.8	11.0	12.8	13.5	12.0
Percentage of Refuse to Coal Cleaned	8.6	10.6	16.8	20.0	19.3	20.1	20.7	22.0	23.1

Source: Bureau of Mines Minerals Yearbooks major reduction in air pollutant emissions from coal cleaning operations over the past five years.

The major air pollutant emission source from coal cleaning operations is thermal drying. It is anticipated that over the next ten years there will be little, if any, increase in the tonnage of coal thermally dried because thermal drying will be almost exclusively limited to the preparation of metallurgical coal. Coal cleaning is essentially a wet operation, and significant advances have been made in mechanical dewatering equipment. Only recently, vibratory oscillating centrifuges have been developed. They can reduce the surface moisture of industrial grade coal with less size degradation than basket type centrifuges, and moisture reduction compares favorably with thermal drying in some cases. Developments of this type will lead the coal preparation industry away from thermal dryers wherever possible, since thermal drying is more expensive than mechanical dewatering of coal.

2.0 PROCESS DESCRIPTION

The mechanization of the coal industry over the past 20 to 30 years has led to substantial changes in the character of mined coal. In 1942, continuous mining machines were virtually unknown and hand loading in underground mines accounted for 55% of the production of bituminous coal and lignite. Hand loading gives an opportunity to separate impurities at the mine face before the coal is sent to the surface. In 1965, only 11% of the total production of coal was hand loaded. Continuous and automatic mining machinery has greatly increased the output of coal as measured by tons per man per day. While more impurities such as overburden rock are now mined, there is a concurrent increase in the demand for low ash coals. In order to meet these demands, there has been an increase in the use of coal preparation plants.

Coal preparation plants are used to separate impurities from the coal and provide a product of appropriate physical size as determined by the end use. Sub-bituminous coals and lignite are hardly ever mechanically cleaned. The principal purpose for mechanical cleaning of coal is to lower the ash content to acceptable levels. Underground coal deposits are seldom found with a clear physical separation between the coal and rock overburden. More commonly, there is an intermediate layer of semi-coal known by many terms such as bony or shale.

The coal industry utilizes mechanical coal preparation methods and equipment for two reasons--to increase its net income per ton of product and to provide a steady outlet for its products. Since coal consumers pay for shipping costs in addition to the cost of the coal at the point of shipping, the coal industry is extremely sensitive to the cost of preparation. Electric utilities, the largest user of coal, consider their costs in terms of BTU as fired in the furnace. The cost of shipping refuse and moisture can be a significant portion of the transportation cost, so coal preparation processes have been adopted by most coal companies in order to be competitive in terms of customer economics. It has been found that the increased production rate in coal mines using continuous mining systems brings more refuse to the surface, but cleaning processes are economical when considering the overall costs of delivery of coal products.

Coal cleaning processes utilize the physical differences in specific gravity of coal and refuse material to attain a separation. The specific gravity of "coal" ranges from 1.23 to 1.72 depending upon the inherent characteristics of the coal. The specific gravity of pure clay and sandstone is about 2.6. Shale ranges from 2.0 to 2.6 and bone or bony coal covers a range of about

1.4 to 2.0. Coal cleaning can be a simple or difficult task depending upon the difference between the specific gravity of the coal and the refuse at any given location.

Some refuse is mined with the coal because there is seldom a clear separation between the coal seam and the rock overburden. Other materials are found as physical inclusions in the coal seam which can be separated once the coal is crushed to a moderate size. Some impurities are so finely divided and intimately mixed that they must be considered a structural part of the coal which cannot be removed by mechanical cleaning no matter how thorough. Pyritic sulfur is an example of material found as a physical inclusion, while organic sulfur is an intimate part of the coal molecular structure.

Coal preparation processes utilize the difference in specific gravity between the coal and refuse materials to attain the desired product purity. The great majority of coal preparation is done by wet processes (Table 3). Moisture adds to shipping costs, detracts from the heating value of coal and can cause handling problems in mechanical feed systems. When shipping coal in the winter, high surface moisture can lead to freezing of railroad cars and attendant higher operating costs for car unloading. For these reasons, dewatering is always a step in wet coal cleaning processes. Dewatering can be mechanical and as simple as draining. Centrifuges can be used, or

TABLE 3

Type of Equipment Used To
Clean Coal and Lignite

PROCESS	Millions of tons cleaned, by year			
Wet Methods	1939	1949	1959	1969
Jigs	37.1	72.4	126.8	155.0
Concentrating Tables	1.4	4.0	27.5	45.3
Dense Medium	4.7	17.8	67.0	97.6
Flotation	*	*	1.7	9.6
Other	24.5	46.5	28.5	8.1
Total Wet	67.7	140.7	251.5	315.6
Dry (Pneumatic) Methods	11.7	12.9	18.2	19.1
TOTAL CLEANED	79.4	153.7	269.8	334.8

*Flotation included with "other" prior to 1959

Source: Bureau of Mines Minerals Yearbook thermal drying can be used for a maximum reduction of surface moisture.

2.1 WET METHODS OF COAL PREPARATION

Wet methods fall into three broad categories: hydraulic separation, heavy medium separation, and flotation.

Hydraulic separation is the dominant process in wet coal cleaning. In its simplest form, hydraulic separation utilizes the differential terminal settling velocity of particles of approximately the same diameter to accomplish a specific gravity separation. Simple trough washers and an elutriation type washer called the rheolaveuer are examples of launders and classifiers which process a small fraction of the total coal cleaned.

Concentrating tables, principally supplied by the Deister Concentrating Company, Inc., and generally known as Deister Tables, are considered dependable and efficient devices for a size range of about 3/8" by 48 mesh. A feed of approximately 2 or 3:1 water:solids goes to a corner of the rhomboid shaped deck. The deck is vibrated and stratification of the coal and refuse is accomplished as the material passes across the table.

Jigging is a process of particle stratification in which particle rearrangement results from an alternate expansion and compaction of a bed of particles by a pulsating fluid flow. The mechanism is essentially one of hindered settling. Particle rearrangement results in a stratification by density, with highest density particles at the bottom of the bed. Jigging is more related to particle density and less to particle size than other hydraulic type processes. It is more efficient for the handling of coarse coal than fine coal.

The basic jig design is the Baum type, where water movement is motivated by air pressure. Coal is fed into a sealed compartment where it travels horizontally through the jig. Air pulsations are delivered to the sealed compartment above the coal. By the time the coal has passed across the wash box of the jig, it is stratified and the refuse product can be removed from the bottom, while the clean coal passes to other processing steps. A different design is used by the Wemco-Remer jig, which does not use either a closed chamber or air plusations. The Wemco-Remer jig is an open trough with a water chamber under the coal bed plate. The entire water chamber is mechanically oscillated to provide the pulsations necessary to attain the hindered settling separation.

Heavy medium separation of refuse from coal is strictly a specific gravity separation. A mixture of megnetite or sand in water is adjusted to the specific gravity desired for the separation. Many mechanical designs are available for processing coarse coal or fine coal. High capacity heavy medium separators for coarse coal are available in many designs, of which the Tromp is typical. The trough-type Tromp vessel accepts raw coal feed at one end and the refuse migrates to the bottom, while the clean coal floats to removal at the other end.

Many recent coal preparation plants have included heavy medium cyclones in their design. These cyclones are particularly well adapted to the cleaning of fine coal. A specific gravity separation is accomplished using the accelerated gravitational force which can be attained in a cyclone.

Jigs, classifiers, and heavy medium processes are generally economical for the cleaning of coal down to approximately 28 mesh size. Below this, froth flotation has been successfully applied to recover clean coal from a mixture of coal and refuse. Flotation depends on the selective adhesion to air of some solids and the simultaneous adhesion to water of other solids. Generally, flotation reagents are selected so that coal adheres to the air and is floated to the surface of flotation cells.

2.2 DRY METHOD OF COAL PREPARATION

Pneumatic cleaning of coal is an all-dry process which is less expensive than wet process coal cleaning.

The equipment used is conceptually similar to a jig, in that it utilizes a pulsating air flow from beneath the deck to accomplish a specific gravity separation by hindered settling. Surface moisture content of 2 or 3% is acceptable, but when surface moisture exceeds about 5% the moisture interferes with the cleaning operation in an air table. Thermal drying has been used to prepare raw coal for separation in air tabling plants.[2]

2.3 DEWATERING OF COAL

The moisture content of coal is a function of the inherent moisture and surface moisture. Inherent moisture depends upon the water solubility of the coal and it cannot be removed by mechanical or thermal drying processes. Eastern bituminous coal may be as low as 2% in inherent moisture. Illinois coals have an inherent moisture of 10-15% and western sub-bituminous coals have an inherent moisture on the order of 25%. Surface moisture, as implied by the name, is attached to the surfaces of the coal particles or retained in cracks and fissures of the coal particles. The weight percentage of surface moisture on coal is a direct function of the surface area per unit weight so it increases significantly as particle size decreases.

Above 1 1/2", shaker screens and vibrating screens are used to remove surface moisture. Between about 48 mesh and 1 1/2", various types of centrifuges are used to reduce surface moisture to 2% to 6%. Vibratory screen centrifuges are particularly efficient. The surface moisture of the filter cake recovered from froth flotation is in the range of 20-30%. Steam can be applied directly to the filter cake to lower the viscosity of the water and reduce filter cake moisture content by about one-third.[6]

Thermal dewatering is used when product surface moisture is to be reduced to less than approximately 5-6%. In this process, wet coal feed is exposed to a hot gas stream to evaporate the surface moisture. When coal is dried to less than 2% surface moisture, extreme dustiness can result. Thermally dried coal presents the most intense dust problem in the coal preparation industry, both at the preparation plant and from railroad cars in transit.

Many mechanical designs of dryers have been used by the coal preparation industry but current installations are almost exclusively utilizing fluidized bed dryers. The major suppliers of fluid bed dryers for coal preparation are McNally-Pittsburg, Heyl and Patterson, Link-Belt and Dorr-Oliver.[5]

The McNally-Pittsburg Flowdryer, the Link-Belt Fluid-Flo dryer and the Heyl and Patterson Fluid Bed dryer operate with a negative pressure in the drying chamber while the Dorr-Oliver FluoSolids dryer operates with a postive pressure in the drying bed. Fires on the bed are not uncommon and explosions have been reported. The U. S. Bureau of Mines has recommended[7] that thermal dryers be physically isolated from the main part of the coal preparation plant and that no building walls be constructed around the dryer. Some positive pressure dryers have been observed to have significant dust losses in the vicinity of the dryer bed as the equipment has aged and air seals become less than perfect.

The moisture content of the coal fed to the thermal dryer is the determining factor in setting the system air volume. The upper temperature limit of the gases supplied underneath the fluidized bed is set by material considerations. An adequate supply of heat must be delivered to the fluid bed to attain the moisture content desired for the product without overdrying the coal.

Air pollution considerations have led some thermal dryer operators to bypass the filter cake, which contains the extreme fines, around the thermal dryer to lessen the burden on air pollution control equipment.[8]

2.4 COST OF COAL PREPARATION

The cost of coal preparation can only be broadly generalized since the degree of cleaning and the qualities of the raw coal can vary widely. Air tabling plants are the least expensive with a capital cost of approximately $1,000 per ton per hour of plant capacity. A wet process plant of 500 to 1,000 tons per hour raw coal handling capacity, washing only 50 to 60% of the raw feed which is plus 3/8" in size can be erected for approximately $3,000 per ton per hour. If this same plant were to wash and thermally dry the minus 3/8" coal, the cost would be $2500 per ton per hour of plus 3/8" feed and $5,000 per ton per hour of minus 3/8" feed. Plant operating costs including labor supplies, power and depreciation for a complete wet processing plant will be about 50¢ per ton of plant output.(1)

An excellent review of the economic impact of air and water pollution control on coal preparation estimates that the cost of eliminating both air and water pollution from coal cleaning plants will add 15-20% to the cost of coal preparation.(3) Another study estimates that the cost for air pollution control alone can range from 3.5 to 10.8 cents per ton of coal processed for plants with thermal dryers and from 1.6 to 2.4 cents per ton for air tabling plants.(4) The price of coal currently is in the range of $8.00 per ton for steam coal and $11.00-14.00 for metallurgical coal. The cost of thermal drying adds 8 to 15 cents per ton, without dust collection equipment.(5)

3.0 EMISSIONS FROM COAL CLEANING PLANTS

While there are minor amounts of some gaseous pollutants, particulate matter is the dominant consideration in air pollution emissions from coal cleaning plants.

3.1 SULFUR OXIDES

Sulfur oxides are potentially generated only at the thermal dryer. The concentration of sulfur oxides in the flue gas is a function of the sulfur content of the fuel used to provide the heat for the thermal dryer. Since thermal dryers are almost universally equipped with wet scrubbers, there will be some degree of emission reduction of sulfur oxides but there are no measurement data to provide definitive baseline information.

