11.10 Coal Cleaning

11.10.1 Process Description[1-2,9]

Coal cleaning is a process by which impurities such as sulfur, ash, and rock are removed from coal to upgrade its value. Coal cleaning processes are categorized as either physical cleaning or chemical cleaning. Physical coal cleaning processes, the mechanical separation of coal from its contaminants using differences in density, are by far the major processes in use today. Chemical coal cleaning processes are currently being developed, but their performance and cost are undetermined at this time. Therefore, chemical processes are not included in this discussion.

The scheme used in physical coal cleaning processes varies among coal cleaning plants but can generally be divided into four basic phases: initial preparation, fine coal processing, coarse coal processing, and final preparation. A process flow diagram for a typical coal cleaning plant is presented in Figure 11.10-1.

In the initial preparation phase of coal cleaning, the raw coal is unloaded, stored, conveyed, crushed, and classified by screening into coarse and fine coal fractions. The size fractions are then conveyed to their respective cleaning processes.

Fine coal processing and coarse coal processing use similar operations and equipment to separate the contaminants. The primary difference is the severity of operating parameters. The majority of coal cleaning processes use upward currents or pulses of a fluid such as water to fluidize a bed of crushed coal and impurities. The lighter coal particles rise and are removed from the top of the bed. The heavier impurities are removed from the bottom. Coal cleaned in the wet processes then must be dried in the final preparation processes.

Final preparation processes are used to remove moisture from coal, thereby reducing freezing problems and weight and raising the heating value. The first processing step is dewatering, in which a major portion of the water is removed by the use of screens, thickeners, and cyclones. The second step is normally thermal drying, achieved by any one of three dryer types: fluidized bed, flash, and multilouvered. In the fluidized bed dryer, the coal is suspended and dried above a perforated plate by rising hot gases. In the flash dryer, coal is fed into a stream of hot gases for instantaneous drying. The dried coal and wet gases are both drawn up a drying column and into a cyclone for separation. In the multilouvered dryer, hot gases are passed through a falling curtain of coal, which is then raised by flights of a specially designed conveyor.

11.10.2 Emissions And Controls[1-2,9-10]

Emissions from the initial coal preparation phase of either wet or dry processes consist primarily of fugitive particulate matter (PM) as coal dust from roadways, stock piles, refuse areas, loaded railroad cars, conveyor belt pouroffs, crushers, and classifiers. The major control technique used to reduce these emissions is water wetting. Another technique that applies to unloading, conveying, crushing, and screening operations involves enclosing the process area and circulating air from the area through fabric filters. Uncontrolled emission factors for various types of fugitive sources in coal cleaning facilities can be developed from the equations found in Section 13.2, "Fugitive Dust Sources".

