12.2 Coke Production

12.2.1 General

Metallurgical coke is produced by destructive distillation of coal in coke ovens. Prepared coal is "coked", or heated in an oxygen-free atmosphere until all volatile components in the coal evaporate. The material remaining is called coke.

Most metallurgical coke is used in iron and steel industry processes such as blast furnaces, sinter plants, and foundries to reduce iron ore to iron. Over 90 percent of the total metallurgical coke production is dedicated to blast furnace operations.

Most coke plants are co-located with iron and steel production facilities. Coke demand is dependent on the iron and steel industry. This represents a continuing decline from the about 40 plants that were operating in 1987.

12.2.2 Process Description[1,2]

All metallurgical coke is produced using the "byproduct" method. Destructive distillation ("coking") of coal occurs in coke ovens without contact with air. Most U. S. coke plants use the Kopper-Becker byproduct oven. These ovens must remain airtight under the cyclic stress of expansion and contraction. Each oven has 3 main parts: coking chambers, heating chambers, and regenerative chambers. All of the chambers are lined with refractory (silica) brick. The coking chamber has ports in the top for charging of the coal.

A coke oven battery is a series of 10 to 100 coke ovens operated together. Figure 12.2-1 illustrates a byproduct coke oven battery. Each oven holds between 9 to 32 megagrams (Mg) (10 to 35 tons) of coal. Offtake flues on either end remove gases produced. Process heat comes from the combustion of gases between the coke chambers. Individual coke ovens operate intermittently, with run times of each oven coordinated to ensure a consistent flow of collectible gas. Approximately 40 percent of cleaned oven gas (after the removal of its byproducts) is used to heat the coke ovens. The rest is either used in other production processes related to steel production or sold. Coke oven gas is the most common fuel for underfiring coke ovens.

A typical coke manufacturing process is shown schematically in Figure 12.2-2. Coke manufacturing includes preparing, charging, and heating the coal; removing and cooling the coke product; and cooling, cleaning, and recycling the oven gas.

Coal is prepared for coking by pulverizing so that 80 to 90 percent passes through a 3.2 millimeter (1/8 inch) screen. Several types of coal may be blended to produce the desired properties, or to control the expansion of the coal mixture in the oven. Water or oil may be added to adjust the density of the coal to control expansion and prevent damage to the oven.

Coal may be added to the ovens in either a dry or wet state. Prepared wet coal is finely crushed before charging to the oven. Flash-dried coal may be transported directly to the ovens by the hot gases used for moisture removal. Wall temperatures should stay above 1100°C (2000°F) during loading operations and actual coking. The ports are closed after charging and sealed with luting ("mud") material.

