Note: This is a reference cited in *AP 42, Compilation of Air Pollutant Emission Factors, Volume I Stationary Point and Area Sources.* AP42 is located on the EPA web site at www.epa.gov/ttn/chief/ap42/

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AP42 Section:	11.20
Reference:	1
Title:	Calciners And Dryers In Mineral Industries-Background Information For Proposed Standards, EPA-450/3-85-025a, U. S. Environmental Protection Agency, Research Triangle Park, NC, October 1985.

AP-42 Section 11.20 AP-42 Section
Reference 1 Reference
Report Sect. 2 Report Sect. 4
Reference 1 Reference 3

United States Environmental Protection Agency

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Calciners and Dryers in Mineral Industries—Background Information for Proposed Standards

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Calciners and Dryers in Mineral Industries— Background Information for Proposed Standards

Emission Standards and Engineering Division

U.S. ENVIRONMENTAL PROTECTION AGENCY
Office of Air and Radiation
Office of Air Quality Planning and Standards
Research Triangle Park, North Carolina 27711

October 1985

Coating-grade clays are those with all particles smaller than 15 μm (6×10^{-4} in.) and at least 70 percent of the particles less than 2 μm (8×10^{-5} in.). These clays also have 50 percent or more of the particles smaller than 1 μm (4×10^{-5} in.) in size. The extremely fine grades of coating clay currently being produced approach the range of 100 percent minus 2 μm (8×10^{-5} in.).[82]

3.2.10.4 Calcining. Because kaolin consists primarily of the mineral kaolinite, it is considered to be a fire clay. Low-temperature calcining produces a kaolin used for filler. High-temperature calcining produces a kaolin for use in the refractory industry. Section 3.2.6 (Fire clay) discusses kaolin use as a refractory material. Multiple hearth furnaces are the most common type of calciner; however, flash and rotary calciners are also used. Multiple hearth furnaces require less space and maintenance than flash calciners although they have a longer startup time.

3.2.11 Lightweight Aggregate

3.2.11.1 Background. The lightweight aggregate (LWA) industry encompasses the processing of clay-like materials into a low-density product. Lightweight aggregate is produced by calcining clay, shale, or slate. The raw materials used to produce LWA are chosen for their bloating properties when heated. When these materials are heated to temperatures of about 1000°C (1800°F), they become plastic and begin to flow like a viscous fluid.[90] As the plastic state is achieved, carbonaceous compounds in the material form gas bubbles, the material begins to expand, and the gas bubbles are trapped in the viscous plastic material. The material is then cooled in the expanded condition to form a porous, solid LWA. Substitutes for the more common raw materials in the production of LWA products are natural pumice and blast furnace slag.

Lightweight aggregate is used principally for the manufacture of structural concrete products such as concrete blocks and prestressed structural units. Concrete made with LWA has about the same strength and approximately two-thirds the weight of concrete made with natural aggregate. Other properties of concrete made with LWA, such as fire resistance and thermal and accoustical insulating qualities, make it

desirable as a building material. Lightweight aggregate is a substitute for more dense, naturally occurring aggregate (granite, limestone) and is used by companies that further process the material into other products. Other applications of LWA include accoustical plaster, roofing granules, highway surfacing, insulating fills, horticulture applications, and running tracks.[91] The end uses of LWA in 1980 were: concrete block (65 percent), structural concrete (25 percent), highway surfacing (6.5 percent), and other uses (3.5 percent).[92] Fine, medium, and coarse grades of LWA are available, ranging in diameter from dust to 3.8 cm (1.5 in.). Seven companies produce approximately 50 percent of the LWA processed in the United States. Typically, LWA cannot be economically shipped beyond approximately a 480-km (300-mi) radius of the production facility. Local demand for LWA may be greater in areas where natural aggregates are scarce.

