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AIR POLLUTANT

EMISSION FACTORS

Supplement

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TRW
SYSTEMS GROUP OF TRW INC.

This report presents emission factors for five industrial processes that were not covered in earlier studies. It supplements the April 1970 report on Air Pollution Emission Factors, and was likewise compiled by Resources Research, Inc., TRW Systems Group for the National Air Pollution Control Administration, Division of Air Quality and Emission Data, under Contract No. CPA 22-69-119.

COAL PREPARATION

Coal as mined, called "run-of-mine" or "through" coal, is usually a mixture of sizes from lumps 3 feet long to the finest dust. It also includes "dirt" or "shale" (not to be confused with rock of the same name), which may vary from pure stony matter to carbonaceous mixtures. Coal is brought to the surface in tubs or skips and tippled on to shaking screens which separate the large coal from the small coal. The nature of these operations varies with the character of the coal. If it is hard and free from shale partings, the simple screening into large and nut sizes and smaller slack and "duff" may be all that is required for marketability. The large coal is usually hand picked and individually cleaned of shale remnants. When coal is friable and there is much small and when it is dirty due to intermixture of shale, cleaning by washing and more elaborate sizing become necessary.

Most cleaning is done by a wet process, using water or a "dense medium" of finely ground magnetites or barytes in colloidal suspension in water. The operation of every mechanical coal-cleaning process depends on the difference in specific gravity of the four ingredients: water, with specific gravity of 1, coal about 1.35, shale about 2.3, and iron pyrites about 5.0. Cleaning is done by washing in either continuous current or pulsating (jigging) machines, where the lighter coal near the surface is removed by a stream of water while the heavier waste falls and is discharged at a lower level or at the bottom of the machine. Two devices are shown in Figures 1 and 2 (Ref. 1).

A dry "washing" or cleaning process is also in use, particularly for cleaning nut coal, where the use of water would cause discoloration of the coal and lessen its marketability. The coal passes over an inclined glass plate which is kept clean by a stream of compressed air. In another dry cleaning device, the coal is passed over a shaking table with a perforated deck through which a current of air blow upward. In each case the shale, being heavier, sinks to a lower level and through a gap, while the coal passes on. Dry cleaners are not as efficient as