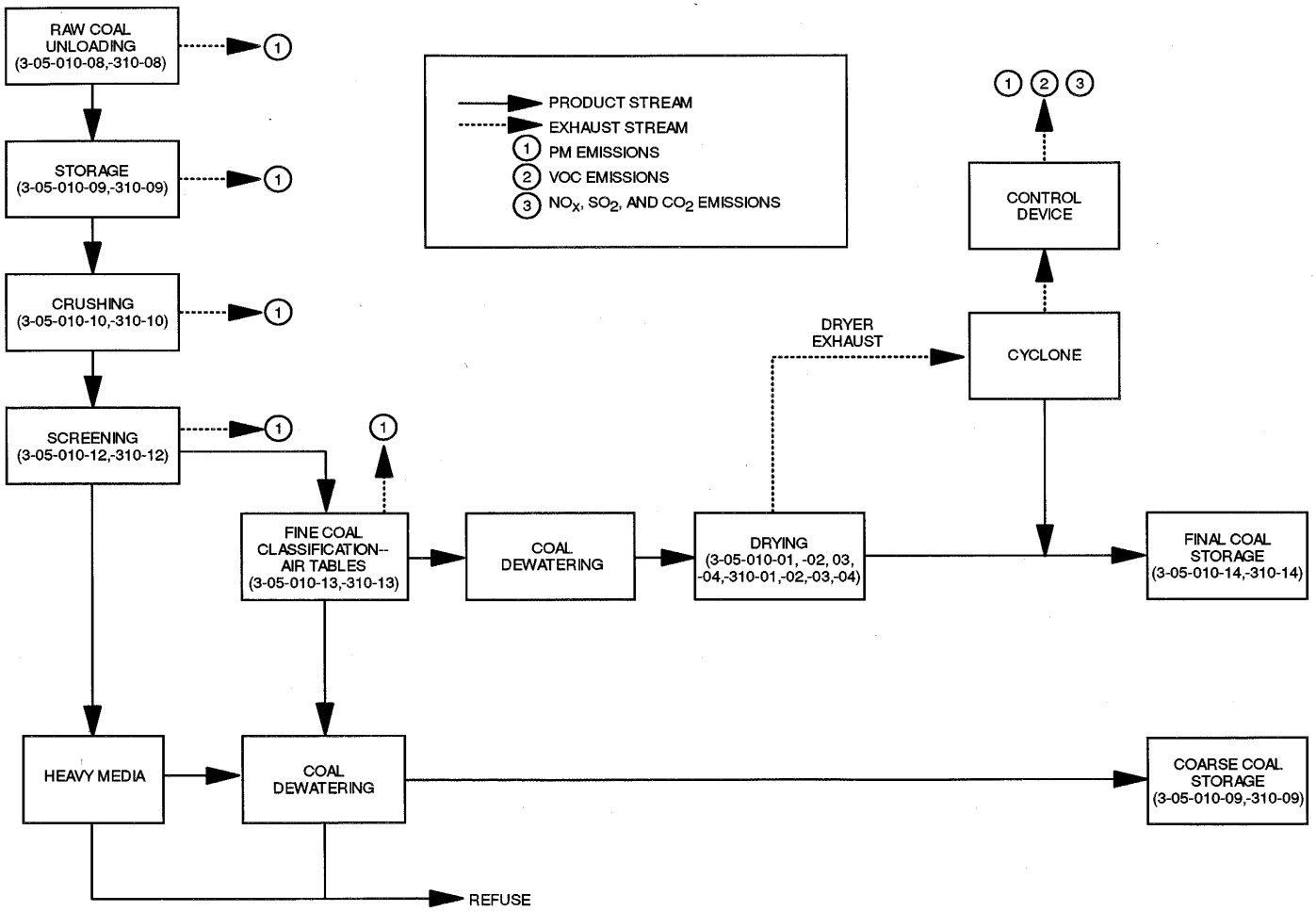

Figure 11.10-1. Typical coal cleaning plant process flow diagram.
(Source Classification Codes in parenthesis.)

The major emission source in the fine or coarse coal processing phases is the air exhaust from the air separation processes (air tables). For the dry cleaning process, these emissions are generated when the coal is stratified by pulses of air. Particulate matter emissions from this source are normally controlled with cyclones followed by fabric filters. Potential emissions from wet cleaning processes are very low.

The major source of emissions from the final preparation phase is the thermal dryer exhaust. This emission stream contains coal particles entrained in the drying gases and volatile organic compounds (VOC) released from the coal, in addition to the standard products of coal combustion resulting from burning coal to generate the hot gases (including carbon monoxide [CO], carbon dioxide [CO_2], VOC, sulfur dioxide [SO_2], and nitrogen oxides [NO_x]). Table 11.10-1 shows emission factors for PM. Emission factors for SO_2, NO_x, VOC, and CO_2 are presented in Table 11.10-2. The most common technology used to control dryer emissions is venturi scrubbers and mist eliminators downstream from the product recovery cyclones. The control efficiency of these techniques for filterable PM ranges from 98 to 99.9 percent. Scrubbers also may achieve between 0 and 95 percent control of SO_2 emissions. The use of a neutralizing agent (such as NaOH) in the scrubber water increases the SO_2 removal efficiency of the scrubber.

A number of inorganic hazardous air pollutants are found in trace quantities in coal. These include arsenic, beryllium, cadmium, chromium, copper, mercury, manganese, nickel, lead, thorium, and uranium. It is likely that many of these are emitted in trace amounts from crushing, grinding, and drying operations.

The new source performance standards (NSPS) for coal preparation plants were promulgated in January 1976 (40 CFR Subpart Y). These standards specify emission limits for PM from coal cleaning thermal dryers and pneumatic cleaning equipment sources, and opacity limits for fugitive emissions from coal processing and conveying equipment, coal storage systems, and coal transfer and loading systems.