3.2 NITROGEN OXIDES

Nitrogen oxides are a potential emission source from coal cleaning plants equipped with thermal dryers. As in the case with sulfur oxides, the wet scrubbers used in conjunction with the thermal dryers will capture some of the nitrogen oxides.

3.3 PARTICULATE MATTER

Three categories of particulate emission can be identified in the coal cleaning industry. Fugitive dust, process emissions from the dry handling of coal, and emissions from thermal dryers will be treated separately. Fugitive dust is generated from sources not amenable to enclosure and capture of the dust, such as roadways and stockpiles. Operations such as crushing, screening, and belt transfer points are considered under dry process emissions.

3.3.1 Fugitive Dust

Principal sources of fugitive dust emission in coal preparation plants are roadways, stockpiles, loaded railroad cars, and refuse disposal areas. Belt transfer points within the immediate confines of the preparation plant will be considered under dry process operations, but transfer points located in remote areas might be considered as fugitive dust sources in some instances.

The generation of fugitive dust from coal preparation plants is heavily dependent upon the surface moisture content of the coal. Wet process plants which do not use thermal drying present a considerably lower potential for fugitive dust generation than plants which use dry cleaning or which dry coal in thermal dryers.

If refuse is trucked to the disposal area, these trucks and the roadways over which they travel are a potential source. If the refuse is delivered to the disposal area by aerial tramway or belt conveyor, less fugitive dust potential exists.

Rail car loading of very dry coal can be quite dusty, especially if elevated belt conveyors are used to drop the coal into the cars. Less dust is generated if choke feed chutes are used. Once the cars are loaded (by either method) there can be significant wind-blown loss both at the preparation plant and in transit.

Wet process plants, especially those utilizing flotation for the cleaning of ultrafine coal, generate a fine refuse slurry. This slurry is normally recovered in a thickener and pumped to a settling pond for recovery and reuse of the water. If these settling ponds are allowed to dry out, the potential exists for blowing of these refuse fines during dry, windy weather.

There have been lawsuits against coal cleaning operations, mainly based on excessive dustfall.

3.3.2 Dry Processing Operations

Depending upon the size gradation and friability of the coal as mined, and the product specifications, there may be a significant amount of crushing and dry screening at preparation plants. These operations are classical materials handling and size reduction processes and as such are amenable to engineering control of in-plant dust by hooding and the use of fan-powered ventilation systems. If the particle size of the dust is generally large, air pollution control can be attained by the use of cyclones or low to medium energy wet scrubbers. If the particle size is small, baghouses are the dust collector of choice.

The pneumatic cleaning of coal, or air tabling, creates more or less fine dust emissions, again depending upon the type of coal processed and the particle size. Some older plants still utilize single large diameter cyclones for the control of dust from air tabling, but newer installations are utilizing baghouses.

3.3.3 Thermal Dryers

The thermal dryer represents the largest source of potential particulate emissions from coal cleaning. The dominant equipment types in current use are flash dryers and fluidized bed dryers. While only the fluidized bed is receiving serious consideration for new installations,[5] there are still a significant number of flash dryers in use. Other types of dryers are being phased out as their useful life is approached (Tables 4 and 5).

The flash dryer uses a very short residence time in a hot zone to accomplish evaporation of surface moisture in seconds. All of the dry product passes to a cyclone, which is an integral part of the dryer.

TABLE 4

Annual Tonnage of Coal Thermally Dried, by Type of Dryer
(millions of tons)

	1957	1959	1961	1963	1965	1967	1969
Continuous Carrier	1.4	0.9	0.8	0.7	0.8	0	0
Fluidized Bed	*	4.6	7.8	14.9	27.3	38.1	40.6
Multilouvre	8.6	9.7	10.6	9.5	12.3	15.1	10.1
Rotary	0.3	0.7	1.0	2.6	1.5	1.7	1.2
Screen	7.5	7.5	8.2	8.8	8.1	6.0	5.1
Suspension or Flash	8.5*	6.6	5.7	8.1	10.4	9.8	7.4
Vertical Tray and Cascade	5.6	5.7	5.6	6.0	4.8	4.0	2.7
TOTAL	31.9	35.8	39.6	50.6	65.4	74.7	67.1

*In 1957, Fluidized Bed included with Suspension or Flash

Source: U. S. Bureau of Mines

TABLE 5

Number of Thermal Drying Units, by Type of Dryer

	1957	1959	1961	1963	1965	1967	1969
Continuous Carrier	5	5	5	4	4	0	0
Fluidized Bed	*	12	23	38	57	67	80
Multilouvre	45	55	56	44	46	49	29
Rotary	5	9	11	11	8	5	5
Screen	62	61	61	53	48	35	25
Suspension or Flash	34*	48	40	49	46	42	35
Vertical Tray and Cascade	50	57	64	54	42	35	18
TOTAL	201	247	260	253	251	233	192

*In 1957, Fluidized Bed included with Suspension or Flash

Source: U. S. Bureau of Mines

Without air pollution control equipment the emissions from flash dryers are estimated at about 10 pounds of dust per ton of coal. Air volume is approximately 16,000 standard cubic feet per ton of coal, so the emissions from uncontrolled flash dryers may be as high as 50 grains per standard cubic foot. The integral cyclone in the flash dryer is a single large diameter unit, so the application of a secondary cyclone and simple spray type scrubbers can reduce these emissions to 0.1 to 0.3 grains per standard cubic foot.

Fluidized bed dryers require a forced draft supply of heated air and most designs utilize a second fan on the clean side so the dryer operates with negative pressure at the bed. Air volume can range from 15,000 to 30,000 standard cubic feet per ton, with about 24,000 scfm per ton considered typical. Cyclone dust collectors are always supplied with these units as a part of the product capture system. Some operators[9] prefer large diameter cyclones over the multiple tube type because of the problems experienced with plugging of the small tubes as the dryer passes through the dew point at startup and shutdown. Dust concentrations leaving the integral cyclone of the thermal dryer unit are estimated at 3 to 6 grains per standard cubic foot although this can go as high as perhaps 20 grains per standard cubic foot in the case of process upsets such as the interruption of the feed. In these upset situations, the coal on the bed is dried to nearly zero surface moisture and becomes extremely dusty. Early installations of medium energy wet scrubbers attained outlet dust concentrations of about 0.2 grains per standard cubic foot for most coals, although values as low as 0.05 and as high as 0.3 have been discussed. In general, the industry now considers that high energy venturi scrubbers are necessary to comply with modern air pollution control regulations.[9,10]

3.3.4 Emission Estimate

Prior to about 1962 very few coal preparation plants were equipped with what would now be considered adequate dust collection equipment. Since the thermal dryer represents the dominant particulate emission source in the industry, estimates have been prepared for the gross particulate emissions from this source from 1958 through 1968. These are based on an average air volume of 22,400 standard cubic feet of dry air per ton of coal. Uncontrolled stack dust concentration is estimated at 4.0 grs/scf; emissions from spray scrubbers at 0.2 grs/scf; and emissions from plants equipped with venturi scrubbers at 0.06 grs/scf. Uncontrolled plants are estimated at 80% in 1958, decreasing to 60% in 1964 and 30% in 1968. It is estimated that the emissions controlled by spray scrubbers increased from 20% in 1958 to 40% in 1964 and 65% in 1968. Venturi scrubber control is a relatively new phenomenon in the industry and the only inclusion of this control was at the level of 5% in 1968. Based on these estimates, and the thermally dried tonnage of coal reported by the U.S. Bureau of Mines, it is estimated that 1964 was the year of maximum particulate emission from the coal preparation industry (Figure 1). As coal preparation plant operators responded to air pollution control regulations, particularly those of West Virginia, Pennsylvania, and Illinois, gross emissions began decreasing below 200,000 tons per year after 1964. Estimates of coal preparation production over the next ten years are discussed in Chapter 8. On the basis of these estimates, Figure 1 also includes a 1980 projection of particulate emissions at 0.10 grains per standard cubic foot. It is estimated that total particulate emissions from the thermal drying of coal will be less than 10% of the 1964 level by 1980 as a result of current state regulations and the impact of the national standards of performance for new and modified installations.

3.4 FLUORIDES

There are no known fluoride emissions from the coal cleaning process.

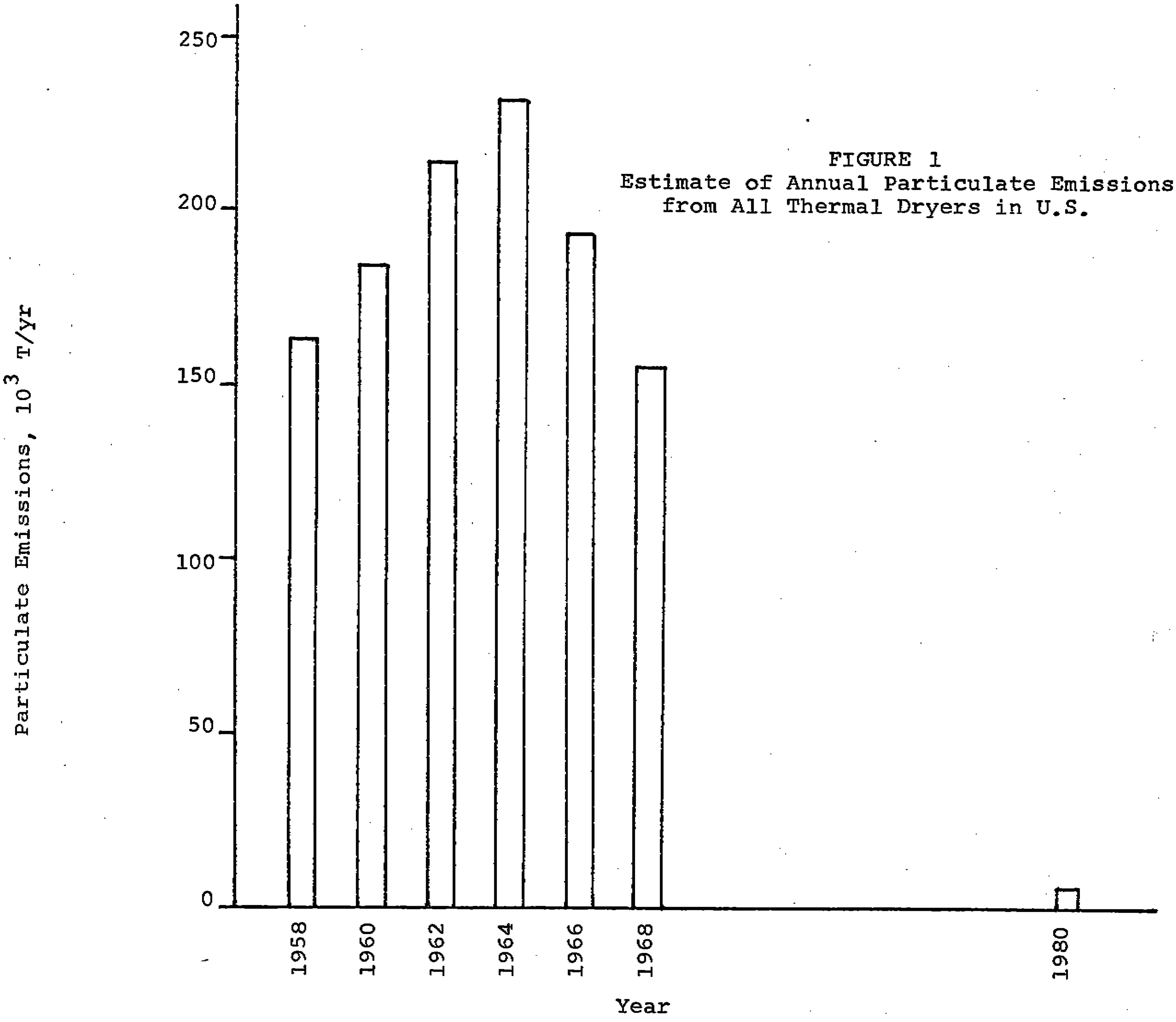

FIGURE 1
Estimate of Annual Particulate Emissions from All Thermal Dryers in U.S.

3.5 TOTAL REDUCED SULFUR COMPOUNDS

In past years, the emission of hydrogen sulfide from burning coal refuse piles has been a significant source of localized air pollution in many areas. Attempts at extinguishing such fires have met with only limited success and the most effective control measure has been a combination of improved disposal practices and the recovery of a higher percentage of coal from the refuse so that the material is basically non-combustible. It is not anticipated that burning refuse piles would be a problem with any new coal cleaning facility because most state laws adequately define practices which must be followed to prevent such burning.

3.6 ODORS

With the exception of reduced sulfur gases from burning refuse piles, odors are not considered a problem at coal cleaning plants.

3.7 VISIBLE EMISSIONS

Fugitive dust swirling in the immediate vicinity of coal preparation plants can, at times, create large clouds of visible dust. This is most common on plant roadways and at the rail car loading station.

Air tables controlled only by cyclones create visible emissions at times, and other dry process emissions can be visible depending on the type of dust collector used.