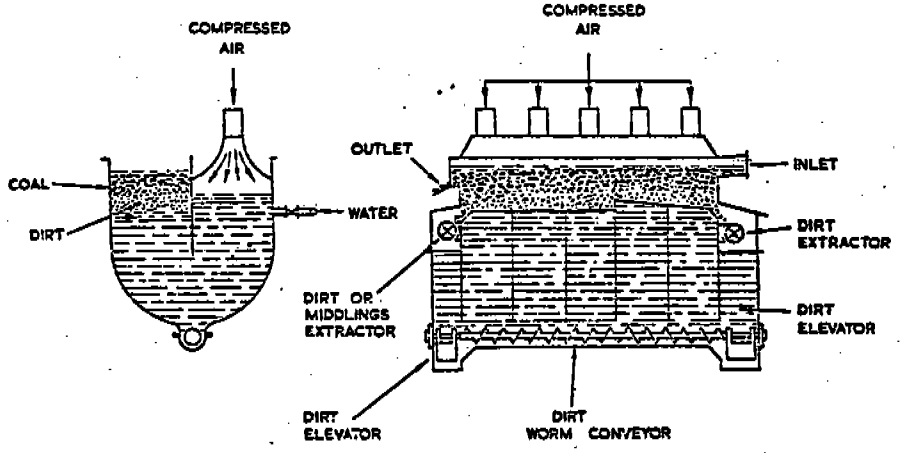


Figure 1. The Baum Coal Washer

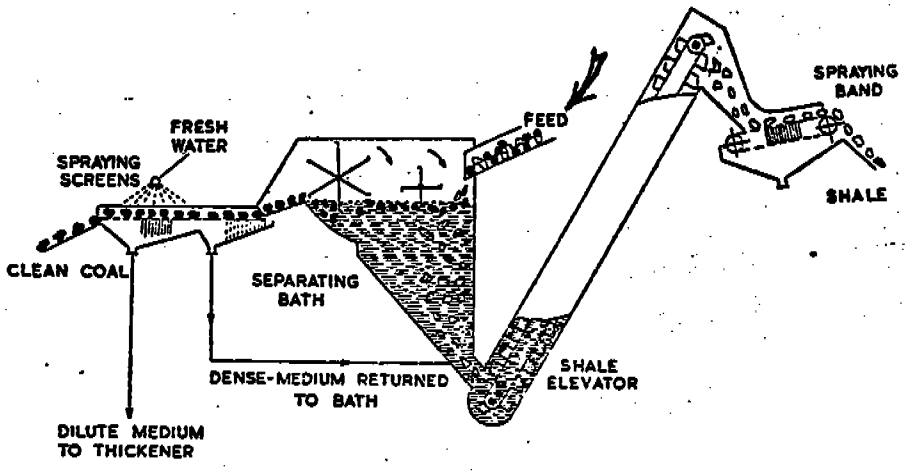


Figure 2. Dense Medium Coal Cleaner

wet washers, and their use is dying out rapidly since water is often used underground to scrub coal dust as a prevention against dust diseases (e.g., pneumoconiosis), and the coal is brought up too wet to be cleaned by dry methods.

Particulate matter that separates from the coal during transport, screening, and entry into the cleaner may cause air in the immediate vicinity of the equipment to be dusty; but otherwise coal preparation up to the drying stage is generally free of emissions to the ambient atmosphere. The major source of air pollution is the exhaust from thermal coal dryers.

Seven types of thermal dryers are presently used:

Rotary. There are two kinds; double shell indirect heated and outer shell only with lifting vanes inside. (See Figure 3, Ref. 2.)

Screen. Moisture is evaporated by hot gases passing through coal conveyed on a reciprocating screen.

Cascade. Coal is dried by flowing through a series of stationary or revolving shelves.

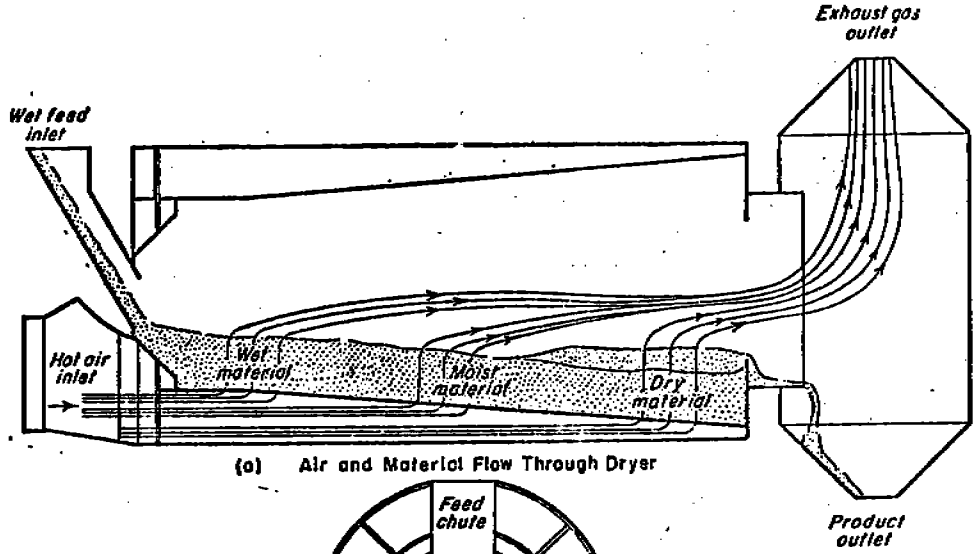
Continuous Carrier. Coal is moved through the dryer on a wire mesh belt.

Flash or Suspension. Coal is fed into a stream of hot gases where instantaneous drying occurs. The dried coal and wet gases are drawn up a drying column and into the cyclone for separation.

Multilouver. Hot gases are passed through falling curtains of coal. The coal is raised by flights of a specially designed conveyor.