The U.S. Bureau of Mines (BOM) categorizes the raw materials used to produce LWA as clays and stone. Clays are classified as kaolin, ball clay, fire clay, bentonite, fuller's earth, and common clay and shale. Approximately 11 percent of the clays mined in the U.S. in 1980 were used for the production of LWA.[91] Crushed slate is the only stone used in LWA production. Approximately 0.05 percent of the crushed stone mined in the U.S. in 1980 was used for the production of LWA.[91] Lightweight aggregate was produced at 34 plants in 24 States in 1981. The BOM estimated that consumption of clay and shale used in the production of LWA was 4.4 $x10^6$ Mg (4.9 $x10^6$ tons) in 1981, compared to 2.15 $x10^5$ Mg (2.4 $x10^5$ tons) of slate and 7.3 $x10^5$ Mg (8.0 $x10^5$ tons) of slag.[91]

Two methods are used to produce LWA. The rotary kiln method is used by approximately 88 percent (30 of 34) of the operating plants in the United States. The remaining 12 percent of the operating plants use the traveling-grate method, or process naturally occurring LWA. Because of the energy intensive nature of the traveling-grate process, no future growth in the use of this process for LWA production is anticipated.

3.2.11.2 Process Description.

3.2.11.2.1 General. The operations involved in producing LWA are quarrying or mining, crushing and screening, calcining or sintering, product cooling, and materials handling and storage. Figure 3-27 shows