Thermal dryer stacks are seldom clear at all times, even with the best venturi scrubbers. At startup and shutdown of operation there is a heavy concentration at the inlet to the scrubber because the coal is very dry, so some visible emissions seem unavoidable.[11]

3.8 PROCESS MODIFICATION

Section 111 (a) (4) of the Clean Air Act of 1970 defines the term 'modification' as "any physical change in, or change in the method of operation of, a stationary source which increases the amount of any air pollutant emitted by such source or which results in the emission of any air pollutant not previously emitted."

Within a coal preparation plant a modification under this definition could be caused by a change in the character of the coal processed at the plant, or by increased production rate. It is not uncommon at large mines for the coal to contain more or less ash, or to be contaminated with more or less refuse, as new areas of the mine are developed. Increased production rate can easily be verified by inspection of plant records, but changes in emissions caused by changes in the character of the coal will probably only be confirmed by source testing.

4.0 CONTROL TECHNOLOGY AVAILABLE FOR NEW PLANTS

Depending upon the characteristics of the coal being processed, dust from primary crushers can be controlled either with water sprays or by hooding the crusher and transporting gases to a dust collector such as a medium energy scrubber or a baghouse. The dust captured by a general ventilation system from transfer points, secondary crushing, and dry screening can be controlled by wet scrubbers or baghouses.

Fugitive dust from car loading is not a major factor when coal surface moisture is about 6% or higher and, in any case, can usually be controlled adequately by the engineering design of the loading system. If cars are loaded by stacking conveyors which allow a long drop of clean coal into the car, significant fugitive dust can be generated and a hooded enclosure might be necessary to attain adequate control. In-plant roads are always a problem, especially if heavy truck traffic is expected through the plant. Regular washing and the use of oil or calcium chloride sometimes controls road dust. Most coal cleaning plants have a large settling pond for water clarification. If allowed to dry over substantial areas, these ponds are a potential source of fugitive dust. Vegetation cover has controlled this dusting in some cases.[12] Stockpiles can contribute to fugitive dust, but control of wind-blown dust from stockpiles has not been satisfactorily attained.[10]

For pneumatic coal cleaning, large diameter cyclones were once universally applied, but new air pollution regulations have caused a change in plant design and baghouses are now the dust collector of choice.

In the wet processing of coal, there are essentially no sources of air pollution except from thermal drying. Emissions from thermal dryers are universally controlled by wet scrubbers. A significant explosion potential exists at thermal dryers since hot gases come in contact with finely divided coal dust. Electrostatic precipitators have not been considered for this reason. Baghouses are generally unsuitable because of the combustion and explosion hazard and the high dew point of the stack gases.

As seen in Figure 2, many early thermal dryer installations were equipped only with primary dry dust collectors and dust emissions were severe.[2, 23] In the 1960's low and medium energy wet scrubbers were applied to thermal dryers, lowering emissions to 0.1-0.2 grs/scfd. The first plant to install a high energy wet scrubber was the Bird Coal Company near Johnstown, Pennsylvania.[11] A court order required that this plant reduce its thermal dryer emissions to 0.05 grs/scfd. The American Air Filter Co. installed a 1000 cfm pilot unit to develop data, since there was no prior experience and little information regarding

FIGURE 2

"Modern Coal Mine Tipple"

Postcard Published in 1965

particle size. Results of these tests indicated that outlet concentrations of 0.066, 0.06, 0.048 and 0.038 grs/scfd could be attained at pressure drops of 10, 15, 20 and 26 inches of water, respectively. The water rate was 8 gpm per thousand cfm, with 20% recycled. A full scale unit was installed, at a pressure drop of 20 inches of water. Gas volume was slightly less than anticipated, so the throat of the venturi was constricted to attain a pressure drop of 25 inches of water. A stack concentration of 0.036 grs/scfd and an inlet concentration of 3.0 grs/scfd were determined by the American Air Filter test method.[13] Particle sizing, by the MSA-Whitby method, indicated an average particle size of 12 microns. It is important to note that, in order to attain the stack dust level desired, 48 mesh by zero filter cake was not dried. The total cost of the air pollution control program was $400,000, with the high energy scrubber alone about $100,000. It is noted that much existing equipment was utilized, and estimated that a new high energy scrubber for a similar 175 tph plant would cost about $150,000. This program was completed in 1966.

In 1967, the Ittman preparation plant of the Pocahontas Fuel Company, an operating unit of the Consolidation Coal Company, replaced four multilouvre driers with a single fluid bed dryer.[2] An American Air Filter venturi scrubber at a pressure drop of 18 inches of water was installed. Dust loadings were reduced from 5.5-6.6 grs/scfd to about 0.06 grs/scfd. Particle size analysis of the inlet dust, determined by Coulter Counter, indicated a mass mean size of about 8 microns. It was concluded that "to meet existing air pollution regulations, high energy scrubbers will be required for Pocahontas coals."

It may not be necessary to apply venturi scrubbers at all plants, depending upon the type of coal processed. The Amherst Coal Company in Logan County, West Virginia, accomplished stack dust concentrations of 0.07 and 0.086 grs/scfd on two separate flash dryers, and 0.1 grs/scfd on a fluid bed dryer, with a Western Precipitation Company Turbalaire scrubber. The pressure drop at these scrubbers is 8-10 inches of water. It is reported that this same type scrubber results in stack concentration of 0.05 grains per cubic foot at Clinchfield Coal's Moss No. 3 plant near Dante, Virginia. Particle size at the inlet, with 2.5-3.5 grs/cf, is reported as 68% less than 5 microns. At Clinchfield's Compass No. 2 plant, Dola, West Virginia, two Turbalaire scrubbers operate with an average stack loading of 0.087 grs/cf.(14)

American Air Filter and Research-Cottrell are the dominant suppliers of high energy scrubbers for thermal dryer applications. Research-Cottrell considers 0.05 grs/scfd a maximum concentration for a non-visible plume, and generalizes that 35 inches of water are necessary to attain this stack concentration.[15] The basic design of the scrubbers from these two manufacturers is somewhat different, in that Research-Cottrell uses a simple spray separator with a one-inch pressure drop for demisting, while American Air Filter uses a low energy wet cyclone at 4-5 inches of water pressure drop for demisting.

Preparation plant builders recognize the need for good air pollution control. One manufacturer's literature states that "high energy venturi-type scrubbers have become standard adjuncts" to their fluid bed dryer.[9]

5.0 COAL CLEANING PLANTS UTILIZING BEST EMISSION CONTROL TECHNOLOGY

Since the recommended standards of performance will be presented in terms of three types of emissions; thermal dryers, dry process operations and fugitive dust, three plants are identified as demonstrating best control technology in each of these areas.

5.1 FUGITIVE DUST

The Bird Coal Company, near Johnstown, Pennsylvania, is identified as the coal preparation plant having the best control of fugitive dust.[11] This plant is located in a residential area and for many years was the subject of neighborhood complaints and eventually, a lawsuit. At the time of the air pollution control engineering program, the Bird Coal Company was owned by the Maust Coal and Coke Corporation, but it is now owned by the Island Creek Coal Company.

During the engineering investigation prior to the corrective program, three specific fugitive dust generation points were identified. At the raw coal transfer point beneath the screening house, vibrating feeders delivered 1/4" by zero coal onto the classifier feed belt. Flooding of the conveyor, especially during periods of startup and shutdown, created significant fugitive dust emissions. The railroad car loading belt beneath the fluid bed dryer was found to be another fugitive dust emission point. Crushed coarse metallurgical coal was first loaded on the belt, then the -3/4" material from the heat dryer was placed on top. This was topped with the extremely dry cyclone catch from the primary dust collector of the thermal dryer. The loading of the material onto the belt and subsequent handling operations were quite dusty. The third point of fugitive dust generation was the railroad car loading area.

In order to eliminate dusting from the raw coal screenhouse, the screening process was changed from dry to wet. The classifier which handled the dry 1/4" by zero coal was removed from the operating circuit, and the 48 mesh by zero fine coal cleaned by froth flotation. The filter cake from the froth flotation bypassed the thermal dryer and was loaded wet, thus reducing dusting at the loading belt underneath the thermal dryer and at the railroad car loading area. The loading cycle on the clean coal belt was changed so that the thermal dryer product was loaded first and then covered with the coarser material which had not been thermally dried. A mixing screw conveyor was installed to blend the primary cyclone dust collector material with the coarse fraction of coal discharged by the dryer thus balancing the moisture content in these two feed materials.

The Director of Preparation for the Island Creek Coal Company is: Mr. Elza F. Burch
Island Creek Coal Company
Bulkley Building
Cleveland, Ohio 44115

5.2 DRY PROCESS OPERATIONS

The coals of western Pennsylvania are particularly amenable to ash reduction by air tabling. The Florence Mining Company operates a preparation plant in Huff, Indiana County, Pennsylvania.[17,18] This plant processes 1200 tons per hour of raw coal feed, with 18-20% discarded as rejects. The Galis Manufacturing Company was the prime contractor for this plant. The air tables were supplied by the Roberts and Schaefer Company. Raw coal is crushed to 3/4" by zero and goes directly to the R&S super air flow unit. The coal is stratified by pulsating air as it moves over the slightly inclined reciprocating perforated deck plate mounted over an air box. Air is supplied to each of the 14 air tables at 25,200 cfm delivered at 10 inches static pressure. On the air tables the refuse gravitates toward the bottom and is withdrawn by screw conveyors. The upper layer of clean coal and the middle layer of middlings travel over the slowly moving bed of refuse and are removed separately at the discharge end of the deck. A rotating butterfly damper in the feed airline provides the pulsations. The air from the tables first passes through cyclone dust collectors and then to Pangborn baghouses. Each of the 14 air tables has a separate 75 horsepower blower and baghouse rated at 31,500 cfm. The cyclone and baghouse catch go to the clean coal belt. The belt can deliver coal directly to the Conemaugh power station, or to stockpiles. All conveyors within the plant are enclosed.

A probable contact for test arrangements is:

Mr. H. A. Cashion
Assistant to the President
for Administration
The Florence Mining Company
Seward, Pennsylvania 15954

5.3 THERMAL DRYERS

The coal preparation plant at the Island Creek Coal Company's Virginia-Pocahontas No. 3 mine in Vansant, Virginia, is identified as the thermal drying installation having the best control technology in the United States.[9,16] Other candidates for this consideration are the Island Creek Coal Company's Bird Coal Company plant near Johnstown, Pennsylvania,[11] Consolidation Coal Company's Ittman preparation plant in West Virginia,[2] and Consolidation Coal Company's Rowland preparation plant in West Virginia.[8] The Rowland and Bird plants bypass filter cake around the thermal dryer, while the Virginia-Pocahontas No. 3 and Bird installations dry the entire burden of filter cake. This was one of the main reasons for selecting the Virginia-Pocahontas No. 3 installation, which has started up more recently than Ittman.

The Virginia-Pocahontas No. 3 mine and preparation plant of the Island Creek Coal Company began operation in 1970. The preparation plant processes 625 tons per hour of raw feed and the McNally-Pittsburg No. 8 flow dryer dries approximately 400 tons per hour of finished coal. The coal is an exceptionally high quality Pocahontas coal which is sold to the metallurgical market.

A Research-Cottrell flooded disc scrubber operating at a pressure drop of approximately 35 inches of water reduces emissions from the stack to an undetermined level. Director of Preparation is:

Mr. R. E. Blankenship
Island Creek Coal Company
Virginia-Pocahontas Division
Keen Mountain, Virginia 24624

The contact for testing at the Ittman plant is:

Dr. G. L. Barthauer, Director
Conservation Department
Consolidation Coal Company
Library, Pennsylvania 15129

6.0 SPECIFIC REGULATIONS CURRENTLY PERTAINING TO EMISSIONS FROM COAL CLEANING PLANTS

Since thermal dryers are the principal source of emissions from coal cleaning plants, a specific review was made of the regulations in the states where thermal dryers are located.

To compare various regulations, "typical new plant" characteristics have been estimated, based on industry trends. This plant should be typical of most of the new thermal drying installations for the next five to ten years.

Stack Height: 100 feet

Process weight rate: 400 tph

Gas Volume: 225,400 acfm, saturated @140°F
which is 160,000 scfm, dry

Air pollution control: Venturi scrubber

Inlet Dust Concentration: 4.0 grs/scfd.

This plant is considerably larger than the average plant of the present, which is estimated at 143 tph.[4]

Colorado has a limitation of 20% opacity for visible emissions. Their process weight regulation (which applies to coal preparation plants) is a modified Bay Area process weight curve. The Colorado values are 75% of the Bay Area values. Fugitive dust regulations are based on the complaints of 20% of a group of people affected by the source, but no less than five people in any case. This regulation is based on qualitative measurement. Upwind and downwind sampling is used to prove that transport of fugitive dust exists from the source.