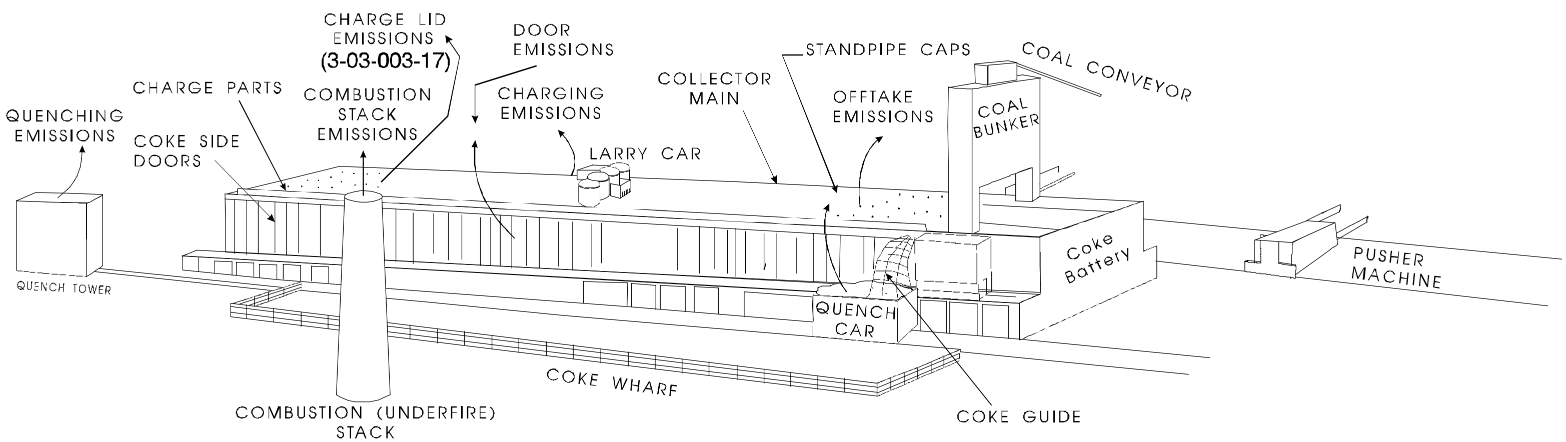

Figure 12.2-1. Byproduct coke oven battery showing major emission points. (Source Classification Codes in parentheses.)

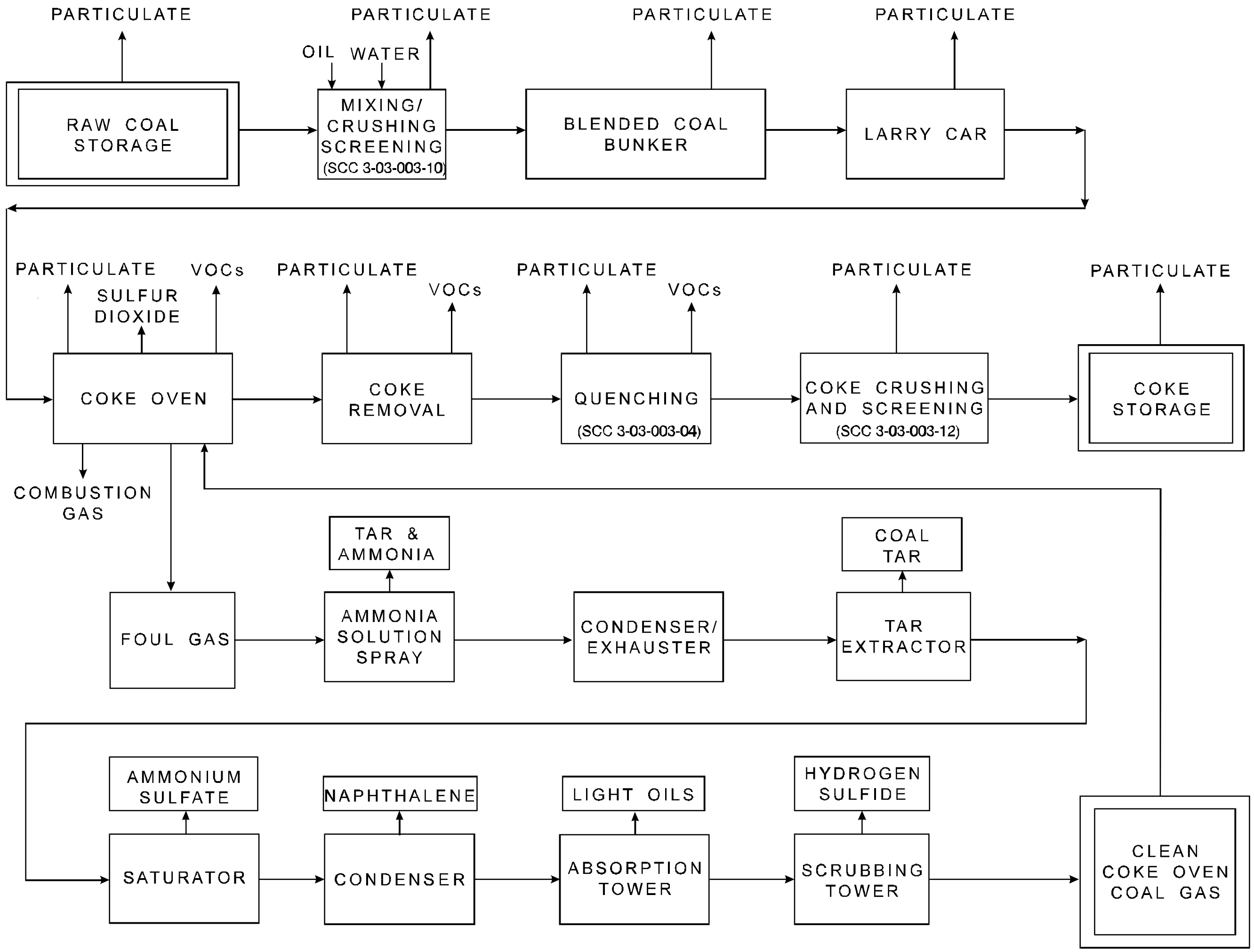

Figure 12.2-2. Flow diagram of coke manufacturing. VOC = volatile organic compound. (Source Classification Codes in parentheses.)