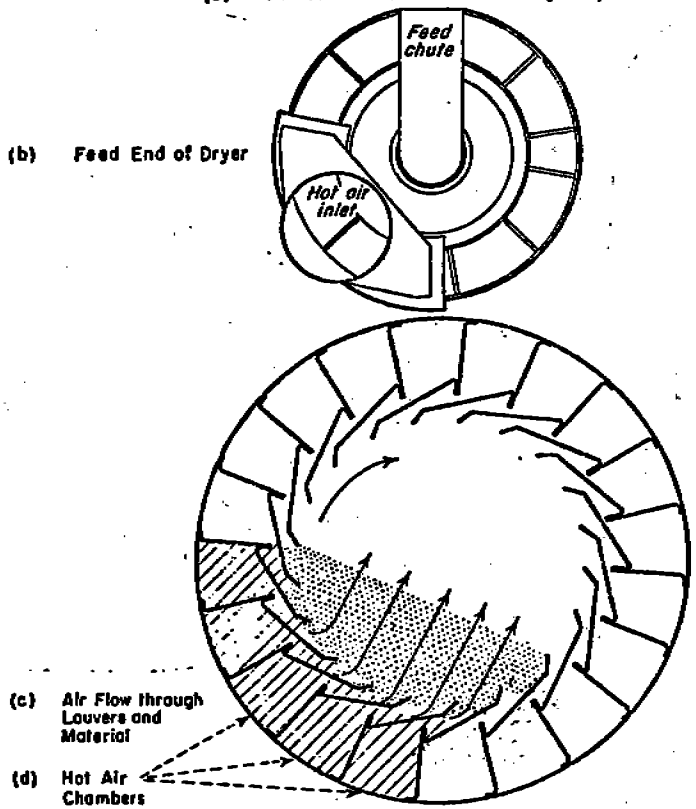
Fluidized Bed. The coal is suspended and dried in a fluid state above a perforated plate by rising hot gases. (See Figure 4, Ref. 2.)

The fluidized bed type has been the most popular in recent years. The gas volumes from this type of dryer range from 50,000 to 250,000 acfm. The exit gas temperature will be about 200°F. Dust concentrations in



(a) Air and Material Flow Through Dryer

Figure 3. Link-Belt Roto-Louvre Dryer (Link-Belt Co.)



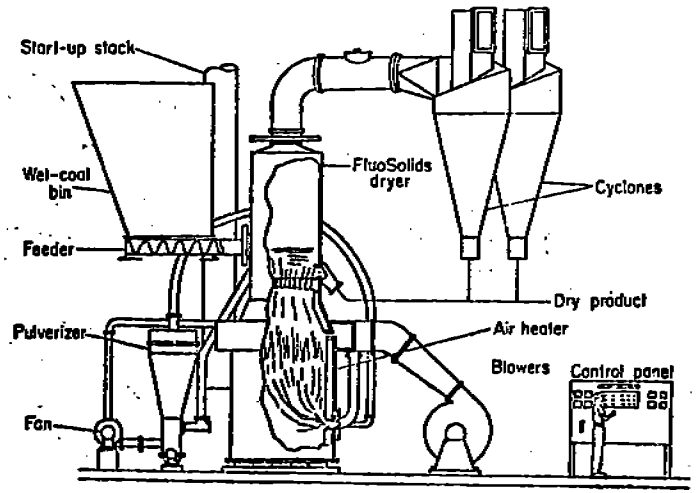
(b) Feed End of Dryer

(c) Air Flow through Louvers and Material

(d) Hot Air Chambers

Figure 4. Fluidized-bed Coal Dryer

(courtesy of Dorr-Oliver, Inc.)



the gases from the dryer are unusually high - 100 to 300 grains per actual cubic foot (gr/acf). A typical particle size analysis of feed to the fluidized bed dryer is listed in Table I..

It is assumed that all the minus 200 mesh material is carried to the cyclones. This means as much as 35% to 40% of the total feed to the dryer is carried over to the primary collectors.[3] No dryers are operated without collectors, and the exhaust gas is fully contained until it leaves the collector system. Hence, the emission data presented here apply to the exhaust gas after control.