Illinois currently has in effect a Bay Area process weight curve. More stringent regulations are being considered. There are no specific regulations for coal preparation plants but they fall into the industrial process emission category. The "typical new plant" would be limited to an emission rate of 66.3 pounds per hour, equivalent to a stack dust concentration of 0.048 grs/scfd.

Indiana has a general process weight regulation but nothing specific for coal preparation plants. There is no fugitive dust regulation in the state of Indiana.

Kentucky Regulation No. 11 uses the Bay Area process weight curve with an opacity limitation of No. 1 Ringelmann for new installations, and No. 2 Ringelmann for existing installations. Fugitive dust control systems and maintenance practices must be conducted in such a manner as to minimize the emission of fugitive particulate matter to a level satisfactory to the Commission. A total dustfall limit of 5.25 grams per square meter per month, three month average, is established by Regulation 9 as an ambient air quality standard.

North Dakota covers coal preparation plants under Regulation No. 82.

Ohio has no statewide emission standards at this time.

Pennsylvania Regulation No. I covers control and prevention of air pollution from coal refuse disposal areas. This is basically a definition of acceptable good practice so as to prevent the combustion of coal refuse. Regulation No. IV defines limits for emission rates of settleable (above 10 microns) and suspended (below 10 microns) particulate matter. This regulation is based on stack height and distance to property line and has been effectively used to limit emissions from existing coal cleaning plants. The emissions of suspended particulate matter for the "typical new plant" would be limited to 63 pounds per hour; equivalent to 0.046 grs/scfd. Regulation V is an air basin regulation and the lower of values obtained from Regulation IV or V is applicable to any new source. Regulation V is based on emission potential rather than dispersion. For a Class C air basin the Regulation V limit is 100 pounds per hour so Regulation IV would control. In a Class D air basin, the emission rate is 60 pounds per hour so this regulation, rather than the 63 pounds per hour of Regulation IV would be allowed. This is equivalent to 0.044 grs/scfd or an efficiency of 98.91%.

Utah has only a visible emission standard for stacks. For existing installations, No. 2 Ringelmann is allowed and for new installations the limitation is No. 1 Ringelmann. They are considering adopting a 1% sulfur in fuel limitation in the near future.

Virginia currently controls the emissions from coal cleaning plants under Rule 5, a potential emission regulation adopted June 30, 1969. The "typical new plant," with an emission potential of 5,486 pounds per hour, would be limited to a stack dust concentration of 0.11 grs/scfd, which is an efficiency of 97.2%. Fugitive dust is controlled by a dustfall standard. Dustfall is measured using not less than four stations, using the geometric mean of readings for at least three months. For residential and commercial areas, the geometric mean is not to exceed 7.00 grams per square meter per month of total dustfall. In other land use areas, the geometric mean is 12.25 grams per square meter per month and in any case, the dustfall rates shall not be unreasonably excessive at any individual station. New rules proposed for public hearing on April 17, 1971, exempt coal preparation plants from the general particulate emissions limitation of 0.03 grains per standard cubic foot of exhaust gas. Specific particulate emissions standards for coal thermal drying operations for process weights of 100 tons per hour or less specify a grain loading of 0.07 grains per standard cubic foot or a maximum of 45 pounds per hour. For operations with process weights of 200 tons per hour and above, the grain loading limitation is 0.05 grains per standard cubic foot with a maximum allowable emission of 105 pounds per hour. Linear interpolation is used between the two values. Stacks are to be at least 80 feet above foundation grade or no less than 10 feet above the top of a structure containing the dryer or any adjacent structure. For air tabling plants, the grain loading of 0.03 grains per standard cubic foot of exhaust gas is specified. For the "typical new plant" the 0.05 grains per standard cubic foot would control, resulting in an emission of 68.6 pounds per hour.

West Virginia establishes emission limits for both existing and new coal cleaning plants in Regulation V, effective September 1, 1968. The effective date for new installations was March 1, 1970. The "typical new plant" would be required to meet a particulate emission regulation of 0.08 grains per standard cubic foot. Stack height must be at least 80 feet above foundation grade and more than ten feet above the top of adjacent buildings. Emissions from air tabling operations are limited to 0.05 grains per standard cubic foot. Fugitive dust is covered by a general statement aimed at good operating practices, Regulation I, effective January 1, 19[illegible] cubic foot or a maximum of 45 pounds per hour. For operations with process weights of 200 tons per hour and above, the grain loading limitation is 0.05 grains per standard cubic foot with a maximum allowable emission of 105 pounds per hour. Linear interpolation is used between the two values. Stacks are to be at least 80 feet above foundation grade or no less than 10 feet above the top of a structure containing the dryer or any adjacent structure. For air tabling plants, the grain loading of 0.03 grains per standard cubic foot of exhaust gas is specified. For the "typical new plant" the 0.05 grains per standard cubic foot would control, resulting in an emission of 68.6 pounds per hour.

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<u>Foreign</u> regulations were not evaluated in depth, but it was found that two recent inquiries from Japan to U. S. preparation plant builders called for thermal dryer stack concentrations of 0.1 G/NM^3 (0.044 grs/scf) and 0.06 G/NM^3 (0.026 grs/scf).

8.0 PRODUCTION AND GROWTH OF THE COAL CLEANING INDUSTRY

Statistics of the U.S. Bureau of Mines provide complete historical information on the coal industry, including coal preparation. The number of coal cleaning plants (Table 6), the number of cleaning plants with thermal dryers (Table 7) and the number of thermal dryers (Table 8) are decreasing (Figure 3). The tonnage of coal cleaned is increasing slightly (Table 2) while the tonnage of coal thermally dried is stable (Table 9).

The Keystone Coal Buyer's Manual, published by the McGraw-Hill Company, provides an annual listing of the coal mines and coal preparation plants active in the United States. Their 1970 Directory of Mechanical Cleaning Plants is included as Table 10 of this report. The 1971 Coal Mine Directory will be available the week of July 26, 1971, and was not available for reference in this report.

Coal production is anticipated to increase by 200 million tons in 1974, with 70% of this new capacity directed to steam generation. By 1990, the National Coal Policy Conference and the Institute of Gas Technology estimate that about 715 million tons of coal will be required for power generation.[19]

TABLE 6

Number of Coal Cleaning Plants, by State

	1957	1959	1961	1963	1965	1967	1969
Alabama	34	34	37	31	26	26	22
Alaska	3	3	3	4	4	4	3
Arkansas	*	*	0	*	*	*	1
Colorado	*	*	2	*	4	4	4
Illinois	60	58	55	53	49	45	43
Indiana	21	20	17	15	15	11	11
Kansas	3	4	3	4	3	4	3
Kentucky	87	81	82	73	60	57	52
Missouri	11	8	6	6	5	5	4
New Mexico	1	1	1	1	1	1	1
Ohio	26	23	21	20	22	20	19
Oklahoma	3	3	3	2	*	1	4
Pennsylvania	99	89	81	89	101	91	77
Tennessee	4	1	1	1	*	2	5
Utah	5	6	6	7	7	5	6
Virginia	30	29	22	29	33	37	33
Washington	4	5	5	3	2	2	3
West Virginia	194	184	153	153	160	154	143
Wyoming	1	2	2	2	1	*	1
Other States	7	9	3	6	4	2	0
TOTAL	593	555	503	499	497	471	435

*Included in Other States

Source: U. S. Bureau of Mines

TABLE 7

Number of Cleaning Plants with Thermal Drying, by State

	1957	1959	1961	1963	1965	1967	1969
Colorado	0	0	0	0	0	0	1
Illinois	16	18	19	23	25	25	21
Indiana	9	11	10	10	10	7	4
Kentucky	9	8	9	7	8	11	10
Ohio	4	5	6	6	9	9	6
Pennsylvania	8	12	11	15	17	13	10
Utah	2	3	4	4	3	2	2
Virginia	3	5	6	3	5	7	8
West Virginia	36	40	43	53	52	55	55
Other States	1	2	2	1	4	3	2
TOTAL	88	104	110	122	133	132	119

Source: U. S. Bureau of Mines

TABLE 8

Number of Thermal Dryers, by State

	1957	1959	1961	1963	1965	1967	1969
Colorado	0	0	0	0	0	0	1
Illinois	40	44	49	53	53	47	39
Indiana	26	30	34	28	22	10	5
Kentucky	16	13	14	10	11	20	18
North Dakota	0	0	0	4	4	3	2
Ohio	13	16	17	18	20	16	13
Pennsylvania	21	27	26	22	26	18	11
Utah	2	3	4	4	4	2	2
Virginia	10	19	22	17	17	19	19
West Virginia	71	92	91	96	94	98	82
Other States	2	3	3	1	0	0	0
TOTAL	201	247	260	253	251	233	192

Source: U. S. Bureau of Mines

TABLE 9

Annual Tonnage of Coal Thermally Dried, by State
(millions of tons)

	1957	1959	1961	1963	1965	1967	1969
Colorado	0	0	0	0	0	0	0.6
Illinois	3.3	4.5	5.8	8.7	10.8	12.6	10.7
Indiana	2.5	2.3	3.0	3.0	3.3	2.5	1.8
Kentucky	1.9	2.3	1.4	2.2	2.6	3.3	3.5
North Dakota	0	0	0	0.3	0.3	0.2	0.1
Ohio	2.7	1.7	2.1	2.5	3.5	3.9	4.2
Pennsylvania	3.1	3.8	3.5	4.8	8.1	6.6	4.6
Utah	0.1	0.5	1.6	1.7	1.1	1.1	0.7
Virginia	2.2	4.1	4.4	3.4	5.9	9.1	10.1
West Virginia	16.1	16.6	17.7	24.0	29.7	35.5	30.8
Other States	0.2	0.1	0.1	0.1	0	0	0
TOTAL	31.9	35.8	39.6	50.6	65.4	74.7	67.1

Source: U. S. Bureau of Mines

TABLE 10

Directory of Mechanical Coal Cleaning Plants

Name & Location • Daily Capacity • Type of Cleaning • Plant Designer

This KEYSTONE information feature is based on data provided by the mining companies and published in mine/plant listings in the MINES DIRECTORY of this 1970 Edition. In many cases, more detail on the make or type of cleaning unit is available in the mine/plant listings, as well as sizes shipped and type of equipment used for crushing, screening, drying, oil treatment, freeze proofing, and other data.

Company, Location	Mine or Plant Name	Daily Capacity	Type/Plant Designer
ALABAMA			
Alabama By-Products Corp., Birmingham	Chetopa	2,500*	HM-WT
Alabama By-Products Corp., Dixiana	Bradford	1,000	J
Alabama By-Products Corp., Maxine	Maxine	5,000*	HM-WT
Alabama Power Co., Gorgas	Gorgas	2,500	WT
Bankhead Mining Co. Inc., Jasper	Cobb	2,500*	J
Black Diamond Coal Mng. Co., W. Blocton	Blocton	1,800	HM-Des: DAN
Black Diamond Coal Mng. Co., Bessemer	Bl. Dia. #3	1,400	J-WT
Brookside-Pratt Mining Co., Marion	New River	—	J-WT
Burgess Co., A.E., Bham	West Blockton	1,000*	WT
Coalite Inc., Glen Allen	Brilliant	750	J
Peabody Coal Co., Hueytown	Warrior	4,500*	W
Republic Steel Corp., Adamsville	Sayre	3,000*	J
Southern Elec. Gen. Co., Parrish	Segco No. 1	6,400	J
Southern Elec. Gen. Co., Maylene	Segco No. 2	2,900	J
U.S. Pipe & Foundry Co., Adamsville	Bessie	2,500	HM-WT
U.S. Pipe & Foundry Co., Flat Top	Flat Top	3,000	J-F
United States Steel Corp., Hueytown	Concord	—	WT-W
Woodward Iron Co., Mulga	Mulga	2,800	J-WT
COLORADO			
The Corley Co., Florence	Pioneer Canon #1	1,000	HM
Imperial Coal Co., Erie	Eagle	1,500*	HM
Mid-Continent Coal & Coke Co., Carbondale	Dutch Creek	2,500	HM
ILLINOIS			
Ayshire Coal Co., Danville	Harmattan	4,000	W-Des: M-P
Ayshire Coal Co., Marion	Delta	4,000	W-Des: M-P
Ayshire Coal Co., Vermont	Sun Spot	3,500	HM
Barbara Kay Coal Co., Marion	Barbara Kay	400	W-WT
Bell & Zoller Coal Co., Johnson City	Zeigler No. 4	6,000	W-WT-Des: M-P
Bell & Zoller Coal Co., Murdock	Murdock	3,300*	W
Truax-Traer Coal Co. Div., Consol, Duquoin	Burning Star #2	13,000	W
Truax-Traer Coal Co. Div., Consol, Sparta	Burning Star #3	9,000*	W
Truax-Traer Coal Co. Div., Consol, Norris	Noris	11,500*	W-Des: J-L
Freeman Coal Mining Corp., Farmersville	Crown	10,000	J-AT-Des: R/S
Freeman Coal Mining Corp., Waltonville	Orient No. 3	14,000	J-HM-AT-Des: A/G
Freeman Coal Mining Corp., Marion	Orient No. 4	7,000	HM-J-AT-R/S
Freeman Coal Mining Corp., West Frankfurt	Orient No. 5	7,000	HM-WT-Des: M-P