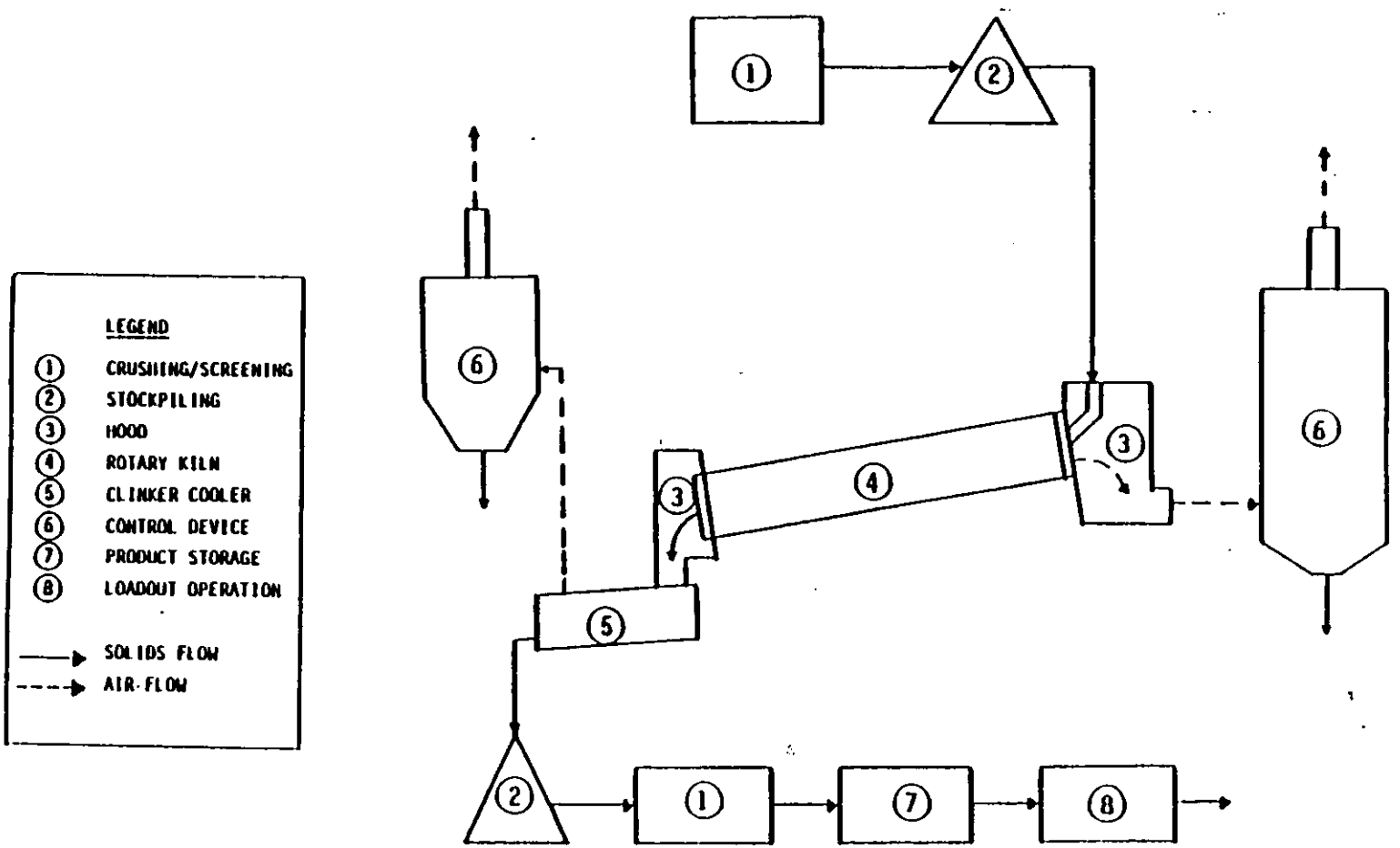


Figure 3-27. Schematic of a typical LWA plant.

a diagram of a typical LWA plant. Raw material is usually strip-mined from open fields by earth movers. Cone crushers, jaw crushers, hammermills, or pugmills are used to reduce the size of the raw material, which is then passed through screens. Any oversize material that does not pass through the screens initially may be returned to the crushers for secondary crushing. Material passing through the screens (about minus 3.8 cm [1.5 in.] in diameter) is transferred by conveyor belts to feed hoppers for charging to the calciner.

3.2.11.2.2 Rotary calciners. Rotary calciners are fired from the discharge end with fuel oil, natural gas, or coal. As the cost of fuel oil and natural gas increases, the trend is toward the use of pulverized coal. The burner used to fire the calciner is installed in the center of a fixed or movable calciner hood. The pilot flame of the burner is normally fueled by natural gas.

Rotary calciner production capacities range from 230 to 910 Mg (250 to 1,000 tons) per day per calciner.[90] Lightweight aggregate plants typically have two or three rotary calciners. One manufacturer of rotary calciners states that the smallest rotary calciner considered to be economical for LWA production in the U.S. is one that produces 450 Mg (500 tons) per day and that is approximately 3.4 m (11 ft) in diameter and 50 m (175 ft) long.[93]

Normal feed sizes range from 2.4 mm (8 mesh) to 33 mm (1.5 in.).[90] When the clay, shale, or slate is not closely screened, segregation of the various size chunks of raw material occurs as the calciner rotates. This segregation of particles is avoided by some calciner operators who screen the feed material so that a narrow range of particle sizes is fed to the calciner.[92] The fines are calcined by direct solid-to-solid heat transfer from the calciner walls, and the larger (coarser) particles are calcined by solid-to-gas heat transfer from the hot gas. The intermediate-size particles are protected from the heat by the layers of fine and coarse particles and may not be completely calcined.

3.2.12 Magnesium Compounds

3.2.12.1 Background. Natural brine solutions, such as sea, lake, and wellwaters are the primary source of domestically produced magnesium compounds. Magnesium compounds are also produced from natural magnesite

period from 1978 through 1983. Recovery in the automotive and housing industry helped to boost kaolin sales in the last half of 1983 but the main source of improvement came from the paper industry. No significant new expansions were initiated in 1983. Capital investment was concentrated in streamlining existing operations, rather than in building new plants.

The average price in 1983 was $87.91/Mg ($79.76/ton), up slightly from the 1982 price of $85.33/Mg ($77.42/ton).

Exports of kaolin, as reported by the U.S. Department of Commerce, decreased 8 percent in 1982 to 1.18 $\times 10^6$ Mg (1.30 $\times 10^6$ tons) valued at $147 million, compared to a value of $156 million in 1981. Kaolin, including calcined material was exported to 68 countries. The major recipients were Japan (34 percent), Canada (15 percent), the Netherlands (14 percent), Italy (8 percent), and Mexico (5 percent).