Table I Typical Particle Size Analysis of Feed to a Fluidized Bed Dryer[1]

Particle size, microns	% by Weight less than State Size
500 (32 mesh)	98%
300	90%
200	78%
100	43%
75 (approximate 200 mesh)	28%
40	7%
20	1%

Table II is a listing of typical particle size analyses of material vented from several types of dryers to primary collectors.

Table II Typical Particle Size Analyses of Material to the Cyclones[3]

	% by Weight less than Stated Size		
Particle Size, microns	Flash Dryer*	Fluidized Bed	Cascade & Multilouvered
60	98	20	70
40	96	14	50
20	90	5	42
10	80	2	25
5	65	0.5	10
2	40	0.1	2.5

NOTE: The average dust concentration from each dryer type:

Flash - 2 gr/acf
Cascade and Multilouvered - 20 gr/acf
Fluidized Bed - 200 gr/acf

*Outlet from main cyclone

EMISSIONS

West Virginia, which is the largest coal producing state in the Union, has adopted Regulation V for the control of thermal coal dryers. The maximum allowable emission, for a dryer exhausting 110,000 cfm or less, is 0.10 grains per standard cubic foot (gr/scf). After September 1, 1971, the limit will be 0.09 gr/scf.

However, it has been reported that to obtain a "clear stack" (no visible emission of coal dust fines) the particulate concentration must be below 0.038 gr/scf.[3]

In one case, a particulate grain loading of 0.047 gr/scf, in the effluent gases from a thermal coal dryer stack, produced an evident gray coal dust plume.[4] After installation of a venturi scrubber system, the outlet grain loading of 0.023 gr/scf produced a plume with no visible emission of coal dust fines. For the particular unit which was tested, the first grain loading corresponded to an emission rate of 38 lbs/hour and the second concentration corresponded to a rate of 15 lbs/hour. The concentration, quantity and particle size range of emissions depend upon the type of collection equipment used to reduce particulate emissions from the dryer stack. Some typical grain loadings from various control equipment are:

Type of Control	Outlet Grain Loading, gr/scf
Cyclones (product recovery)	6-9 gr/scf
Multiple cyclones (product recovery)	2.5-3.5 gr/scf
Water Sprays*	0.7-1.5 gr/scf
Wet scrubber*(pressure drop less than 5 inches H_2O)	0.1-0.2 gr/scf
Wet scrubber*(pressure drop 8-15 inches H_2O)	0.035-0.05 gr/scf
Wet scrubber*(pressure drop greater than 20 inches H_2O)	0.02-0.03 gr/scf

*Following product recovery systems on the thermal dryer effluent.

Collection efficiencies over 99% are achievable by use of a scrubber on a fluidized bed cyclone,[3] as shown by Figure 5. Greater collection efficiency can be obtained by using cyclones with a fluidized bed dryer than with certain other types of dryers,[3] for the same pressure drop. See Figure 6.

Practically, to meet the present regulations and public demands, wet scrubbers must be employed to control the emissions from thermal coal dryers. With wet scrubbers, the outlet grain loading is inversely related to the energy expended in the scrubber, which is measured by the scrubber pressure drop. Simply, the greater the pressure drop, the greater the collection efficiency.

Table III lists recommended emission factors for the only dryers to which any data were available . (See Appendix.) These figures are tenuous because of the scarcity of published data.

Table III Emission Factors for Thermal Coal Dryer:
Pounds of Particulate per ton of Coal Dried(after control)

Type of Thermal Dryer	Particulate Emission from Product Recovery System
Fluidized Bed	6
Flash	5
Multilouvered	7.5

FACTORS AFFECTING EMISSIONS

Dust emissions are not related to the percentage of fines nor to the moisture in the dryer feed or product. Increasing the amount of coal filter coke in the feed also has no effect upon emissions. However, emission control from a thermal coal dryer hinges upon the selection of an adequate collection device and proper use of this equipment. In the case of scrubbers, for example, if a venturi system is used, the pressure drop must be regulated and maintained. With impingement scrubbers the prescribed critical speed for impingement must be maintained.