Company, Location	Mine or Plant Name	Daily Capacity	Type/Plant Designer
ILLINOIS (continued)			
Freeman Coal Mining Corp., Waltonville	Orient No. 6	12,000*	HM-Des: R/S
Harrisburg Coal Co., Inc., Marion	Harrisburg	—	WT
Inland Steel Co., Sesser	Inland	10,000*	F-HM
Monterey Coal Co., Carlinville	No. 1	14,000	HM-Des: M-P
Old Ben Coal Corp., Sesser	Old Ben No. 21	15,000*	J-HM-F
Old Ben Coal Corp., Sesser	Old Ben No. 26	—	J-AT
Peabody Coal Co., Pawnee	No. 10	15,500	W-Des: R/S
Peabody Coal Co., Millstadt	Midwest	3,000	W
Peabody Coal Co., Wilmington	No. Illinois	6,500	W-Des: M-P
Peabody Coal Co., Freeburg	River King	1,000	W-Des: M-P
Peabody Coal Co., Victoria	Mecco	7,000*	J
Peabody Coal Co., Edwards	Edwards	1,400	J-C
Peabody Coal Co., Trivoli	Elm	10,000*	J
Peabody Coal Co., Shawneetown	Eagle	14,000	J
Peabody Coal Co., Stonefort	Will Scarlet	6,500	J
Peabody Coal Co., Wyoming	Allendale	2,800	J
Sahara Coal Co., Inc., Harrisburg	Central	10,000	J-WT-Des: M-P, R/S
Southwestern Illinois Coal Corp., Percy	Streamline	4,200	W-Des: M-P
Southwestern Illinois Coal Co., Percy	Captain	—	W-Des: M-P
United Electric Coal Cos., Canton	Buckheart No. 17	7,000	HM-Des: N-D
United Electric Coal Cos., Cuba	Cuba No. 9	4,500	W-HM-WT-Des: M-P
United Electric Coal Cos., Duquoin	Fidelity No. 11	7,000	W-Des: K
United Electric Coal Cos., Glasford	Banner #27	3,500*	MH-AT
V-Day Coal Co., Danville	No. 1	—	AT-Des: R/S
Ziegler Coal & Coke Co., Sparta	Spartan	4,500	J
INDIANA			
Ayshire Coal Co., Staunton	Chinook	4,000	J-HM-Des: M-P, L-B
Ayshire Coal Co., Sullivan	Minnehaha	7,500	J-Des: J
Ayshire Coal Co., Farmersburg	Thunderbird	—	W-Des: M-P
Enos Coal Corp., Oakland City	Enos	7,500	W-Des: M-E
Enos Coal Corp., Winslow	Blackfoot No. 5	7,000*	W-Des: R/S
Kings Station Coal Corp., Princeton	Kings Station	5,000	J
Peabody Coal Co., Lynnville	Lynnville	7,000	W-WT
Peabody Coal Co., Boonville	Squaw Creek	6,000	W-Des: M-P
Peabody Coal Co., Dugger	Sycamore	9,000*	J
KANSAS			
Clemens Coal Co., Pittsburg	Clemens #22	1,800	J
Pittsburg & Midway Mng Co., Hallowell	No. 19	5,000	W-Des: M-P
KENTUCKY			
Apache Coal Co., Flanary	Apache	1,200	W
Ashlo Coal Co., Combs	Sunfire	1,000	W
Beth-Elkhorn Corp., Jenkins	No. 27	—	HM-WT-Des: FM

Table 10(Cont.)

Company, Location	Mine or Plant Name	Daily Capacity	Type/Plant Designer
KENTUCKY (continued)			
Beth-Elkhorn Corp., Jenkins	Hendrix #22	—	J-Des: R/S & M-P
Beth-Elkhorn Corp., Jenkins	Pike #26	—	HM-F-Des: M-P
Blue Diamond Coal Co., Leatherwood	Leatherwood #1	7,000	J-F-Des: R/S
Clintwood Coal Co., Mouthcard	Levisa River	1,200	HM
Eastern Coal Corp., Stone	Stone	7,000	W-WT-F
Elkhorn & Jellico Coal Co., Whitesburg	Sapphire Mine	2,000	J
Feds Creek Coal Co., Inc., Biggs	No. 1	2,500	HM-Des: R/S
Gibraltar Coal Corp., Central City	Gibraltar	10,000	J-Des: M-P
Golden Glow Coals Inc., Liggett	Liggett	1,000	J-AT
Grays Knob Coal Co., Grays Knob	Grays Knob #1	1,600	HM-WT
Green Coal Co., Owensboro	K-9	2,000*	HM
Guaranty Mines Corp., Drift	Guaranty	600*	HM
Harlan Collieries Co., Brookside	Brookside	2,400	W-HM-AT
Harlan Fuel Co., Yancey	Yancey	1,800*	HM-WT
Harold Fuel Co. Inc., Harold	Harold No. 1	1,000	W
Ikerd & Bandy Co., Inc., Ferguson	#1	—	AT
International Harvester Co., Benham	Wise/Steel Mns	4,000*	J-WT
Island Creek Coal Co., Madisonville	East Diamond	7,800*	W
Island Creek Coal Co., Central City	Crescent	4,200*	W-AT
Island Creek Coal Co., Madisonville	Fies	6,400	J-WT
Island Creek Coal Co., Uniontown	Uniontown	6,000	J-WT
Island Creek Coal Co., Mannington	Williams	1,000	WT
Island Creek Coal Co., Madisonville	Atkinson	5,500*	J
Island Creek Coal Co., Morganfield	Hamilton	24,800	HM
Island Creek Coal Co., Price	Wheelwright	5,000	J-WT
Island Creek Coal Co., Wayland	Spurlock	2,800	HM-WT
Island Creek Coal Co., Turkey Creek	Gund	5,000	HM
Kenmont Coals, Inc., Hazard	Kenmont	—	W
Kentland-Elkhorn Coal Corp., Pikeville	Kentland	6,500	WT-HM-Des: H-P
Kentucky Carbon Corp., Phelps	Kentucky Carbon	5,200*	HM-WT
Kentucky Mountain Coal Co., Manchester	Kentucky Mt.	1,000*	HM
Kentucky Mountain Coal Co., Manchester	No. 6	1,000*	HM
Kentucky Mountain Coal Co., Hyden	No. 7	200*	HM
Kentucky Oak Mining Co., Hazard	Knott	—	W
Kilo Coal Co., Combs	Sunfire	1,500*	W
Kirkpatrick Mining Co., Greenville	Caney Creek	3,500*	W-Des: M-P
Loftis Coal Co., Toler	No. 1	1,000	W
Osborne Mining Corp., S. Williamson	Osborne	1,600	HM
Path Fork-Harlan Coal Co., Alva	Alva	1,000*	W-Des: M-P
Patsy Development Co. Inc., David	No. 1	3,000	HM
Peabody Coal Co., Beaver Dam	Ken	10,000	W
Peabody Coal Co., Greenville	River Queen	5,100	W
Peabody Coal Co., Madisonville	Vogue	3,500	W-Des: M-P
Peabody Coal Co., Hartford	Riverview	2,300*	J-Des: M-P
Phelps Collieries Co., Phelps	Freeburn	—	J
Pikeville Coal Co., Phelps	Chrisholm	4,500*	HM-F
Pittsburg & Midway Coal Mng. Co., Paradise	Paradise	14,000	J-Des: M-P
Pittsburg & Midway, Madisonville	Colonial	10,000	W-Des: M-P
Pittsburg & Midway, Drakesboro	Drake	10,000*	W
Republic Steel Corp., Pikeville	Republic	3,500	HM-WT
Rialto Coal Co. Inc., Nortonville	Jitly No. 6	3,000*	W
River Coal Co., Combs	River No. 4	2,000*	W
Russell Fork Coal Co. Inc., Elkhorn City	Russell Fork	4,500	HM-WT
KENTUCKY (continued)			
Scotia Coal Co., Cumberland	Scotia	5,000	HM-WT-F-Des: M-P
Seagraves Coal Co., High Splint	Hilo #2 & 3	1,600*	J
Shackleford Coal Co., Holmes Mill	Glenbrook	2,000*	W
Shamrock Coal Co., Manchester	Oakleaf	2,000	J
Sigmon Construction Co., Coalgood	Merna	2,000*	W
South-East Coal Co., Irvine	Irvine	15,000	J-WF-F
Sovereign Coal Co., Jamboree	Jamboree	—	J
Stratton Coal Co., Harold	Harold	1,200	W
Sunfire Coal Co., Combs	Sunfire	1,400	W
U.S. Steel Corp., Corbin	Corbin	—	HM-WT-Des: A/G
Utilities Esco Coal Co., Robinson Creek	No. 3, 6 & 7	3,000	J-AT
Weirs Creek Coal Co., Providence	Shamrock	4,000*	J
Wright Coal Co., Greenville	Wright	2,500*	W
MISSOURI			
Peabody Coal Co., Macon	Bevier	3,500	W-Des: M-P
Peabody Coal Co., Columbia	Mark Twain	3,200	W
Peabody Coal Co., Calhoun	Tebo	—	J
NEW MEXICO			
Kaiser Steel Corp., Raton	York Canyon	4,200	HM-F-Des: M-P
OHIO			
C V & W Coal Co. Inc., Quaker City	Concord	1,000	W
Central Ohio Coal Co., Zanesville	Muskingum	12,500	J-Des: R/S
Clean Coal Co., Bellair	Carnegie	255	W
Collins Mining Co., Hanging Rock	Collins	1,000*	W
Hanna Coal Co. Div., Consol, Cadiz	Georgetown	27,000	J-HM-WT-Des: A/G
Hanna Coal Div., Consol, Piney Fork	Piney Fork #1	4,250	W-Des: L-B
Hardy Coal Co., Berlin	Highland #2	1,000*	J
Island Creek Coal Co., Freeport	Vail	5,000	HM

Daily capacity, cleaned coal unless noted*.
* Daily mine capacity as reported.
** Plant temporarily inactive

Type of Cleaning Employed:
J—Jigs, jig washers
AT—Air tables, air cleaners, air concentrators
F—Flotation, froth flotation
HM—Heavy-media, heavy-density, chance cones calcium chloride washers, etc.
WT—Water tables, concentrating tables, wet tabling
W—Washery, washer, not otherwise specified, including Belknap washer & Menzies cones

Plant Designer (where available)—"Des:"
A/G—Allen & Garcia
A-M—Arthur McKee & Co.
DAN—Daniels Co.
D-O—Dorr Oliver
FM—Fairmont Machinery
F-P—Fuel Process
G-M—Galis Mfg.
H/P—Heyl & Patterson
I-E—Industrial Engineers
J—Jeffrey
J-L—J. O. Lively Mfg. Corp.
KA—Kanawha Mfg.
K—Koppers Co.
L-B—Link-Belt
M-P—McNally Pittsburg
M-E—Mines Engineering
N-D—Nelson Davis Co.
R/S—Roberts & Schaefer
U-E—United Engineers
W-E—Wilmot Engineering

Table 10(Cont)