The blended coal mass is heated for 12 to 20 hours for metallurgical coke. Thermal energy from the walls of the coke chamber heats the coal mass by conduction from the sides to the middle of the coke chamber. During the coking process, the charge is in direct contact with the heated wall surfaces and develops into an aggregate "plastic zone". As additional thermal energy is absorbed, the plastic zone thickens and merges toward the middle of the charge. Volatile gases escape in front of the developing zone due to heat progression from the side walls. The maximum temperature attained at the center of the coke mass is usually 1100 to 1150°C (2000 to 2100°F). This distills all volatile matter from the coal mass and forms a high-quality metallurgical coke.

After coking is completed (no volatiles remain), the coke in the chamber is ready to be removed. Doors on both sides of the chamber are opened and a ram is inserted into the chamber. The coke is pushed out of the oven in less than 1 minute, through the coke guide and into a quench car. After the coke is pushed from the oven, the doors are cleaned and repositioned. The oven is then ready to receive another charge of coal.

The quench car carrying the hot coke moves along the battery tracks to a quench tower where approximately 1130 liters (L) of water per Mg of coke (270 gallons of water per ton) are sprayed onto the coke mass to cool it from about 1100 to 80°C (2000 to 180°F) and to prevent it from igniting. The quench car may rely on a movable hood to collect particulate emissions, or it may have a scrubber car attached. The car then discharges the coke onto a wharf to drain and continue cooling. Gates on the wharf are opened to allow the coke to fall onto a conveyor that carries it to the crushing and screening station. After sizing, coke is sent to the blast furnace or to storage.

The primary purpose of modern coke ovens is the production of quality coke for the iron and steel industry. The recovery of coal chemicals is an economical necessity, as they equal approximately 35 percent of the value of the coal.

To produce quality metallurgical coke, a high-temperature carbonization process is used. High-temperature carbonization, which takes place above 900°C (1650°F), involves chemical conversion of coal into a mostly gaseous product. Gaseous products from high-temperature carbonization consist of hydrogen, methane, ethylene, carbon monoxide, carbon dioxide, hydrogen sulfide, ammonia, and nitrogen. Liquid products include water, tar, and crude light oil. The coking process produces approximately 338,000 L of coke oven gas (COG) per megagram of coal charged (10,800 standard cubic feet of COG per ton).

During the coking cycle, volatile matter driven from the coal mass passes upward through cast iron "goosenecks" into a common horizontal steel pipe (called the collecting main), which connects all the ovens in series. This unpurified "foul" gas contains water vapor, tar, light oils, solid particulate of coal dust, heavy hydrocarbons, and complex carbon compounds. The condensable materials are removed from the exhaust gas to obtain purified coke oven gas.

As it leaves the coke chamber, coke oven coal gas is initially cleaned with a weak ammonia spray, which condenses some tar and ammonia from the gas. This liquid condensate flows down the collecting main until it reaches a settling tank. Collected ammonia is used in the weak ammonia spray, while the rest is pumped to an ammonia still. Collected coal tar is pumped to a storage tank and sold to tar distillers, or used as fuel.

The remaining gas is cooled as it passes through a condenser and then compressed by an exhauster. Any remaining coal tar is removed by a tar extractor, either by impingement against a metal surface or collection by an electrostatic precipitator (ESP). The gas still contains 75 percent of original ammonia and 95 percent of the original light oils. Ammonia is removed by passing the gas through a saturator containing a 5 to 10 percent solution of sulfuric acid. In the saturator, ammonia reacts with sulfuric acid to form ammonium sulfate. Ammonium sulfate is then crystallized and removed. The gas is further cooled, resulting in the condensation of naphthalene. The light oils are removed in an absorption tower containing water mixed with "straw oil" (a heavy fraction of petroleum). Straw oil acts as an absorbent for the light oils, and is later heated to release the light oils for recovery and refinement. The last cleaning step is the removal of hydrogen sulfide from the gas. This is normally done in a scrubbing tower containing a solution of ethanolamine (Girbotol), although several other methods have been used in the past. The clean coke oven coal gas is used as fuel for the coke ovens, other plant combustion processes, or sold.