Imports of kaolin decreased 31 percent in 1982 to 8,500 Mg (9,400 tons) valued at $800,000. The United Kingdom supplied about 94 percent and Canada supplied about 6 percent. The demand for kaolin is expected to increase from a 1982 base at an annual rate of 2 to 4 percent through 1990.

9.1.2.6 Lightweight Aggregate. Lightweight aggregate (LWA) is produced by sintering either flyash or claylike materials (i.e., clay, shale, or slate) to produce an expanded and relatively low-density product. Lightweight aggregate is used in concrete in place of sand, gravel, or stone. Other uses are roofing granules, acoustical plaster, insulating fills, and landscaping materials. Substitutes for the more common raw materials (clay, shale, and slate) in the production of LWA are perlite, vermiculite, natural pumice, and blast furnace slag.

Average annual production of lightweight aggregate during the 6-year period 1978 through 1983 was 4.6 $\times 10^6$ Mg (5.0 $\times 10^6$ tons). During this time production generally declined. Domestic production of LWA decreased 18 percent in 1982 to 3.6 $\times 10^6$ Mg (4.0 $\times 10^6$ tons) valued at $25 million, compared with 4.4 $\times 10^6$ Mg (4.9 $\times 10^6$ tons) valued at $31 million in 1981.[10]

There is no import or export of LWA because of the high transportation cost. Neither the raw materials nor the products can be shipped profitably beyond approximately a 485-km (300-mile) radius of a plant. Also, most countries have local deposits of clays and/or shales that are adequate for manufacturing structural clay products, cement clinker, and LWA, and thus they have no need to import such materials.

A typical LWA production facility obtains raw material from mining/quarrying sites located near the plant. The LWA produced is sold to companies that further process the aggregate into other products, therefore most plants are not vertically integrated operations. Only one company (Solite Corporation) is known to use its aggregate in the production of end products. Other companies may do so to a lesser extent.

In 1978, the predominant end use of LWA according to the U.S. Bureau of Mines was concrete block products, utilizing over 60 percent of LWA production. The next major use was in structural concrete, followed by highway surfacing.

The LWA industry faces varying degrees of competition from several substitutes, including construction sand and gravel, crushed stone, pumice, and to a lesser degree perlite and vermiculite. Some of these are closer substitutes than others, depending on the end product application. Thus, LWA, crushed stone, pumice, perlite and the others are not perfect substitutes competing "head-to-head" with each other in every application. But, to varying degrees, there are substitutes available for LWA, and these must be considered in any economic analysis. For example, in end uses where weight savings are important, such as in bridge deckings and high-rise buildings, lightweight aggregate has a significant competitve advantage.

Capacity expansions at existing plants, construction of new plants and merger activity all slowed during 1982. The construction industry, which is the largest consumer of heavy clay products, has experienced a slow rebound in growth in recent years.

The demand for LWA products is tied directly to the availability and cost of transportation and raw materials connected with the building and construction industries. The fluctuations in these industries, together with the availability of substitute products, makes it difficult to forecast growth in the LWA industry.

9.1.3 Diatomite

The major processed diatomite products are powders and aggregates of variable sizes and grades that are uncalcined (natural), straight-calcined, or flux-calcined. All domestic commercial diatomite originates in the Western States, but the major markets are in the East. Because the majority of diatomite powders are packaged in 23-kg (50-lb) bags, transportation costs are a substantial portion of the total cost.

The United States is the world's largest diatomite producer, followed by the U.S.S.R. and France.[11] Total value of sales declined in 1982 to $108 million, compared with $113 million in 1981. However, production increased in 1983 to 0.57 $x10^6$ Mg (0.63 $x10^6$ tons), compared to 0.56 $x10^6$ Mg (0.61 $x10^6$ tons) in 1982. Average annual production during the 6-year period from 1978 through 1983 was 0.60 $x10^6$ Mg (0.66 $x10^6$ tons). Prices increased during this period, reaching $215/Mg ($195/ton) in 1983.[12]

Principal uses of diatomite have not changed over the years with the majority (68 percent) used in filtration media, and the remaining 32 percent used in industrial fillers, insulation, and other uses.