Directory of Mechanical Cleaning Plants . . . Cont'd

Company, Location	Mine or Plant Name	Daily Capacity	Type/Plant Designer
OHIO (continued)			
North American Coal Corp., Powhatan Pt	Powhatan #1	9,100*	HM-AT
North American Coal Corp., Powhatan Pt	Powhatan #3	9,000*	HM
North American Coal Corp., Powhatan Pt	Powhatan #5	5,000*	J
North American Coal Corp., E. Springfield	Jensie	3,500*	HM
Oglebay Norton Co., St. Clairsville	Saginaw	4,500	HM
Oglebay Norton Co., Jacobsburg	Norton #3	5,200	HM
Peabody Coal Co., New Lexington	Sunnyhill #9	6,000	J
Peacock Coal Co., Cheshire	Peacock	300	HM
Waterloo Coal Co. Inc., Oak Hill	Waterloo	1,000*	W
Youghiogheny & Ohio Coal Co., Cadiz	Nelms #1	6,000	HM-W-Des: M-P
Youghiogheny & Ohio Coal Co., Beallsville	Allison	10,000*	W-Des: M-P
OKLAHOMA			
Evans Coal Co., McCurtain	Evans	1,000	W-AT
Howe Coal Co. Inc., Heavener	No. 1	6,140	HM-F-Des: R/S
Kerr-McGee Corp., Haskell Co.	Choctaw	1,000	HM-F-Des: M-P
PENNSYLVANIA (ANTHRACITE)			
Ace Coal Co., Blakely	Ace	125	J-W
Anthracite Fine Coals, Inc., Donaldson	Donaldson	—	W
Blue Bell Enterprise, Tremont	Blue Bell	600*	HM-WT-AT
Blue Coal Corp., Ashley	Huber	—	HM-W
Blue Coal Corp., Plymouth	Loree-Woodward	—	J-HM
Buckley Coal Co., Eckley	Buckley	800	HM-W
Cass Constr. Co., Marlin	Marlin	450	HM-W
Colcby Coal Co., McAdoo	Candleton	500	W-WT
DeAngelis Supreme Anth. Inc., Carbondale	Boland	1,000*	HM-WT
Film Coal Co., Middleport	Kaska	700	HM
Gilberton Coal Co., Gilberton	Gilberton	1,000*	HM-W
Gilberton Coal Co., Gilberton	Candlemas	—	HM
Glen Burn Colliery, Shamokin	Glen Burn	1,800	HM
Gowen Coal Co., Fern Glen	Gowen	400	HM-WT
Greenwood Mng. Co., Tamaqua	Greenwood	6,000	HM-F-W
Honey Brook Mines, Inc., Audenried	Audenried	2,000*	HM
Jeddo-Highland Coal Co., Jeddo	Jeddo #7	—	HM-W
Jeddo-Highland Coal Co., Jeddo	Highland #5	—	WT-F-W
KM & F Coal Co., Middleport	KM & F	500	HM
K & P Coal Co., Seltzer	K & P	600	J-W
Kocher Coal Co., Valley View	Kocher	1,600	W
Legal Coal Co., Tremont	Legal	900	HM-AT
Lehigh Valley Anth. Inc., Swoyerville	Harry E.	—	HM-W
Lehigh Valley Anth. Inc., Hazleton	Hazleton Shaft	—	HM-W
Lehigh Valley Anth. Inc., Raven Run	Mammoth	—	HM-W
Locust Valley Coal Co., Mahanoy City	Locust Valley	1,000	HM
Manbeck Dredging Co., Tremont	Westwood	400	WT
Manbeck Dredging Co., Summit Hill	Lansford #6	400	WT
Moffat Premium Anth., Inc., Taylor	Taylor	2,000	J-HM-W
Pine Creek Coal Co., Spring Glen	Pine Creek	500	WT-W
Reading Anthracite Co., Pottsville	New St. Nicholas	—	HM-W
Reading Anthracite Co., St. Nicholas	St. Nicholas	—	W

Company, Location	Mine or Plant Name	Daily Capacity	Type/Plant Designer
PENNSYLVANIA (ANTHRACITE) (continued)			
Reading Anthracite Co., Trevorton	Trevorton	—	HM-W
Reidinger Coal Service, Paxinos	Reidinger	350	HM
Rosini Coal Co., Shamokin	Carbon Run	1,000	J-WT-W
Thos. W. Schneck Coal Co., Pine Grove	Breaker	—	HM
Skytop Coal Co., Inc., Mahanoy City	Skytop	700	HM-W
Starwood Coal Co., Mahanoy City	Park Pl & Delano	1,000*	HM
Sun Coal Co., Inc., Atlas	Sun	2,000	HM
Susquehanna Coal Co., Glen Lyon	Glen Lyon	2,500	HM-W
Swatara Coal Co., Minersville	Breaker	800	HM-WT
Underkoffler Coal Service, Lykens	Underkoffler	500	HM
PENNSYLVANIA (BITUMINOUS)			
Allegheny River Mng Co., Cadogan	Cadogan	3,000	HM-Des: H/P
Allegheny River Mng Co., Timblin	Ringgold	1,000	W-AT-Des: FM & R/S
Allison Engineering Co., Sligo	Allison #12	1,800	W
Aloe Coal Co., Imperial	Russell No. 2	1,000	HM-WT
Altmire Bros Coal Col Inc., North Apollo	No. 1	750	W
Alumbaugh Coal Co., Inc., Friedens	Alumbaugh	800*	AT
Armagh Coal Co., Inc., Indiana	Dias #1	600*	AT
Barnes & Tucker Co., Barnesboro	Lancashire #24	12,000	J-AT
Barnes & Tucker Co., Barnesboro	Lancashire #25	7,500	AT-W
Barnes & Tucker Co., Barnesboro	Lancashire #26	16,000	J
Barr Coal Corp., Marsteller	Moss Creek #3	—	AT
Benjamin Coal Co., Westover	Benjamin No. 3	1,700	HM-AT
Bethlehem Mines Corp., Ebensburg	Cambria Slope	—	HM-F-Des: R/S
Bethlehem Mines Corp., Mineral Point	Brookdale #77	—	HM-Des: R/S
Bethlehem Mines Corp., Ellsworth	Ellsworth #51	—	WT-HM-F-Des: FM
Bethlehem Mines Corp., Marianna	Marianna No. 58	—	J-F-Des: R/S
Bethlehem Mines Corp., Ellsworth	Somerset #60	—	J-F-Des: R/S
Bradford Coal Co., Bigler	Bigler Ref.	2,500	HM
The Buckeye Coal Co., Nemacolin	Nemacolin	5,800	HM-F
C & K Coal Co., Clarion	Fox	7,000	AT-J
Cammos Coal Mining Co., Heverly	Cammos No. 1	500*	AT
Canterbury Coal Co., Avonmore	David Mine	2,600	HM
R. S. Carlin, Inc., Snow Shoe	Carlin #6	160	AT
Coal Junction Coal Co., Friedens	No. 8	3,500	AT
Pittsburgh Coal Co. Div., Consol, Imperial	Champion No. 1	14,000	J-WT
Pittsburgh Coal Co. Div., Consol, Hutchinson	Hutchinson	3,000	W-WT-Des: H/P & FM
Pittsburgh Coal Co., Div., Consol, Renton	Renton	4,000	J-WT-Des: FM
Cooney Bros. Coal Co., Cresson	Cooney	3,500	HM
Denise Coal Co., Shanksville	Denise No. 1	1,000	AT
Doverspike Bros. Coal Co., Dora	Sugar Camp	1,500	HM-AT
Duquesne Light Co., Greensboro	Warwick	10,000	W-Des: R/S
Eastern Assoc. Coal Co., Colver	Colver	3,000	HM-AT-Des: R/S
Eastern Assoc. Coal Co., Hunkers	Delmont No. 10	2,300	J-AT
Edmon Coal Co., Edmon	Sarah Bell	500*	J

Table 10(Cont.)

Company, Location	Mine or Plant Name	Daily Capacity	Type/Plant Designer
PENNSYLVANIA (BITUMINOUS) (continued)			
Elliot Coal Mining Co., Osceola Mills	Elliot	2,500	AT-W
M. F. Fetterolf Coal Co., Boswell	Fetterolf No. 1	2,500*	HM-AT
Florence Mining Co., Seward	No. 1	—	AT
Glen Irvan Corp., Gipsy	Moose Run	900	AT
Harman Coal Corp., Mayport	Mohawk	1,200*	W
Harmar Coal Co., Pittsburgh	Harmar	6,500	HM-AT-F-Des: A/G
Island Creek Coal Co., Tire Hill	Bird No. 3	4,000*	HM-WT-F
J. E. Hoffman Coal Co., Inc., Karthaus	Hoffman	—	HM
Jandy Coal Co., Inc., Windber	Eureka #40	2,450	W-AT
Johnstown Coal & Coke Co., Glen Campbell	Bear Run	1,500	AT-HM
Jones & Laughlin Steel Co., La Belle	Vesta Shannopin	18,000	HM-WT-Des: N-D
Leechburg Mining Co., Leechburg	Foster #4 & 5	2,450	HM-AT
Longwall Mining, Inc., Windber	Longwall	3,000*	AT
Markle-Bullers Coal Co., Kittanning	Goheen	900*	AT
Mathies Coal Co., Finleyville	Mathies	15,000	HM-WT-F-Des: FM
Mays Coal Co., Clarion	Mays	500*	AT
Meehan Co., Johnstown	Meehan	1,000	AT
Minns Coal Co., Falls Creek	Falls Creek	1,000*	AT
Mohawk Mining Co., Parker	Brookes	1,500*	W
National Mines Corp., Isabella	Isabella	4,000	J
North American Coal Corp., Seward	No. 4	2,500	AT
North American Coal Corp., Seward	No. 3	1,200	AT
PBS Coals, Inc., Central City	Shade Creek	—	AT-HM
Peggs Run Coal Co., Inc., Shippingport	Peggs Run	2,450	HM-AT
Penna. Coal & Coke Corp., Ehrenfeld	Pennsylvania #8	4,000	HM-Des: FM
Penfeigh Smokeless Coal, Garrett	Mt. Valley	1,500	J-Des: J
Geo. Radomsky Coal Co., Hastings	Driscoll Hollow	—	HM-AT
Reitz Coal Co., Central City	No. 4	2,500	HM-AT-Des: R/S & FM
Republic Steel Corp., Frederickstown	Clyde	6,000	HM-WT-F
Republic Steel Corp., Russellton	Russellton	3,000	HM-WT-Des: U-E
Republic Steel Corp., Van Meter	Banning No. 4	5,200*	HM-WT-F
Solar Fuel Co., Hooversville	Solar	5,400	J-W-AT
W. P. Stahlman Coal Co., Inc., Corsica	Stahlman	2,400	J-Des: J
Stott Coal Co., Phillipsburg	Royal No. 1	1,000	AT
Sunbeam Coal Corp., Boyers	Sunbeam	1,500	W
Testa Bros., Inc., Sandy Lake	Olga No. 1	750*	W-AT
Union Carbide Corp., Saxonburg	Fawn	2,500*	HM
United Industries, Inc., Dora	Schrock No. 3	900*	AT
U.S. Steel Corp., Greensboro	Robena	—	HM-WT-Des: M-P
U.S. Steel Corp., New Eagle	Maple Creek	—	WT-HM-F
Valley Coal Co., Heilwood	Valley #8	400*	HM-W-AT
A. P. Weaver & Sons, Fryburg	Weaver	1,500*	W
Zacherl Coal Co., Inc., Oil City	Madden	500*	W
TENNESSEE			
Anderson Coal Corp., Motch	Anderson	700	HM-Des: A-M
Clear Creek Coal Co., Inc., Monterey	No. 2	600	W-AT
Consolidation Coal Co., Tenn. Div., Devonia	Morco	2,200*	AT
Consolidation Coal Co., Tenn. Div., Devonia	Matthews	6,200*	HM
Marthann Coal Co., Inc., Clairfield	Martham	220	J
Mingo Mt. Coal Co., Motch	Miracle Mason #2	1,500	W

Company, Location	Mine or Plant Name	Daily Capacity	Type/Plant Designer
UTAH			
Carbon Fuel Corp., Helper	Carbon Fuel	3,000*	HM
Kaiser Steel Corp., Sunnyside	Central	8,000	J-F-Des: M-P
No. American Coal Corp., Castle Gate	Castle Gate	3,000*	J-Des: L-B
Spring Canyon Coal Co., Helper	Spring Canyon	—	HM
United States Fuel Co., Hiawatha	King	3,800	J
VIRGINIA			
Anchor Smokeless Coal Co., Grundy	Anchor Smokeless	500	W-AT
Banner Splashdam Coal Co., Wakenva	Red Banner	400	J
Bostic Coal Co., Swords Creek	Bostic	350	HM
Buchanan County Coal Corp., Big Rock	Buchanan #4 & 5	3,500*	J-AT
Cambridge Smokeless Coal Corp., Page	Cambridge	5,000*	J
Clifton Fork Coal Co., Whitewood	No. 1	800*	J
Coal Processing Corp., Dixiana	Dixiana Deep	2,500	J
Harman Mining Corp., Harman	Harman	3,500*	HM-WT-Des: AE
Holston Corp., Swords Creek	Kennedy	1,000	J
Island Creek Coal Co., Grundy	Va. Pocahontas #1	7,500	HM-WT-F-Des: M-P
Island Creek Coal Co., Grundy	Beatrice	7,500	HM-WT-F-Des: L-B
Jewell Ridge Coal Corp., Jewell Valley	Jewell Valley	6,000	HM-WT-F
Jewell Ridge Coal Corp., Jewell Valley	No. 12	1,500	HM-Des: DAN
Jewell Smokeless Coal Corp., Whitewood	Coronet Jewell No. 1	4,000*	W-WT
Jewell Smokeless Coal Co., Vansant	#2	7,500*	W-AT
Keen & Runyon Coal Co., Lebanon	K & R #4	300	AT
Leetown Coal Co., Grundy	Leetown	1,700*	J-AT
Leetown Coal Co., Grundy	Poplar Creek	2,100	J
Leetown Coal Co., Grundy	Rainbow	1,700*	J
Lester Coal Co., Inc., Grundy	Kelsa	2,500*	J
Little Bear Coal Corp., Big Rock	Little Bear #2	2,800*	HM
Lynn Camp Coal Corp., Grundy	Lynn Camp	1,000*	W
Margaret Ann Coal Co., Conaway	Margaret Ann	1,000	HM-Des: KA
New Garden Coal Corp., Red Ash	Premier	600	J-AT
Norma Mining Corp., Richlands	Norma	1,100	W-AT
Norton Coal Co., Norton	Norton	500	AT
Paragon Jewel Coal Co., Inc., Whitewood	Queen	3,000	J
Patterson Coal Co., Patterson	Buccaneer	800*	HM-Des: L-B

\# Daily capacity, cleaned coal unless noted*.
* Daily mine capacity as reported.
** Plant temporarily inactive

Type of Cleaning Employed:
J—Jigs, jig washers
AT—Air tables, air cleaners, air concentrators
F—Flotation, froth flotation
HM—Heavy-media, heavy-density, chance cones calcium chloride washers, etc.
WT—Water tables, concentrating tables, wet tabling
W—Washery, washer, not otherwise specified, including Belknap washer & Menzies cones

Plant Designer (where available)—"Des:"
A/G—Allen & Garcia
A-M—Arthur McKee & Co.
DAN—Daniels Co.
D-O—Dorr Oliver
FM—Fairmont Machinery
F-P—Fuel Process
G-M—Galis Mfg.
H/P—Heyl & Patterson
I-E—Industrial Engineers
J—Jeffrey
J-L—J. O. Lively Mfg. Corp.
KA—Kanawha Mfg.
K—Koppers Co.
L-B—Link-Belt
M-P—McNally Pittsburg
M-E—Mines Engineering
N-D—Nelson Davis Co.
R/S—Roberts & Schaefer
U-E—United Engineers
W-E—Wilmot Engineering

Table 10(Cont.)