12.2.3 Emissions And Controls

Particulate, VOCs, carbon monoxide and other emissions originate from several byproduct coking operations: (1) coal preparation, (2) coal preheating (if used), (3) coal charging, (4) oven leakage during the coking period, (5) coke removal, (6) hot coke quenching and (7) underfire combustion stacks. Gaseous emissions collected from the ovens during the coking process are subjected to various operations for separating ammonia, coke oven gas, tar, phenol, light oils (benzene, toluene, xylene), and pyridine. These unit operations are potential sources of VOC emissions. Small emissions may occur when transferring coal between conveyors or from conveyors to bunkers. Figure 12.2-2 portrays major emission points from a typical coke oven battery.

The emission factors available for coking operations for total particulate, sulfur dioxide, carbon monoxide, VOCs, nitrogen oxides, and ammonia are given in Tables 12.2-1 and 12.2-2. Tables 12.2-3 and 12.2-4 give size-specific emission factors for coking operations.

A few domestic plants preheat the coal to about 260°C (500°F) before charging, using a flash drying column heated by the combustion of coke oven gas or by natural gas. The air stream that conveys coal through the drying column usually passes through conventional wet scrubbers for particulate removal before discharging to the atmosphere. Leaks occasionally occur from charge lids and oven doors during pipeline charging due to the positive pressure. Emissions from the other methods are similar to conventional wet charging.

Oven charging can produce significant emissions of particulate matter and VOCs from coal decomposition if not properly controlled. Charging techniques can draw most charging emissions into the battery collecting main. Effective control requires that goosenecks and the collecting main passages be cleaned frequently to prevent obstructions.

During the coking cycle, VOC emissions from the thermal distillation process can occur through poorly sealed doors, charge lids, offtake caps, collecting main, and cracks that may develop in oven brickwork. Door leaks may be controlled by diligent door cleaning and maintenance, rebuilding doors, and, in some plants, by manual application of lute (seal) material. Charge lid and offtake leaks may be controlled by an effective patching and luting program. Pushing coke into the quench car is another major source of particulate emissions. If the coke mass is not fully coked, VOCs and combustion products will be emitted. Most facilities control pushing emissions by using mobile scrubber cars with hoods, shed enclosures evacuated to a gas cleaning device, or traveling hoods with a fixed duct leading to a stationary gas cleaner.

Coke quenching entrains particulate from the coke mass. In addition, dissolved solids from the quench water may become entrained in the steam plume rising from the tower. Trace organic compounds may also be present.

Table 12.2-1 (Metric Units). EMISSION FACTORS FOR COKE MANUFACTURING[a]

Type Of Operation	Particulate[b]	EMISSION FACTOR RATING	SO_2	EMISSION FACTOR RATING	CO[c]	EMISSION FACTOR RATING	VOC[c,d]	EMISSION FACTOR RATING	NO_x[c]	EMISSION FACTOR RATING	Ammonia[c]	EMISSION FACTOR RATING
Coal crushing (SCC 3-03-003-10)												
With cyclone	0.055	D	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Coal preheating (SCC 3-03-003-13)												
Uncontrolled[e]	1.75	C	ND	NA	ND	NA	ND	NA	ND	NA	ND	NA
With scrubber	0.125	C	ND	NA	ND	NA	ND	NA	ND	NA	ND	NA
With wet ESP	0.006	C	ND	NA	ND	NA	ND	NA	ND	NA	ND	NA
Oven charging[f] (larry car) (SCC 3-03-003-02)												
Uncontrolled	0.24	E	0.01	D	0.3	D	1.25	D	0.015	D	0.01	D
With sequential charging	0.008	E	ND	NA	ND	NA	ND	NA	ND	NA	ND	NA
With scrubber	0.007	E	ND	NA	ND	NA	ND	NA	ND	NA	ND	NA
Oven door leaks (SCC 3-03-003-08)												
Uncontrolled	0.27	D		D	0.3	D	0.75	D	0.005	D	0.03	D
Oven pushing (SCC 3-03-003-03)												
Uncontrolled	0.58	B	ND	NA	0.035	D	0.1	D	ND	NA	0.05	D
With ESP[g]	0.225	C	ND	NA	0.035	D	0.1	D	ND	NA	ND	NA
With venturi scrubber[h]	0.09	D	ND	NA	0.035	D	0.1	D	ND	NA	ND	NA
With baghouse[h]	0.045	D	ND	NA	0.035	D	0.1	D	ND	NA	ND	NA
With mobile scrubber car[j]	0.036	C	ND	NA	0.035	D	0.1	D	ND	NA	ND	NA
Quenching (SCC 3-03-003-04)												
Uncontrolled												
Dirty water[k]	2.62	D	NA	NA	ND	NA	ND	NA	NA	NA	ND	NA
Clean water[m]	0.57	D	NA	NA	ND	NA	ND	NA	NA	NA	ND	NA
With baffles												
Dirty water[k]	0.65	B	NA	NA	ND	NA	ND	NA	NA	NA	ND	NA
Clean water[m]	0.27	B	NA	NA	ND	NA	ND	NA	NA	NA	ND	NA