Exports of diatomite reached a peak in 1980, and declined in 1981 and 1982. In 1982, exports declined 13 percent to 0.13 $x10^6$ Mg (0.14 $x10^6$ tons), compared with 0.15 $x10^6$ Mg (0.16 $x10^6$ tons) in 1981. The quantity of diatomite exported in 1982 represented 23 percent of U.S. production, which has changed very little in recent years. Exports increased slightly in 1983 to 0.13 $x10^6$ Mg (0.15 $x10^6$ tons). Imports of diatomite, which are relatively small, declined in 1982 to 229 Mg (252 tons), compared with 349 Mg (385 tons) in 1981.

outlet of the fabric filter controlling emissions from a spray dryer. The dryer operated at 83 percent of design capacity during the tests. The design air-to-cloth ratio for the fabric filter is 3.8:1, and the design pressure drop across the unit is 1.5 kPa (6 in. w.c.). The report noted that isokinetic sampling ratios were 100 percent ±10 percent. Individual isokinetic ratios were not reported for each run. No process upsets were noted in the report.

C.1.10.4 Plant J4--Industry Test. Figure C-18 is a schematic of the system tested. Particulate emission tests were conducted on a shaker-type fabric filter controlling emissions from a spray dryer. The dryer operated at 104 percent of maximum capacity during the tests and was fired by natural gas. Actual baghouse operating parameters were not reported. Design parameters for the fabric filter include an inlet gas flow rate of 39.18 m^3/s (83,000 acfm), a total cloth area of 4,459 m^2 (48,000 ft^2), and an air-to-cloth ratio of 1.7:1. No process upsets were noted in the test report.

C.1.11 Lightweight Aggregate

C.1.11.1 Plant K1--EPA Test. Figure C-20 is a schematic of the system tested. Particulate emission tests were conducted on the inlet and outlet of a medium-energy wet scrubber controlling emissions from a rotary calciner at Plant K1. Other tests included sulfur dioxide, nitrogen oxide, and hydrocarbon emissions (outlet only) and particle size distribution (inlet and outlet). Visible emission observations were made at the scrubber stack, and fugitive emission observations were made at the calciner seals.

The rotary calciner operated at 83 percent of design capacity during the tests and was fired by pulverized coal. No instrumentation was present at the test site to indicate water flow rate to the wet scrubber or the inlet and outlet gas flow rates, temperatures, or pressure drop. The design pressure drop is 1.5 kPa (6 in. w.c.). The 6-minute average opacities at the scrubber stack ranged from 0 to 3.8 percent. All process fugitive emission observations were zero percent opacity. No process upsets were reported.

C.1.11.2 Plant K2--EPA Test. Figure C-20 is a schematic of the system tested. Emission tests were conducted on a rotary calciner at

Plant K2 that was controlled by a wet scrubber. The production rate during the test was kept constant at 83 percent of design capacity. The calciner was fired with pulverized coal. No instrumentation was present at the plant to measure the scrubber pressure drop, inlet and outlet gas flow rates and temperatures, or liquid flow rates.

Particulate and particle size tests were conducted simultaneously at the scrubber inlet and outlet test locations. The first set of particulate tests at the scrubber inlet was voided due to an excessive post-test leak and loss of sample during the recovery phase. These data were not included in the report. The scrubber mist eliminator was not functional during testing; therefore, outlet data are not representative of normal scrubber performance and are not included.