Directory of Mechanical Cleaning Plants . . . Cont'd

Company, Location	Mine or Plant Name	Daily Capacity	Type/Plant Designer
VIRGINIA (continued)			
Pittston Co., Clinchfield Coal Div., Dante	Moss Mine #2	7,500	HM-Des: L-B
Pittston Co., Clinchfield Coal Div., Clintwood	Moss Mine #1	6,500	HM-WT-F-Des: FM
Pittston Co., Clinchfield Coal Div., Dante	Moss Mine #3	25,000*	HM-WT-F-Des: L-B
Raven Smokeless Coal Co., Raven	Raven Red Ash	800*	HM-AT
Southwestern Virginia Coal Corp., Grundy	Wolfpen	1,800*	HM
Universal Coal Co., Inc., Richlands	Mills Smokeless	1,600	J
Virginia Anthracite Coal Corp., McCoy	Process Plant	—**	J-AT
Virginia By-Product Coal Co., Grundy	By-Product	250	HM
Virginia Iron Coal & Coke Co., Coeburn	Dale Ridge	2,500*	J
Virginia Iron Coal & Coke Co., Coeburn	Virginia City	3,500*	J-AT
Virginia Iron Coal & Coke Co., Coeburn	Nora	2,500*	J
Westmoreland Coal Co., Big Stone Gap	Wentz	5,000	HM-WT-F
Westmoreland Coal Co., Dunbar	Pine Branch	3,500	HM-WT-J-F
WEST VIRGINIA			
Amherst Coal Co., Amherstdale	Amherst No. 1	8,000	HM-J-WT-F-Des: L-B & DAN
Amherst Coal Co., Yolyn	McGregor	7,000	J-F-Des: M-P
Amigo Smokeless Coal Div., Pittston, Amigo	Amigo	1,600	HM
Amigo Smokeless Coal Div., Pittston, Wyco	Wyco	3,500*	HM-AT-Des: H/P
Armco Steel Corp., Montcoal	Montcoal	5,000	HM-WT-F-Des: A-M
Armco Steel Corp., Twilight	Robin Hood	5,000*	HM-WT-F-Des: A-M
Ashland Mining Corp., Ashland	Ashland	1,400*	J
Badger Coal Co., Inc., Philippi	No. 13 & 14	5,000	HM-WT-Des: M-P
Beards Fork Coal Mng Co., Beards Fork	Beards Fork	4,000*	HM
Belfry Coal Corp., Matewan	Belfry	1,500*	AT
Bethlehem Mines Corp., Barrackville	Barrackville 41	—	HM-J-Des: R/S
Bethlehem Mines Corp., Idamay	Idamay #44	—	HM-J-Des: R/S
Bethlehem Mines Corp., Century	Century #101	—	HM-Des: R/S & M-P
Bethlehem Mines Corp., Kayford	Shamrock Central	—	J-Des: M-P
Bishop Coal Co., Bishop	Bishop	10,000	WT-HM-F-Des: DAN
Black Lode Coal Co., Belva	Vaughan	1,000	W
Boone County Coal Corp., Sharples	Central Cleaning	10,000	J-F-HM-Des: M-P & DAN
Branch Fuel Co., Lawton	Thayer	2,500	J
Buffalo Mng Co., Lorado	Lorado	4,500*	J
Burning Creek Fuel Corp., Kermit	Burning Creek	1,200*	W
Cannelton Coal Co., Cannelton	Lady Dunn	7,500	HM-WT-F-Des: J-L
Cannelton Coal Co., Superior	Cannelton	3,000	J-Des: KA
Carbon Fuel Co., Decota	Carbon #9, 20 & 29	7,500	HM-AT-WT-Des: FM; R/S; J-L
Carbon Fuel Co., Winifrede	Carbon #6 & 31	5,300	HM-WT-F
Carbon Fuel Co., Winifrede	Carbon # 34	5,500	W-Des: J-L
Cardiff Coal Co., Bradshaw	Bradshaw	800	W
Central Applachian Coal Co., Montgomery	Morris Creek	6,000	J-Des: R/S
WEST VIRGINIA (continued)			
Consol Coal Co., Christopher Coal Div., Osage	Humphrey #7	20,000	HM-WT-Des: FM
Consol Mountaineer Div., Rivesville	No. 93	3,000	HM-WT-Des: R/S
Consol Mountaineer Div., Worthington	Williams	5,500	HM-WT-Des: FM
Consol Mountaineer Coal Div., Fairview	Loveridge	13,000*	J-WT
Consol Mountaineer Div., Farmington	Consol #9	2,500	J-WT-Des: IE
Consol, Mountaineer Div., Shinnston	Consol #95	8,000*	HM-WT-F-Des: M-P
Consol, Mountaineer Div., Four States	No. 20	4,200*	J
Consol, Ohio Valley Div., Moundsville	Ireland	15,000	HM-Des: A/G & U-E
Consol, Ohio Valley Div., Benwood	Shoemaker	13,000	HM-Des: G-M
Consol, Pocahontas Fuel Sou. Div. McComas	Crane Creek	6,000	HM-WT-F-Des: DAN & D-O
Consol Pocahontas Fuel Sou. Div., Jenkinjones	Jenkinjones	6,000	HM-WT-F-Des: DAN
Consol, Pocahontas Fuel Sou. Div., Pageton	Pageton	4,500	HM-WT-Des: R/S
Consol, Pocahontas Fuel No. Div., Stephenson	Buckeye	1,800	HM-F
Consol, Pocahontas Fuel No. Div., Lynco	Lynco	4,000	HM-WT-AT
Consol, Pocahontas Fuel No. Div., Dott	Turkey Gap	3,000	W-WT-AT
Crystal Block Coal & Coke Co., Matewan	Grapevine #8	2,000	HM-J
Darr Red Ash Coal Co., Tazewell	Darr	1,000*	J
Douglas Pocahontas Coal Corp., Welch	Marytown	700	J
Eastern Assoc. Coal Corp., Grant Town	Federal #1	12,500	HM-WT-F-Des: R/S
Eastern Assoc. Coal Corp., Keystone	Keystone #1	7,500	F-HM-AT-Des: KA-R/S & I-E
Eastern Assoc. Coal Corp., Herndon	Keystone #2	5,000	HM-F-Des: R/S
Eastern Assoc. Coal Corp., Herndon	Keystone #3	2,000	HM-AT
Eastern Assoc. Coal Corp., Barrett	Wharton #2	6,000	J-F-WT-HM-Des: M-P & KA
Eastern Assoc. Coal Corp., Kopperston	Kopperston #1	12,700	HM-WT-F-Des: R/S
Eastern Assoc. Coal Corp., Kopperston	Harris	7,000	HM-Des: R/S
Eastern Assoc. Coal Corp., Stotesbury	Keystone #4	5,000	HM-F-Des: R/S
Eastern Assoc. Coal Corp., Fairview	Federal #2	12,500	HM-WT-F-Des: R/S
Eastern Assoc. Coal Corp., Rachel	Joanne	4,800	J-WT-F-Des: L-B
Elkay Mining Co., Lyburn	Elkay 3A	2,500*	J
Galloway Land Co., Clarksburg	Dawson	4,500*	HM-AT
Grafton Coal Co., Clarksburg	Pepper #2	3,000	W
Hayes Coal Co., Inc., Summersville	Hayes No. 4	300*	W
Imperial Colliery Co., Burnwell	Imperial #12 & 14	2,500*	HM-AT
Imperial Colliery Co., Eskdale	Imperial #11	1,500*	HM-AT
Imperial Smokeless Coal, Carl	Quinwood #2	6,000	HM-WT-J-F-Des: R/S
Island Creek Coal Co., Coal Mountain	No. 9B	3,500	HM-WT-F-Des: J-L
Island Creek Coal Co., Emmett	No. 10	2,500*	J
Island Creek Coal Co., Coal Mountain	Coal Mountain	4,000	J-Des: M-P

Table 10(Cont.)