Table 12.2-1 (cont.).

Type Of Operation	Particulate[b]	EMISSION FACTOR RATING	SO_2	EMISSION FACTOR RATING	CO[c]	EMISSION FACTOR RATING	VOC[c,d]	EMISSION FACTOR RATING	NO_x[c]	EMISSION FACTOR RATING	Ammonia[c]	EMISSION FACTOR RATING
Combustion stack (SCC 3-03-003-17, for COG) (SCC 3-03-003-16, for BFG)												
Uncontrolled (raw COG)	0.234	A	2.0[n]	D	ND	NA	ND	NA	ND	NA	ND	NA
Uncontrolled (desulfurized COG)	0.234	A	0.14[p]	C	ND	NA	ND	NA	ND	NA	ND	NA
Uncontrolled (BFG)	0.085	A	0.54[q]	D	ND	NA	ND	NA	ND	NA	ND	NA
With ESP (BFG)	0.046	B	0.32[r]	C	ND	NA	ND	NA	ND	NA	ND	NA
With ESP (COG)	0.055	D	ND	NA	ND	NA	ND	NA	ND	NA	ND	NA
With baghouse (COG)	0.055	D	ND	NA	ND	NA	ND	NA	ND	NA	ND	NA
Coke handling (SCC 3-03-003-12)												
With cyclone[s]	0.003	D	ND	NA	ND	NA	NA	NA	NA	NA	NA	NA

[a] Emission Factors are expressed in kg of pollutant/Mg of coke produced. SCC = Source Classification Code. NA = not applicable. ND = no data. BFG = blast furnace gas.
[b] Reference 1.
[c] Reference 23.
[d] Expressed as methane.
[e] Exhaust gas discharged from series of primary and secondary cyclones used to separate flash-dried coal from hot gas.
[f] Charged coal has not been dried.
[g] Emissions captured by coke side shed.
[h] Emissions captured by travelling hood.
[j] Emissions captured by quench car enclosure.
[k] Dirty water ≥5000 Mg/L total dissolved solids.
[m] Clean water ≤1500 Mg/L total dissolved solids.
[n] Reference 4. Factor for SO_2 is based on these representative conditions: (1) sulfur content of coal charged to oven is 0.8 weight %; (2) about 33 weight % of total sulfur in coal charged to oven is transferred to coke oven gas; (3) about 40% of coke oven gas is burned during underfiring operation, and about 60% is used in other operations where the rest of the SO_2 (3 kilograms/megagrams [6 lb/ton] of coal charged) is discharged; (4) gas used in underfiring has not been desulfurized.
[p] Reference 21, desulfurized COG.
[q] Reference 22.
[r] Reference 23.
[s] Defined as crushing and screening.

