United States
Environmental Protection
Agency

Air and Energy Engineering
Research Laboratory
Research Triangle Park NC 27711

Research and Development

EPA/600/S7-86/050 Apr. 1987

EPA

Project Summary

Metallurgical Coke Industry Particulate Emissions: Source Category Report

John Fitzgerald, John Jeffery, and Paul Wolf

The objective of this study was to develop particulate emission factors based on cutoff size for inhalable particles for the metallurgical coke industry. After a review of available information characterizing particulate emissions from metallurgical coke plants, the data were summarized and rated in terms of reliability. Size specific emission factors were developed from these data for the major processes used in the manufacture of metallurgical coke. A detailed process description is presented with emphasis on factors affecting the generation of emissions. A replacement for Section 7.2 (Coke Manufacturing) of EPA report AP-42, A Compilation of Air Pollutant Emissions Factors, was prepared, containing the size specific emission factors developed during this program.

This Project Summary was developed by EPA's Air and Energy Engineering Research Laboratory, Research Triangle Park, NC, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

The purpose of this program was to summarize the best available information on emissions of inhalable particulate matter in the metallurgical coke industry. The main objective of the program was to develop reliable size-specific emission factors for the various processes used in the production of metallurgical coke. Both uncontrolled and controlled emission factors are presented in the report. The uncontrolled factors represent emissions which would result if the particulate control device (baghouse, ESP, etc.) were bypassed, and the controlled factors represent emissions emanating from a particular type of control system. The size-specific emission factors are generally based on the results of simultaneous sampling conducted at the inlet and outlet of the control device(s), utilizing a variety of particle sizing techniques. Other objectives of this program were to present current information on the metallurgical coke industry as well as prepare a replacement for Section 7.2 in EPA report AP-42, "A Compilation of Air Pollutant Emissions Factors."

The above objectives were met by a literature search that included:

- Data from an inhalable particulate characterization program,
- Fine Particle Emissions Inventory System (FPEIS),
- AP-42 background file at EPA's Office of Air Quality Planning and Standards (OAQPS),
- State and local air pollution control agencies, and
- Various industry sources.

The emission data contained in the reference documents were reviewed, analyzed, summarized, and ranked according to the criteria established by OAQPS as published in the EPA report, "Technical Procedures for Developing AP-42 Emission Factors and Preparing AP-42 Sections," April 1980. After the data were ranked, emission factors were calculated using the highest quality data available. The quality of the data used to develop each emission factor is indicated by the emission factor rating.

Process control system operating data and general industry information were also obtained and summarized as general

background information. It was not part of this program to provide detailed engineering analyses, product specifications, or detailed evaluation of trends in the industry.

Summary of Results

Particulate emissions from the production of coke originate from: (1) coal preparation, (2) coal preheating, (3) charging coal into incandescent ovens, (4) over leakage during coking, (5) pushing coke out of the oven, (6) quenching hot coke, and (7) combustion (underfire) stacks.

Coal preparation consists of pulverizing, screening, blending of several coal types, and oil or water additives for bulk density control. Particulate emissions are sometimes controlled by evacuated or unevacuated enclosures. A few domestic plants preheat coal before charging, using a flash drying column heated by combustion of oven or natural gas. The air stream that conveys the coal through the column is typically passed through conventional wet scrubbers for particulate removal prior to atmospheric discharge.

Oven charging can produce emissions of particulate matter and volatile organic compounds from coal decomposition. Staged, or sequential, charging techniques used on virtually all batteries draw most charging emissions into the battery collector main, and on to the byproduct plant. During the coking cycle, volatile organic emissions from the thermal distillation process occasionally leak to the atmosphere through poorly sealed doors, charge lids, offtake caps, and cracks which may develop in oven brickwork, the offtakes, and collector mains. Door leaks are controlled by diligent door cleaning and maintenance, rebuilding of doors, and, in some plants, by manual application of sealant Charge lid and offtake leaks are controlled by an effective patching and luting (sealing) program.