Table 11.10-1. PM EMISSION FACTORS FOR COAL CLEANING[a]

EMISSION FACTOR RATING: D (except as noted)

Process	Filterable PM[b]			Condensible PM[c]	
	PM	PM-2.5	PM-1.0	Inorganic	Organic
Multilouvered dryer[d] (SCC 3-05-010-03)	3.7	ND	ND	0.057	0.018
Fluidized bed dryer[e] (SCC 3-05-010-01)	26[f]	3.8[g]	1.1[g]	0.034[h]	0.0075[h]
Fluidized bed dryer with venturi scrubber[j] (SCC 3-05-010-01)	0.17	ND	ND	0.043	0.0048
Fluidized bed dryer with venturi scrubber and tray scrubber[k] (SCC 3-05-010-01)	0.025	ND	ND	ND	ND
Air tables with fabric filter[m] (SCC 3-05-010-13)	0.032[n]	ND	ND	0.033[p]	0.0026[q]

[a] Emission factor units are lb/ton of coal feed, unless noted. 1 lb/ton = 2 kg/Mg. SCC = Source Classification Code. ND = no data.

[b] Filterable PM is that PM collected on or prior to the filter of an EPA Method 5 (or equivalent) sampling train.

[c] Condensible PM is that PM collected in the impinger portion of a PM sampling train.

[d] Reference 11. Alternate SCC is 3-05-310-03, which corresponds to units of lb/thousand tons of coal feed. To determine the emission factor for this alternate SCC, multiply the factor in this table by 1,000.

[e] Alternate SCC is 3-05-310-01, which corresponds to units of lb/thousand tons of coal feed. To determine the emission factor for this alternate SCC, multiply the factor in this table by 1,000.

[f] References 12,15.

[g] References 12,15. EMISSION FACTOR RATING: E. Particle size data from Reference 15 used in conjunction with filterable PM data from References 12 and 15. Actual cut size of PM-2.5 data was 2.7 microns.

[h] Reference 12.

[j] References 12-13,15-16,20. See footnote "e" above for alternate SCC.

[k] Reference 21. Tray scrubber using NaOH as the scrubbing liquid. See footnote "e" above for alternate SCC.

[m] Alternate SCC is 3-05-310-13, which corresponds to units of lb/thousand tons of coal feed. To determine the emission factor for this alternate SCC, multiply the factor in this table by 1,000.

[n] References 18-19.

[p] Reference 19.

[q] Reference 18.

Table 11.10-2. GASEOUS POLLUTANT EMISSION FACTORS FOR COAL CLEANING[a]

EMISSION FACTOR RATING: D (except as noted)

Process	VOC[b]	SO_2	NO_x	CO_2
Multilouvered dryer[c] (SCC 3-05-010-03)	ND	ND	ND	160
Fluidized bed dryer[d] (SCC 3-05-010-01)	ND	1.4[e]	0.16[f]	30[g]
Fluidized bed dryer with venturi scrubber[h] (SCC 3-05-010-01)	0.098[j]	[k]	0.16[f]	30[g]
Fluidized bed dryer with venturi scrubber and tray scrubber[m] (SCC 3-05-010-01)	ND	0.072[n]	0.16[f]	30[g]

[a] Emission factor units are lb/ton of coal feed, unless noted. 1 lb/ton = 2 kg/Mg. SCC = Source Classification Code. ND = no data.

[b] VOC as methane, measured with an EPA Method 25A sampling train. Measurement may include compounds designated as nonreactive.

[c] Reference 11. EMISSION FACTOR RATING: E. Alternate SCC is 3-05-310-03, which corresponds to units of lb/thousand tons of coal feed. To determine the emission factor for this alternate SCC, multiply the factor in this table by 1,000.

[d] Alternate SCC is 3-05-310-01, which corresponds to units of lb/thousand tons of coal feed. To determine the emission factor for this alternate, SCC, multiply the factor in this table by 1,000.

[e] References 12,14,17. EMISSION FACTOR RATING: E.

[f] References 12,14,21. Includes NO_x measurements before and after control devices that are not expected to provide control of NO_x emissions.

[g] References 12-16,20. Includes CO_2 measurements before and after control devices that are not expected to provide control of CO_2 emissions.

[h] See footnote "d" above for alternate SCC.

[j] References 13-14.

[k] Venturi scrubbers may achieve between 0 and 95% control of SO_2 emissions. The use of a neutralizing agent in the scrubber water increases the SO_2 control efficiency.