Table 12.2-2 (English Units). EMISSION FACTORS FOR COKE MANUFACTURING[a]

Type Of Operation	Particulate[b]	EMISSION FACTOR RATING	SO_2	EMISSION FACTOR RATING	CO[c]	EMISSION FACTOR RATING	VOC[c,d]	EMISSION FACTOR RATING	NO_x[c]	EMISSION FACTOR RATING	Ammonia[c]	EMISSION FACTOR RATING
Coal crushing (SCC 3-03-003-10)												
With cyclone	0.11	D	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Coal preheating (SCC 3-03-003-13)												
Uncontrolled[e]	3.50	C	ND	NA	ND	NA	ND	NA	ND	NA	ND	NA
With scrubber	0.25	C	ND	NA	ND	NA	ND	NA	ND	NA	ND	NA
With wet ESP	0.012	C	ND	NA	ND	NA	ND	NA	ND	NA	ND	NA
Oven charging[f] (larry car) (SCC 3-03-003-02)												
Uncontrolled	0.48	E	0.02	D	0.6	D	2.5	D	0.03	D	0.02	D
With sequential charging	0.016	E	ND	NA	ND	NA	ND	NA	ND	NA	ND	NA
With scrubber	0.014	E	ND	NA	ND	NA	ND	NA	ND	NA	ND	NA
Oven door leaks (SCC 3-03-003-08)												
Uncontrolled	0.54	D	ND	D	0.6	D	1.50	D	0.01	D	0.06	D
Oven pushing (SCC 3-03-003-03)												
Uncontrolled	1.15	B	ND	NA	0.07	D	0.2	D	ND	NA	0.1	D
With ESP[g]	0.45	C	ND	NA	0.07	D	0.2	D	ND	NA	ND	NA
With venturi scrubber[h]	0.18	D	ND	NA	0.07	D	0.2	D	ND	NA	ND	NA
With baghouse[h]	0.09	D	ND	NA	0.07	D	0.2	D	ND	NA	ND	NA
With mobile scrubber car	0.072	C	ND	NA	0.07	D	0.2	D	ND	NA	ND	NA
Quenching[j] (SCC 3-03-003-04)												
Uncontrolled												
Dirty water[k]	5.24	D	NA	NA	ND	NA	ND	NA	NA	NA	ND	NA
Clean water[m]	1.13	D	NA	NA	ND	NA	ND	NA	NA	NA	ND	NA
With baffles												
Dirty water[k]	1.30	B	NA	NA	ND	NA	ND	NA	NA	NA	ND	NA
Clean water[m]	0.54	B	NA	NA	ND	NA	ND	NA	NA	NA	ND	NA

Table 12.2-2 (cont.).

Type Of Operation	Particulate[b]	EMISSION FACTOR RATING	SO_2	EMISSION FACTOR RATING	CO[c]	EMISSION FACTOR RATING	VOC[c,d]	EMISSION FACTOR RATING	NO_x[c]	EMISSION FACTOR RATING	Ammonia[c]	EMISSION FACTOR RATING
Combustion stack (SCC 3-03-003-17, for COG) (SCC 3-03-003-18, for BFG)												
Uncontrolled (raw COG)	0.47	A	4.0[n]	D	ND	NA	ND	NA	ND	NA	ND	NA
Uncontrolled (desulfurized COG)	0.47	A	0.28[p]	C	ND	NA	ND	NA	ND	NA	ND	NA
Uncontrolled (BFG)	0.17	A	1.08[q]	C	ND	NA	ND	NA	ND	NA	ND	NA
With ESP (BFG)	ND	B	0.64[r]	C	ND	NA	ND	NA	ND	NA	ND	NA
With ESP (COG)	0.091	D	ND	NA	ND	NA	ND	NA	ND	NA	ND	NA
With baghouse (COG)	0.11	D	ND	NA	ND	NA	ND	NA	ND	NA	ND	NA
Coke handling (SCC 3-03-003-12)												
With cyclone[s]	0.006	D	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

[a] Emission Factors are expressed in lb/ton of coke produced. SCC = Source Classification Code. NA = not applicable. ND = no data. BFG = blast furnace gas.
[b] Reference 1.
[c] References 23.
[d] Expressed as methane.
[e] Exhaust gas discharged from series of primary and secondary cyclones used to separate flash dried coal from hot gas.
[f] Charged coal has not been dried.
[g] Emissions captured by coke side shed.
[h] Emissions captured by travelling hood.
[j] Emissions captured by quench car enclosure.
[k] Dirty water ≥5000 mg/L total dissolved solids.
[m] Clean water ≤1500 mg/L total dissolved solids.
[n] Reference 4. Factor for SO_2 is based on these representative conditions: (1) sulfur content of coal charged to oven is 0.8 weight %; (2) about 33 weight % of total sulfur in coal charged to oven is transferred to coke oven gas; (3) about 40% of coke oven gas is burned during underfiring operation, and about 60% is used in other operations where the rest of the SO_2 (3 kilogram/megagram [6 pounds/ton] of coal charged) is discharged; (4) gas used in underfiring has not been desulfurized.
[p] Reference 21, desulfurized COG.
[q] Reference 22.
[r] Reference 23.
[s] Defined as crushing and screening.