Pushing coke into the quench car is another major source of particulate emissions, volatile organic compounds, and combustion products if the coke mass is not fully coked. Most batteries use pushing emission controls consisting of hooded, mobile scrubber cars; shed enclosures evacuated to a gas cleaning device; or travelling hoods with a fixed duct leading to a stationary gas cleaner. Quenching generates emissions from the quench tower consisting of particulate from the coke mass and dissolved solids from the quench water which become entrained in the steam plume rising from the tower.

The combustion of gas in the flues produces emissions through the underfire or combustion stack. If coke oven gas is not desulfurized, SO_x emissions accompany the particulate and combustion emissions. If flues are damaged, coal fines and decomposition products from a recently charged oven may leak into the waste combustion gases. Electrostatic precipitators and fabric filters are typically used for control of particulate in combustion stack gases.

The total mass controlled and uncontrolled emission factors for metallurgical coke manufacturing are presented in Table 1. The size-specific controlled and uncontrolled emission factors are presented in Table 2.

Table 1. *Emission Factors For Coke Manufacturing*[a]

Operation	Particulate emission factor rating	Particulates kg/Mg	Particulates lb/ton
Coal Crushing with Cyclone	D	0.055	0.11
Coal Preheating			
Uncontrolled	C	1.75	3.50
With Venturi Scrubber	C	0.125	0.25
With Wet ESP	C	0.006	0.012
Wet Coal Charging[b]			
Larry Car (Uncontrolled)	E	0.24	0.48
Larry Car with Sequential Charging	E	0.008	0.016
Larry Car with Scrubber	E	0.007	0.014
Door Leaks (Uncontrolled)	D	0.27	0.54
Coke Pushing			
Uncontrolled	B	0.58	1.15
With ESP[c]	C	0.225	0.45
With Venturi Scrubber[d]	D	0.09	0.18
With Baghouse[d]	D	0.045	0.09
With Mobile Scrubber Car[e]	C	0.036	0.072
Quenching			
Uncontrolled (Dirty Water)[f]	D	2.62	5.24
Uncontrolled (Clean Water)[g]	D	0.57	1.13
With Baffles (Dirty Water)[f]	B	0.65	1.30
With Baffles (Clean Water)[g]	B	0.27	0.54
Combustion Stacks			
Uncontrolled (COG)	A	0.234	0.47
Uncontrolled (BFG)	A	0.085	0.17
With ESP (COG)	D	0.046	0.091
With Baghouse (COG)	D	0.055	0.11
Coke Handling with Cyclone[h]	D	0.003	0.006

[a] *Emission factors expressed as units per weight of coal charged.*
[b] *Charged coal has not been dried.*
[c] *Emissions captured by coke side shed.*
[d] *Emissions captured by traveling hood.*
[e] *Emissions captured by quench car enclosure.*
[f] *Dirty water > 5000 mg/L total dissolved solids.*
[g] *Clean water < 1500 mg/L total dissolved solids.*
[h] *Handling defined as crushing and screening.*