[m] Venturi scrubber followed by tray scrubber using a NaOH solution as the scrubbing liquid. See footnote "d" above for alternate SCC.

[n] Reference 21.

References For Section 11.10

1. *Background Information For Establishment Of National Standards Of Performance For New Sources: Coal Cleaning Industry*, EPA Contract No. CPA-70-142, Environmental Engineering, Inc., Gainesville, FL, July 1971.

2. *Air Pollutant Emissions Factors*, Contract No. CPA-22-69-119, Resources Research Inc., Reston, VA, April 1970.

3. *Stack Test Results On Thermal Coal Dryers (Unpublished)*, Bureau Of Air Pollution Control, Pennsylvania Department Of Health, Harrisburg, PA.

4. "Amherst's Answer To Air Pollution Laws", *Coal Mining And Processing*, *7*(2):26-29, February 1970.

5. D. W. Jones, "Dust Collection At Moss No. 3", *Mining Congress Journal*, *55*(7):53-56, July 1969.

6. E. Northcott, "Dust Abatement At Bird Coal", *Mining Congress Journal*, *53*:26-29, November 1967.

7. *Background Information For Standards Of Performance: Coal Preparation Plants, Volume 2: Test Data Summary*, EPA-450/2-74-021b, U. S. Environmental Protection Agency, Research Triangle Park, NC, October 1974.

8. *Estimating Air Toxic Emissions From Coal And Oil Combustion Sources*, EPA-450/2-89-001, U. S. Environmental Protection Agency, Research Triangle Park, NC, April 1989.

9. *Second Review Of New Source Performance Standards For Coal Preparation Plants*, EPA-450/3-88-001, U. S. Environmental Protection Agency, Research Triangle Park, NC, February 1988.

10. *Estimating Air Toxic Emissions From Coal and Oil Combustion Sources*, EPA-450/2-89-001, U. S. Environmental Protection Agency, Research Triangle Park, NC, April 1989.

11. *Emission Testing Report: Bureau Of Mines, Grand Forks, North Dakota*, EMB Report 73-CCL-5, U. S. Environmental Protection Agency, Research Triangle Park, NC, April 1973.

12. *Coal Preparation Plant Emission Tests, Consolidation Coal Company, Bishop, West Virginia*, EMB Report 72-CCL-19A, U. S. Environmental Protection Agency, Research Triangle Park, NC, February 1972.

13. *Coal Preparation Plant Emission Tests, Westmoreland Coal Company, Wentz Plant*, EMB Report 72-CCL-22, U. S. Environmental Protection Agency, Research Triangle Park, NC, April 1972.

14. *Emission Test Report, U.S. Steel #50, Pineville, West Virginia*, EMB Report 73-CCL-1, U. S. Environmental Protection Agency, Research Triangle Park, NC, September 1972.

15. *Emission Test Report, Westmoreland Coal Company, Quinwood, West Virginia*, EMB Report 75-CCL-7, U. S. Environmental Protection Agency, Research Triangle Park, NC, May 1976.

16. *Coal Preparation Plant Emission Tests: Consolidation Coal Company, Bishop, West Virginia*, EMB Report 73-CCL-19, U. S. Environmental Protection Agency, Research Triangle Park, NC, November 1972.

17. *Report By York Research Corporation On Emissions From The Island Creek Coal Company Coal Processing Plant, Vansant, Virginia*, EMB Report 72-CCL-6, U. S. Environmental Protection Agency, Research Triangle Park, NC, February 1972.

18. *Report By York Research Corporation On Emissions From The Florence Mining Company Coal Processing Plant, Seward, Pennsylvania*, EMB Report 72-CCL-4, U. S. Environmental Protection Agency, Research Triangle Park, NC, February 1972.

19. *Coal Preparation Plant Emission Tests: Eastern Associates Coal Company, Keystone, West Virginia*, EMB Report 72-CCL-13, U. S. Environmental Protection Agency, Research Triangle Park, NC, February 1972.

20. *Coal Preparation Plant Emission Tests: Island Creek Coal Company, Vansant, Virginia*, EMB Report 73-CCL-2, U. S. Environmental Protection Agency, Research Triangle Park, NC, September 1972.

21. *Report On Compliance Testing, Performed For Peabody Coal Company, Hawthorne Mine, Carlisle, Indiana*, Clean Air Engineering, Palatine, IL, May 6, 1993.