Directory of Mechanical Cleaning Plants . . . Cont'd

Company, Location	Mine or Plant Name	Daily Capacity	Type/Plant Designer
WEST VIRGINIA (continued)			
Island Creek Coal Co., Red Jacket	No. 17	3,400	J-WT-Des: R/S & W-E
Island Creek Coal Co., Amherstdale	Guyan #1	6,000	W-F-Des: L-B & M-P
Island Creek Coal Co., Amherstdale	Guyan #4	4,000	J-Des: M-P
Island Creek Coal Co., Amherstdale	Guyan #5	6,000	W-Des: M-P
Island Creek Coal Co., Hammer Div., Henry	Alpine	6,000	HM-F
Island Creek Coal Co., Ham. Div., Richwood	Beckley No. 1	2,500	HM-AT
Island Creek Coal Co., Ham. Div., Richwood	Donegan No. 1	6,500	WT-HM-F
Island Creek Coal Co., Ham. Div., Richwood	Donegan No. 10	—	WT-W
Island Creek Coal Co., Ham. Div., Richwood	Tioga No. 1	4,500	WT-HM
Island Creek Coal Co., Ham. Div., Bayard	North Branch	10,000	HM
Island Creek Coal Co., Ham. Div., Richwood	Gauley Eagle No. 4	8,000	HM
Island Creek Coal Co., Ham. Div., Richwood	No. 2A	4,000*	HM
Itmann Coal Co., Itmann	Itmann	12,000	HM-WT-F-Des: L-B
Kingwood Mining Co., Kingwood	Kingwood	2,000*	AT
Kitchekan Pocahontas Coal Mng., Matoaka	Kitchekan	1,600*	W
Mart Coal Co., Masontown	Mart	800	AT
Masteller Coal Co., Keyser	Lynwd & Welton	500	AT
Meadows Coal Co., Fireco	Meadows	1,500	W
Milburn Colliery Co., Milburn	Milburn #4 & 5	1,400*	W
National Coal Mining Co., Ragland	No. 25	5,000	J-HM-Des: R/S & M-P
New River Co., Mount Hope	Lochgelly No. 2	2,000	HM-WT-Des: J-L
New River Co., Mount Hope	Garden Ground	2,000	J-Des: KA
New River Co., Cranberry	Cranberry	1,200	HM-J-Des: J-L
North Atlantic Coal Corp., Borderland	Cameo #1	2,600	W
Oglebay Norton Co., Ceredo	Ceredo	8,000	J-W-Des: M-P
Olga Coal Co., Coalwood	Olga	6,500	HM-WT-F
Omar Mining Co., Madison	Chesterfield	7,200*	HM-AT
Peerless Eagle Co., Summersville	No. 1	3,500	HM-AT-Des: R/S
Peter White Mng. Corp., Isaban	Peter White	2,500*	HM
Petitto Brothers, Clarksburg	Arthur	1,500	W
Pittston Co. Clinchfield Div., Dola	Compass #2	6,000	HM-WT-F-Des: FM
Pocahontas Empire Coal Corp., Squire	No. 7	3,000*	J-AT
Pocahontas Empire Coal Corp., Keystone	No. 4	2,400*	HM-AT
Pocahontas Red Ash Mining Co., Jaeger	Pauley	1,850	W
Pocahontas Red Bird Coal Co., Jaeger	Red Bird	1,500*	J
Powellton Co., Garnette	Jane Ann Nos. 2, 10 & 11	1,750	HM
Powellton Co., Garnette	Jane Ann Nos. 7B, 15A	1,750	W
Raleigh Empire Coal Corp., Raleigh	Raleigh Empire	1,500*	HM-WT
Ranger Fuel Corp., Bolt	Bolt	8,000*	HM
Robinson-Phillips Coal Co., Baileysville	Claude	1,500	J
Robinson-Phillips Coal Co., Baileysville	Douglas #2	2,000	J
Royal Sparks Mng. Co., Layland	Royal	1,500	W
Royalty Smokeless Coal Co., Premier	Premier	2,500	J-WT
Semet-Solvay Div., Allied Chem., Longacre	Harewood	6,200*	HM-WT
Semet-Solvay Div., Allied Chem., Tralee	Tralee	2,000*	HM-WT
Sewell Coal Co., Nettie	Sewell #1	4,000*	HM-F
Sewell Coal Co., Nettie	Sewell #4	4,000*	HM-AT
Slab Fork Co., Slab Fork	Slab Fork No. 8	5,600	W-WT-AT-HM-Des: KA
Slab Fork Coal Co., Slab Fork	No. 10	5,600	W-WT-F-AT-Des: KA
Slab Fork Coal., Alpoca	Gaston #2	1,600	HM-AT-WT-Des: M-P, R/S & KA
Smith & Stover Coal Co., Beckley	Burma	600	HM
Sparks Coal Co., Layland	Sparks	2,500	HM
Spruce River Coal Co., Jeffrey	Spruce River	2,400	HM
Sterling Smokeless Coal Co., Whitby	Sterling	4,000	HM
Tygart Coal & Coke Co., Junior	Tygart	1,200	AT
Union Carbide Corp., Mammoth	Bell Creek #3	2,880*	HM
Union Carbide Corp., Mammoth	Bell Creek #5	2,880*	HM
Union Mining Co., Webster Springs	Sugar Creek	—	HM-AT
United Pocahontas Coal Co., Crumpler	Indian Ridge	2,500	HM-W-Des: L-B
United Pocahontas Coal Co., Algoma	Algoma	2,500	WT-HM-Des: L-B
U.S. Steel Corp., Gary	Alpheus	—	J-WT-Des: M-P & A/G
Upshur Coals Ltd., Buckhannon	Adrian	2,000	HM-WT
Valley Camp Coal Co., Moundsville	Alexander	3,400*	J
Valley Camp Coal Co., Triadelphia	Valley Camp #1	22,500	J-Des: L-B
Valley Camp Coal Co., Triadelphia	Valley Camp #3	6,500	W-WT-Des: M-P & A/G
Valley Camp Coal Co., Shrewsbury	Valley Camp #8	6,500	J-AT-Des: KA
Valley Camp Coal Co., Cedar Grove	Buff Lick	3,000	HM-AT
Webco, Inc., Webster Springs	Bolair	800	W-J
Westmoreland Coal Co., Clothier	Hampton #3	5,900	HM-F-WT
Westmoreland Coal Co., Clothier	Hampton #4	6,000*	J-F-WT
Wheeling-Pittsburgh St. Corp., Stirrat	Omar	5,000	HM-WT-F-Des: M-P & FM
Winding Gulf Coals, Inc., East Gulf	Winding Gulf #4	2,300	AT-HM
Winding Gulf Coals, Inc., MacAlpin	MacAlpin	1,800	HM
Winding Gulf Coals, Inc., Tams	Tams	1,500	HM-AT-F
Winding Gulf Coast, Inc., Maben	Maben	3,000	J-WT-HM-Des: H/P
Winding Gulf Coals, Inc., East Gulf	East Gulf	2,900*	J-AT-HM
Winding Gulf Coals, Inc., Eccles	# 5	2,200	HM-Des. R/S
Winding Gulf Coals, Inc., Eccles	# 6	2,000	HM
Winding Gulf Coals, Inc., Clifftop	Clifftop #1 & 2	3,500	J-Des: R/S
Windsor Power House Coal, Windsor Hts.	Beech Bottom	2,900*	W
Youngstown Mine Corp., Dehue	Dehue	3,700	HM-J-F
WYOMING			
Gunn-Quealy Coal Co., Frontier	Rainbow	1,000*	AT

\# Daily capacity, cleaned coal unless noted*.
* Daily mine capacity as reported.
** Plant temporarily inactive

Type of Cleaning Employed:

J—Jigs, jig washers
AT—Air tables, air cleaners, air concentrators
F—Flotation, froth flotation
HM—Heavy-media, heavy-density, chance cones calcium chloride washers, etc.
WT—Water tables, concentrating tables, wet tabling
W—Washery, washer, not otherwise specified, including Bellnap washer & Menzies cones

Plant Designer (where available)—"Des:"

A/G—Allen & Garcia
A-M—Arthur McKee & Co.
DAN—Daniels Co.
D-O—Dorr Oliver
FM—Fairmount Machinery
F-P—Fuel Process
G-M—Galis Mfg.
H/P—Heyl & Patterson
I-E—Industrial Engineers
J—Jeffrey
J-L—J. O. Lively Mfg. Corp.
KA—Kanawha Mfg.
K—Koppers Co.
L-B—Link Belt
M-P—McNally Pittsburg
M-E—Mines Engineering
N-D—Nelson Davis Co.
R/S—Roberts & Schaefer
U-E—United Engineers
W-E—Wilmot Engineering

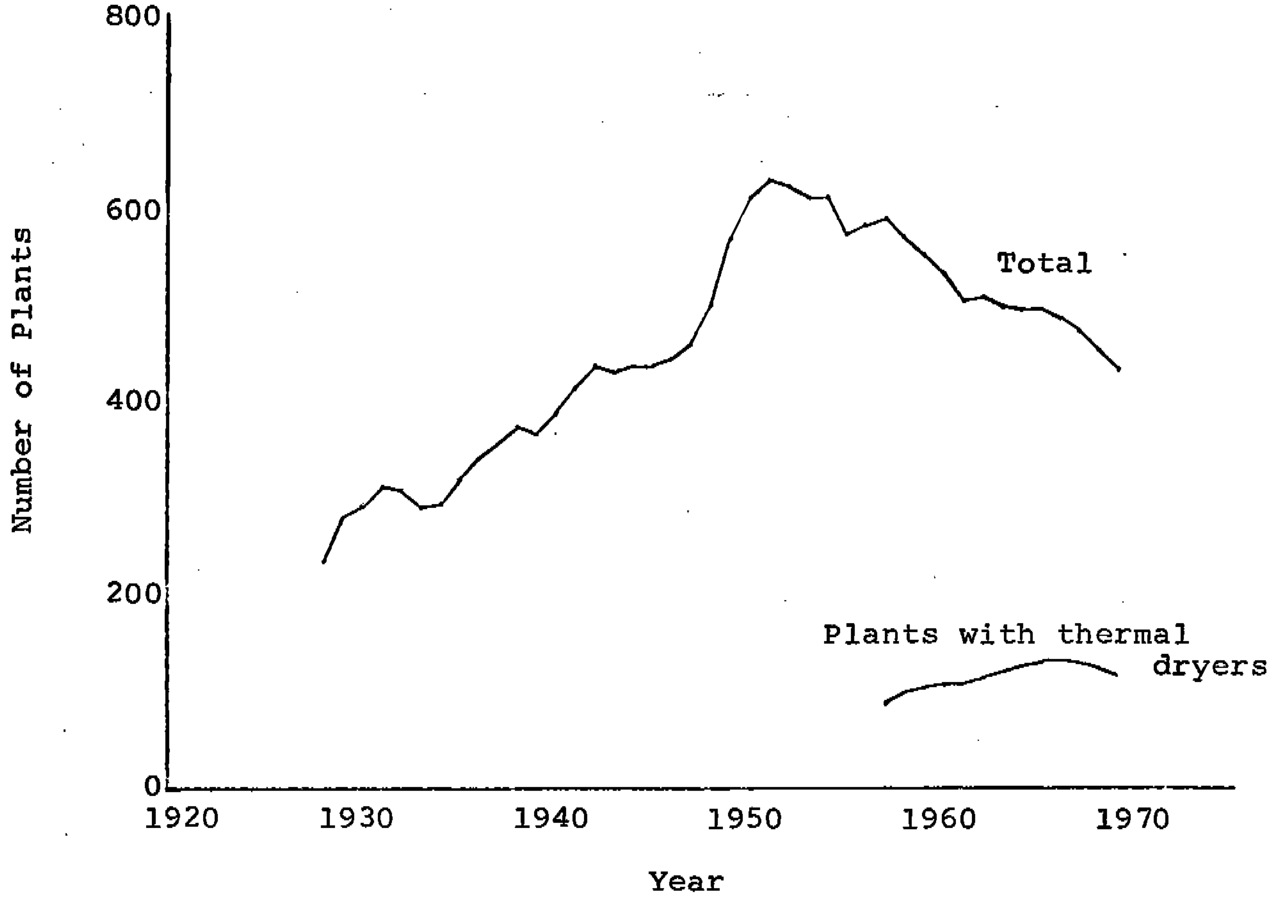

Figure 3

Number of Coal Cleaning Plants,
Total and with Thermal Dryers, By Year

During the next ten years, new coal preparation plants in the utility market will utilize as simple and inexpensive a flow scheme as possible to meet product specifications.[20] Thermal drying will probably not be used unless it is a necessary preliminary step in air tabling plants. The increased use of water sprays underground, brought about by the Coal Mine Health and Safety Act, has caused an increase in the surface moisture content of coal mined underground.

The increased utilization of western sub-bituminous coal will cause a reduction in the percentage of coal cleaned. The coal from the 27 foot thick Rosebud seam needs only to be crushed to two inches or less for shipment to electric utility customers.[21]

The cost of thermal drying is a major disincentive to this step in the operation of coal preparation. Wherever possible, alternative methods of dewatering are used to save processing costs in the industry. For many years, 28 mesh by zero coal was considered ultrafine. New plants such as the Rowland preparation plant of Consolidation Coal[8] are designed so that 100 mesh by zero coal is the bottom size range and this filter cake is not thermally dried. Some thermal dryers have been abandoned in favor of centrifuges.[22] Steam dewatering of filter cakes can reduce the 20-30% moisture content by about one-third.

Each of these new steps is adopted by the industry after it is demonstrated that the product quality is acceptable and the cost is less than thermal drying. It is anticipated that in 1980 approximately 90,000,000 tons per year of coal will be processed by thermal dryers. This is only a moderate increase from the tonnage dried in the period 1967-1969. It is further anticipated that nearly all of the coal processed by thermal dryers will be directed to metallurgical use. New dryers will be significantly larger, e.g., 400 tons per hour, than the average thermal dryer now in operation which is approximately 150 tons per hour capacity.

Coal cleaning plants will continue to be located in isolated areas near the location where the coal is mined. In those instances where coal preparation plants are located in populous areas, fugitive dust is anticipated to be more of a problem than stack emissions.

9.0 INDUSTRY EXPERTS

The American Mining Congress is the central organization representing coal processors. The AMC Coal Preparation Committee is composed of approximately 700 members representing coal companies, coal users, and plant designers.

The principal designers of coal preparation plants are the McNally-Pittsburg Manufacturing Company, Pittsburg, Kansas; and the Roberts and Schaefer Company, Chicago, Illinois. Other designers are noted in Table 10.

Thermal dryers are supplied by the McNally-Pittsburg Company, Heyl and Patterson, Inc., Pittsburgh, Pennsylvania; the Dorr-Oliver Company, and Link-Belt, Inc.

Each of the major coal companies and the major steel companies have a coal preparation director. These men are particularly skilled in the applications of their company's coal or product and are keenly aware of the costs involved in coal preparation and attendant environmental pollution control. Mr. D. T. King of United States Steel and Mr. W. Benzon of the Bethlehem Steel Company are in charge of their respective coal preparation operations.

The principal literature reference in the coal preparation field is Coal Preparation, a large volume published by the American Institute of Mining, Metallurgical and Petroleum Engineers, New York. The principal journals in the field are "Coal Mining and Processing" and the

"Mining Congress Journal." The Keystone Coal Buyers Manual, published by McGraw-Hill, is a particularly good source of information about individual plants. The U.S. Bureau of Mines compiles historical data on coal cleaning by state, but not by individual company.

The American Air Filter Company and Research-Cottrell, Inc., are the principal suppliers of high energy scrubbers for fluid bed dryers. Air pollution consulting and testing firms with experience in the coal preparation industry include Resources Research, Inc., Herrick Associates, and York Research. A new firm, Test, Inc., has been formed by Mr. David Ellis who spent a number of years with the West Virginia Air Pollution Commission.

Mr. A. Deurbrouck of the U. S. Bureau of Mines, Bruceton, Pennsylvania, is familiar with new techniques for coal preparation. The Paul A. Wier Company, Chicago, Illinois, prepared a report under a NAPCA contract relative to the use of coal cleaning to meet emission limits for sulfur oxides. The University of West Virginia and Pennsylvania State University have major programs in coal utilization.

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