Three particle size distribution samples were collected at the scrubber inlet. Tests for sulfur dioxide were conducted simultaneously at the scrubber inlet and outlet test locations, and tests for nitrogen dioxide and hydrocarbon contents in the scrubber exhaust gas were performed concurrent with the SO_2 tests. Visible emission observations and SO_2 tests performed at the scrubber outlet are not representative due to the faulty mist eliminator. Fugitive emission observations were made at the calciner feed inlet and at the calciner seals. The 6-minute average opacities at the inlet ranged from 6.3 to 10.0 percent. All opacities were 0 percent at the calciner seals. The process operated normally for the duration of the tests.

C.1.11.3 Plant K3--Industry Test. Figure C-21 is a schematic of the systems tested. Particulate emission tests were conducted at the outlets of wet scrubbers controlling emissions from two rotary calciners at Plant K3. The calciners operated at 109 and 100 percent of design capacity, respectively, and were fired by pulverized coal. The pressure drop across each of the scrubbers was 3.5 kPa (14 in. w.c.). During the tests on one calciner, a multiple cyclone collector preceded the wet scrubber for product recovery. The cyclone collector was bypassed during the tests on the other calciner. Measurements of SO_2 concentration were also made at the multiple cyclone collector inlet. No process upsets were reported in the test reports.

C.1.11.4 Plant K4--Industry Test. Figure C-22 is a schematic of the system tested. Particulate emission tests were conducted at the outlet of a wet scrubber (gravity spray chamber) controlling emissions from a rotary calciner. The calciner operated at 92 percent of capacity during the tests and was fired by No. 2 fuel oil. Visible emission observations were made at the scrubber outlet after completion of the third particulate run and have not been tabulated. The design pressure drop for the wet scrubber is 0.5 kPa (2 in. w.c.). The pressure drop during the test was not reported. During the period of testing, the plant and all associated air pollution control equipment were operating normally.

C.1.11.5 Plant K5--Industry Test. Figure C-23 is a schematic of the system tested. Particulate emission tests were conducted at the inlet and outlet of a reverse-air fabric filter controlling emissions from a rotary calciner. The calciner operated at maximum capacity during the tests and was fueled by pulverized coal. Actual operating parameters for the fabric filter were not reported. Design parameters for the fabric filter include a total cloth area of 520 m^2 (5,600 ft^2), a pressure drop of 1.2 to 1.9 kPa (5 to 8 in. w.c.), and an air-to-cloth ratio of 5:1.

During Run No. 2, a malfunction of the coal mill caused a temporary shutdown of the system. Testing was resumed in about 2 minutes. No other process upsets were noted in the test report.

C.1.11.6 Plant K6--EPA Test. Emission tests were conducted on a medium-energy impinjet wet scrubber controlling emissions from a rotary calciner. The rotary calciner operated at 100 percent of design capacity and was fired with pulverized coal. Tests included particulate emissions, sulfur dioxide, nitrogen oxide, and hydrocarbon emissions, and trace metal content.

Some problems occurred during hydrocarbon sampling due to the high moisture content of the scrubber exhaust gas. Subsequently, only 1 hour of continuous hydrocarbon monitoring data was obtained. The hydrocarbon concentrations varied from 140 to 220 ppm with an average concentration of 175 ppm as methane. This average concentration corresponds to an emission rate of 4.2 kg/h (9.3 lb/h).

Visible emission observations were made at the scrubber exhaust stack, and fugitive emission observations were made at the calciner seals. The 6-minute average opacity measurements at the scrubber outlet ranged from 0 to 15 percent. All fugitive emission observations were 0 percent opacity.

No instrumentation was present at the test site to indicate the water flow rate, the inlet and outlet gas flow rates, or pressure drop for the wet scrubber. The design pressure drop across the wet scrubber is 2.5 kPa (10 in. w.c.). Process operations were normal.

C.1.12 Magnesium Compounds

C.1.12.1 Plant L1--Industry Test. Figure C-24 is a schematic of the system tested. Particulate emission tests were conducted at the outlet of a reverse-air fabric filter controlling emissions from a multiple hearth furnace. The furnace operated at 85 percent of capacity (based on process feed rates) during the test and was fired by No. 6 fuel oil. The report notes that opacity was observed by State testing personnel and that all opacity readings were 0 percent. The air-to-cloth ratio of the fabric filter during the tests was 1.4:1. Process operations were normal.