Table 12.2-3. (Metric Units). SIZE-SPECIFIC EMISSION FACTORS FOR COKE MANUFACTURING[a]

EMISSION FACTOR RATING: D (except as noted)

Process	Particle Size (µm)[b]	Cumulative Mass % ≤ Stated Size	Cumulative Mass Emission Factors	Reference Source Number
Coal preheating (SCC 3-03-003-13)	0.5	44	0.8	8
Uncontrolled	1.0	48.5	0.8	
	2.0	55	1.0	
	2.5	59.5	1.0	
	5.0	79.5	1.4	
	10.0	97.5	1.7	
	15.0	99.9	1.7	
		100	1.7	
Controlled with venturi scrubber	0.5	78	0.10	8
	1.0	80	0.10	
	2.0	83	0.10	
	2.5	84	0.11	
	5.0	88	0.11	
	10.0	94	0.12	
	15.0	96.5	0.12	
		100	0.12	
Oven charging sequential or stage[c]	0.5	13.5	0.001	9
	1.0	25.2	0.002	
	2.0	33.6	0.003	
	2.5	39.1	0.003	
	5.0	45.8	0.004	
	10.0	48.9	0.004	
	15.0	49.0	0.004	
		100	0.008	
Coke pushing (SCC 3-03-003-03)	0.5	3.1	0.02	10 - 15
Uncontrolled	1.0	7.7	0.04	
	2.0	14.8	0.09	
	2.5	16.7	0.10	
	5.0	26.6	0.15	
	10.0	43.3	0.25	
	15.0	50.0	0.29	
		100	0.58	

Table 12.2-3 (cont.).

Process	Particle Size (µm)[b]	Cumulative Mass % ≤ Stated Size	Cumulative Mass Emission Factors	Reference Source Number
Controlled with venturi scrubber	0.5	24	0.02	10, 12
	1.0	47	0.04	
	2.0	66.5	0.06	
	2.5	73.5	0.07	
	5.0	75	0.07	
	10.0	87	0.08	
	15.0	92	0.08	
		100	0.09	
Mobile scrubber car	1.0	28.0	0.010	16
	2.0	29.5	0.011	
	2.5	30.0	0.011	
	5.0	30.0	0.011	
	10.0	32.0	0.012	
	15.0	35.0	0.013	
		100	0.036	
Quenching (SCC 3-03-003-04)				17
Uncontrolled (dirty water)	1.0	13.8	0.36	
	2.5	19.3	0.51	
	5.0	21.4	0.56	
	10.0	22.8	0.60	
	15.0	26.4	0.69	
		100	2.62	
Uncontrolled (clean water)	1.0	4.0	0.02	17
	2.5	11.1	0.06	
	5.0	19.1	0.11	
	10.0	30.1	0.17	
	15.0	37.4	0.21	
		100	0.57	
With baffles (dirty water)	1.0	8.5	0.06	17
	2.5	20.4	0.13	
	5.0	24.8	0.16	
	10.0	32.3	0.21	
	15.0	49.8	0.32	
		100	0.65	

Table 12.2-3 (cont.).

Process	Particle Size (μm)[b]	Cumulative Mass % ≤ Stated Size	Cumulative Mass Emission Factors	Reference Source Number
With baffles (clean water)	1.0	1.2	0.003	17
	2.5	6.0	0.02	
	5.0	7.0	0.02	
	10.0	9.8	0.03	
	15.0	15.1	0.04	
		100	0.27	
Combustion stack[d]				
Uncontrolled	1.0	77.4	0.18	18 - 20
	2.0	85.7	0.20	
	2.5	93.5	0.22	
	5.0	95.8	0.22	
	10.0	95.9	0.22	
	15.0	96	0.22	
		100	0.23	

[a] Emission factors are expressed in kg of pollutant/Mg of material processed.
[b] μm = micrometers
[c] EMISSION FACTOR RATING: E
[d] Material processed is coke.