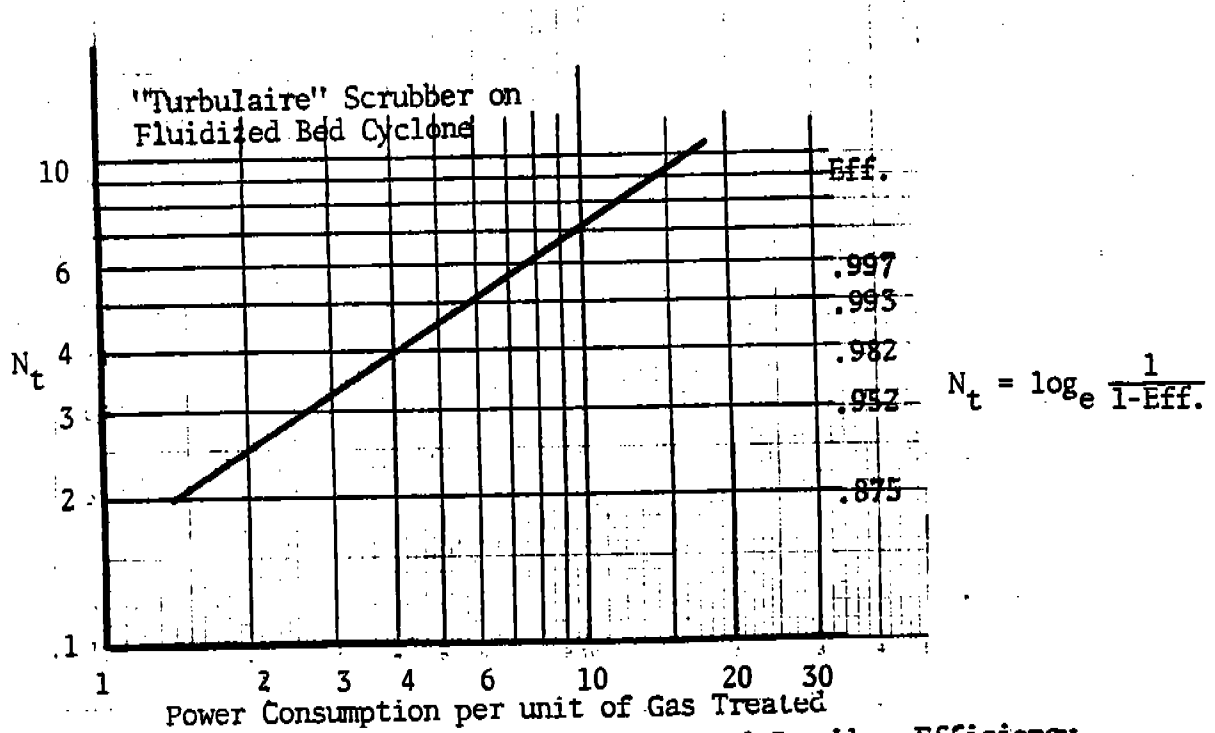


Figure 5. Relation between Power Consumption and Scrubber Efficiency

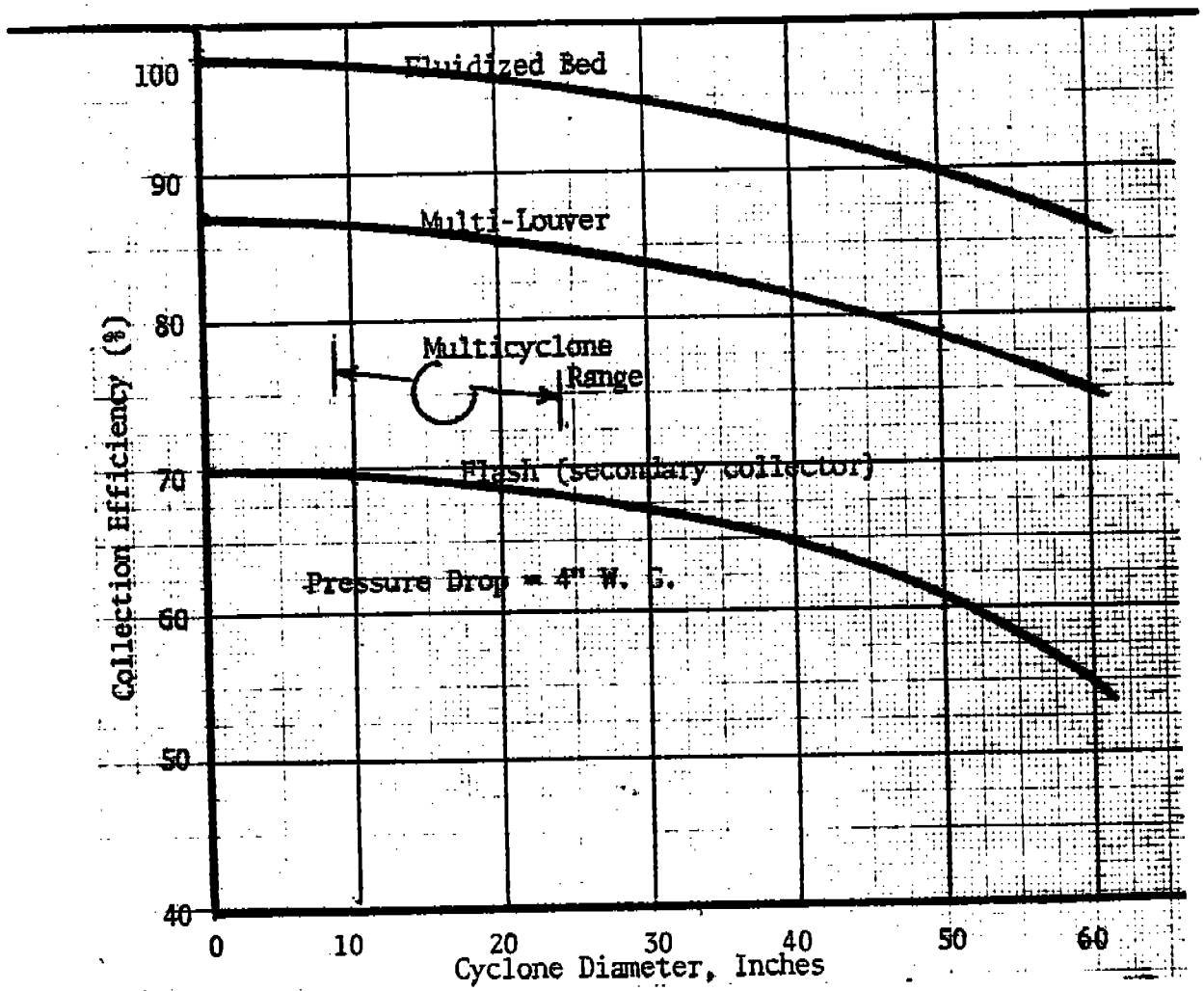


Figure 6. Relation between Cyclone Diameter and Collection Efficiency

APPENDIX
THERMAL COAL DRYERS

Type of Thermal Dryer	Emission Factor* lbs of particulate/ ton of coal dried	Reference Number
Fluidized Bed	5	4
	4	4
	10	5
Flash	4.5-8	4
	3.8	5
	4.7	5
Multilouvered	6.5	6
	8.5	6

*Particulate Emission Factor is the particulate from cyclone collector.

Reliability of Emission Factors

Table IIIa lists rankings of emission factors of Table II on a scale of reliability based on a maximum point value of 40.

Table IIIa. Ranking of Emission Factors

	Emission Data 0-20	Process Data 0-10	Engineering Analysis 0-10	Total 0-40
Fluidized Bed	12	8	5	25
Flash Dryer	15	8	5	28
Multilouvered Dryer	12	8	5	25

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4. Pennsylvania Department of Health, Bureau of Air Pollution Control. Stack Test Results.

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6. Jones, Donald W. "Dust Collection at Mass No. 3". Mining Congress Journal. July 1969. p. 53-56.