C.1.12.2 Plant L2--Industry Test. Figure C-25 is a schematic of the system tested. Particulate emission tests were conducted at the outlet of two ESP's in series controlling emissions from a rotary calciner. The calciner operated at 92 percent of capacity during the tests and was fired by natural gas. The combined specific collection area of the two ESP's was 1.8 m^2 per m^3/min (550 ft^3/1,000 acfm) during the tests. No process upsets were noted in the report.

C.1.12.3 Plant L3--Industry Test. Emission tests were conducted at the outlet of the wet scrubber controlling emissions from a rotary calciner. The scrubber was preceded by a product recovery cyclone. During the tests, pressure drop across the scrubber was 2.5 kPa (10 in. w.c.). The calciner operated at 95 percent of capacity during the tests and was fired by No. 6 fuel oil. No process upsets were noted in the test report.

C.1.12.4 Plant L4--Industry Test. Particulate emission tests were conducted at the outlet of an ESP controlling emissions from a rotary

TABLE C-79. SUMMARY OF EMISSION TEST RESULTS--PLANT K1
Industry: Lightweight aggregate
Process unit: Rotary calciner
Emission source: Scrubber inlet

Data	Run No. 1	Run No. 2	Run No. 3	Average for test series
General				
Date	7/14/81	7/15/81	7/15/81	--
Sampling time, minutes	120	120	120	--
Isokinetic ratio, percent	106	105	106	--
Production rate, Mg/h	26	26	26	26
(tons/h)	(29)	(29)	(29)	(29)
Capacity utilization, percent	83	83	83	83
Gas stream data				
Temperature, °C	415	413	422	417
(°F)	(779)	(775)	(792)	(782)
Moisture, percent	7.2	8.4	8.5	8.0
Flow rate, m^3/s	48	51	52	50
(acfm)	(101,000)	(107,000)	(109,000)	(106,000)
Flow rate, dsm^3/s	19	19	20	19
(dscfm)	(39,400)	(41,300)	(41,500)	(40,800)
Particulate emissions				
g/dsm^3	54.4	62.9	62.9	59.7
(gr/dscf)	(23.8)	(27.5)	(27.1)	(26.1)
kg/h	3,600	4,400	4,700	4,200
(lb/h)	(8,000)	(9,700)	(9,600)	(9,100)
kg/Mg	140	170	180	160
(lb/ton)	(280)	(340)	(330)	(320)