Table 2. Size Specific Emission Factors For Coke Manufacturing

Process	Particulate emission factor rating	Particle size (μm)	Cumulative mass % ≤ stated size	Cumulative mass emission factors	
				kg/Mg	lb/ton
Coal Preheating, Uncontrolled	D	0.5	44	0.8	1.5
		1.0	48.5	0.8	1.7
		2.0	55	1.0	1.9
		2.5	59.5	1.0	2.1
		5.0	79.5	1.4	2.8
		10.0	97.5	1.7	3.4
		15.0	99.9	1.7	3.5
			100	1.7	3.5
Controlled with Venturi Scrubber	D	0.5	78	0.10	0.20
		1.0	80	0.10	0.20
		2.0	83	0.10	0.21
		2.5	84	0.11	0.21
		5.0	88	0.11	0.22
		10.0	94	0.12	0.24
		15.0	96.5	0.12	0.24
			100	0.12	0.25
Coal Charging, Sequential or Staged	E	0.5	13.5	0.001	0.002
		1.0	25.2	0.002	0.004
		2.0	33.6	0.003	0.005
		2.5	39.1	0.003	0.006
		5.0	45.8	0.004	0.007
		10.0	48.9	0.004	0.008
		15.0	49.0	0.004	0.008
			100	0.008	0.016
Coke Pushing, Uncontrolled	D	0.5	3.1	0.02	0.04
		1.0	7.7	0.04	0.09
		2.0	14.8	0.09	0.17
		2.5	16.7	0.10	0.19
		5.0	26.6	0.15	0.30
		10.0	43.3	0.25	0.50
		15.0	50.0	0.29	0.58
			100	0.58	1.15
Controlled with Venturi Scrubber	D	0.5	24	0.02	0.04
		1.0	47	0.04	0.08
		2.0	66.5	0.06	0.12
		2.5	73.5	0.07	0.13
		5.0	75	0.07	0.13
		10.0	87	0.08	0.16
		15.0	92	0.08	0.17
			100	0.09	0.18
Mobile Scrubber Car	D	1.0	28.0	0.010	0.020
		2.0	29.5	0.011	0.021
		2.5	30.0	0.011	0.022
		5.0	30.0	0.011	0.022
		10.0	32.0	0.012	0.024
		15.0	35.0	0.013	0.023
			100	0.036	0.072
Quenching Uncontrolled (Dirty Water)	D	1.0	13.8	0.36	0.72
		2.5	19.3	0.51	1.01
		5.0	21.4	0.56	1.12
		10.0	22.8	0.60	1.19
		15.0	26.4	0.69	1.38
			100	2.62	5.24
Uncontrolled (Clean Water)	B	1.0	4.0	0.02	0.05
		2.5	11.1	0.06	0.13
		5.0	19.1	0.11	0.22
		10.0	30.1	0.17	0.34

Table 2. *(continued)*

Process	Particulate emission factor rating	Particle size (μm)	Cumulative mass % ≤ stated size	Cumulative mass emission factors	
				kg/Mg	lb/ton
		15.0	37.4	0.21	0.42
			100	0.57	1.13
With Baffles (Dirty Water)	D	1.0	8.5	0.06	0.11
		2.5	20.4	0.13	0.27
		5.0	24.8	0.16	0.32
		10.0	32.3	0.21	0.42
		15.0	49.8	0.32	0.65
			100	0.65	1.30
With Baffles (Clean Water)	D	1.0	1.2	0.003	0.006
		2.5	6.0	0.02	0.03
		5.0	7.0	0.02	0.04
		10.0	9.8	0.03	0.05
		15.0	15.1	0.04	0.08
			100	0.27	0.54
Combustion Stack, Uncontrolled	D	1.0	77.4	0.18	0.36
		2.0	85.7	0.20	0.40
		2.5	93.5	0.22	0.44
		5.0	95.8	0.22	0.45
		10.0	95.9	0.22	0.45
		15.0	96	0.22	0.45
			100	0.23	0.47

John Fitzgerald, John Jeffery, and Paul Wolf are with GCA/Technology Division, Bedford, MA 01730.
***Dale L. Harmon** is the EPA Project Officer (see below).*
The complete report, entitled "Metallurgical Coke Industry Particulate Emissions: Source Category Report," (Order No. PB 87-140 331/AS; Cost: $13.95, subject to change) will be available only from:
National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
Telephone: 703-487-4650
The EPA Project Officer can be contacted at:
Air and Energy Engineering Research Laboratory
U.S. Environmental Protection Agency
Research Triangle Park, NC 27711

United States
Environmental Protection
Agency

Center for Environmental Research
Information
Cincinnati OH 45268

Official Business
Penalty for Private Use $300
EPA/600/S7-86/050