Table 12.2-4. (English Units). SIZE-SPECIFIC EMISSION FACTORS FOR COKE MANUFACTURING[a]

EMISSION FACTOR RATING: D (except as noted)

Process	Particle Size (μm)[b]	Cumulative Mass % ≤ Stated Size	Cumulative Mass Emission Factors	Reference Source Number
Coal preheating (SCC 3-03-003-13)	0.5	44	0.8	8
Uncontrolled	1.0	48.5	0.8	
	2.0	55	1.0	
	2.5	59.5	1.0	
	5.0	79.5	1.4	
	10.0	97.5	1.7	
	15.0	99.9	1.7	
		100	1.7	
Controlled with venturi scrubber	0.5	78	0.10	8
	1.0	80	0.10	
	2.0	83	0.10	
	2.5	84	0.11	
	5.0	88	0.11	
	10.0	94	0.12	
	15.0	96.5	0.12	
		100	0.12	
Oven charging sequential or stage[c]	0.5	13.5	0.001	9
	1.0	25.2	0.002	
	2.0	33.6	0.003	
	2.5	39.1	0.003	
	5.0	45.8	0.004	
	10.0	48.9	0.004	
	15.0	49.0	0.004	
		100	0.008	
Coke pushing (SCC 3-03-003-03)	0.5	3.1	0.02	10 - 15
Uncontrolled	1.0	7.7	0.04	
	2.0	14.8	0.09	
	2.5	16.7	0.10	
	5.0	26.6	0.15	
	10.0	43.3	0.25	
	15.0	50.0	0.29	
		100	0.58	

Table 12.2-4 (cont.).

Process	Particle Size (µm)[b]	Cumulative Mass % ≤ Stated Size	Cumulative Mass Emission Factors	Reference Source Number
Controlled with venturi scrubber	0.5	24	0.02	10, 12
	1.0	47	0.04	
	2.0	66.5	0.06	
	2.5	73.5	0.07	
	5.0	75	0.07	
	10.0	87	0.08	
	15.0	92	0.08	
		100	0.09	
Mobile scrubber car	1.0	28.0	0.010	16
	2.0	29.5	0.011	
	2.5	30.0	0.011	
	5.0	30.0	0.011	
	10.0	32.0	0.012	
	15.0	35.0	0.013	
		100	0.036	
Quenching (SCC 3-03-003-04)				17
Uncontrolled (dirty water)	1.0	13.8	0.36	
	2.5	19.3	0.51	
	5.0	21.4	0.56	
	10.0	22.8	0.60	
	15.0	26.4	0.69	
		100	2.62	
Uncontrolled (clean water)	1.0	4.0	0.02	17
	2.5	11.1	0.06	
	5.0	19.1	0.11	
	10.0	30.1	0.17	
	15.0	37.4	0.21	
		100	0.57	
With baffles (dirty water)	1.0	8.5	0.06	17
	2.5	20.4	0.13	
	5.0	24.8	0.16	
	10.0	32.3	0.21	
	15.0	49.8	0.32	
		100	0.65	

Table 12.2-4 (cont.).

Process	Particle Size (µm)[b]	Cumulative Mass % ≤ Stated Size	Cumulative Mass Emission Factors	Reference Source Number
With baffles (clean water)	1.0	1.2	0.003	17
	2.5	6.0	0.02	
	5.0	7.0	0.02	
	10.0	9.8	0.03	
	15.0	15.1	0.04	
		100	0.27	
Combustion stack[d]				
Uncontrolled	1.0	77.4	0.18	18 - 20
	2.0	85.7	0.20	
	2.5	93.5	0.22	
	5.0	95.8	0.22	
	10.0	95.9	0.22	
	15.0	96	0.22	
		100	0.23	

[a] Emission factors are expressed in lb of pollutant/ton of material processed.
[b] µm = micrometers.
[c] EMISSION FACTOR RATING: E
[d] Material processed is coke.

Combustion of gas in the battery flues produces emissions from the underfire or combustion stack. Sulfur dioxide emissions may also occur if the coke oven gas is not desulfurized. Coal fines may leak into the waste combustion gases if the oven wall brickwork is damaged. Conventional gas cleaning equipment, including electrostatic precipitators and fabric filters, have been installed on battery combustion stacks.

Fugitive particulate emissions are associated with material handling operations. These operations consist of unloading, storing, grinding and sizing of coal, screening, crushing, storing, and unloading of coke.

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