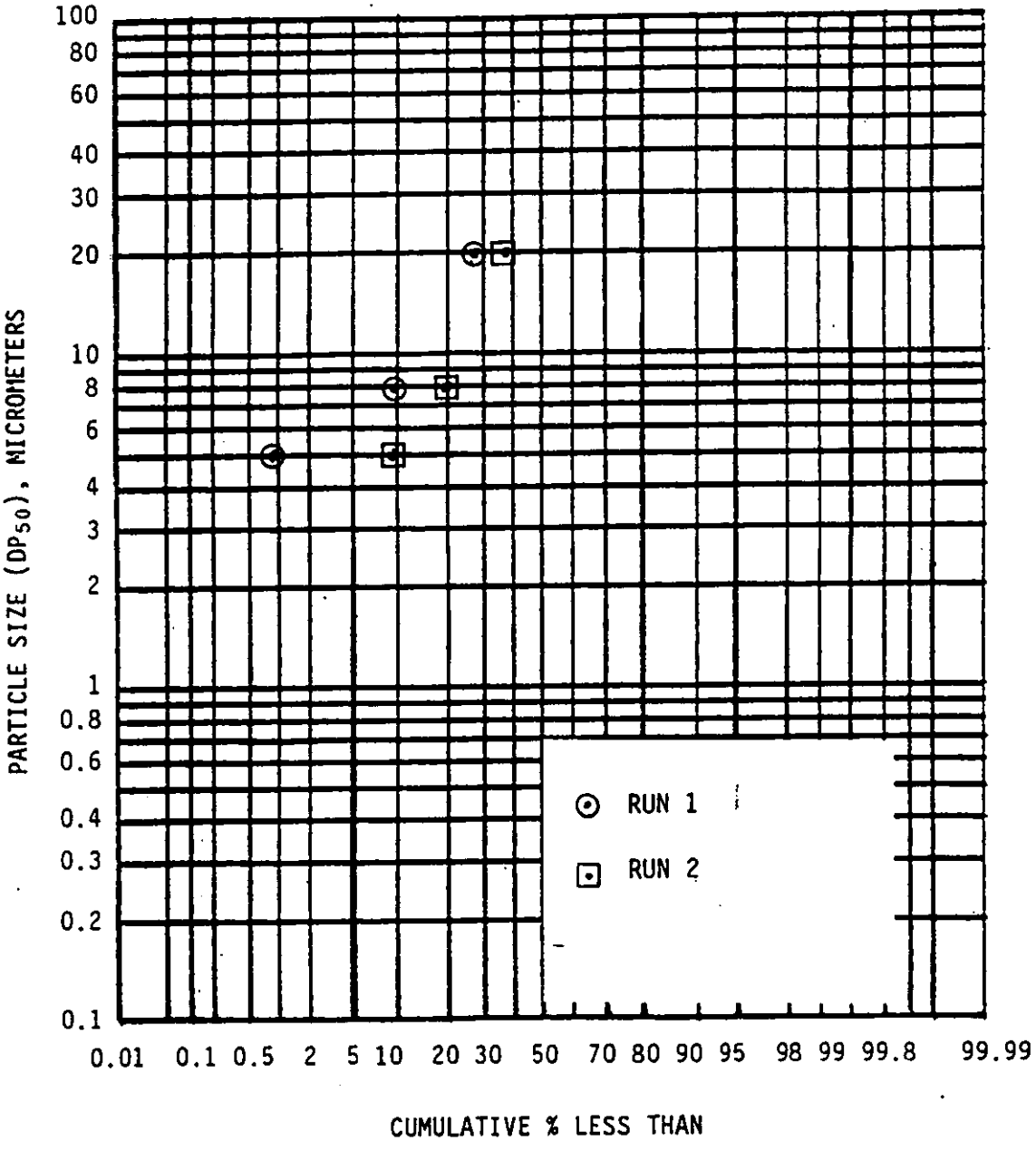


Figure C-54. Particle size distribution data: rotary calciner scrubber inlet--Plant K1.

TABLE C-80. SUMMARY OF EMISSION TEST RESULTS--PLANT K1
Industry: Lightweight aggregate
Process unit: Rotary calciner
Emission source: Scrubber outlet

Data	Run No. 1	Run No. 2	Run No. 3	Average for test series
General				
Date	7/14/81	7/15/81	7/15/81	
Sampling time, minutes	128	128	128	--
Isokinetic ratio, percent	104	103	105	--
Production rate, Mg/h (tons/h)	26 (29)	26 (29)	26 (29)	26 (29)
Capacity utilization, percent	83	83	83	83
Gas stream data				
Temperature, °C (°F)	65 (149)	63 (145)	65 (148)	64 (147)
Moisture, percent	21.2	21.4	22.1	21.6
Flow rate, m^3/s (acfm)	29 (61,100)	29 (62,400)	30 (63,200)	29 (62,300)
Flow rate, dsm^3/s (dscfm)	19 (41,200)	20 (42,100)	20 (42,000)	20 (41,800)
Particulate emissions				
g/dsm^3 (gr/dscf)	0.095 (0.041)	0.101 (0.044)	0.100 (0.044)	0.099 (0.043)
kg/h (lb/h)	6.6 (15)	7.2 (16)	7.2 (16)	7.0 (15)
kg/Mg (lb/ton)	0.25 (0.50)	0.28 (0.55)	0.28 (0.54)	0.27 (0.53)

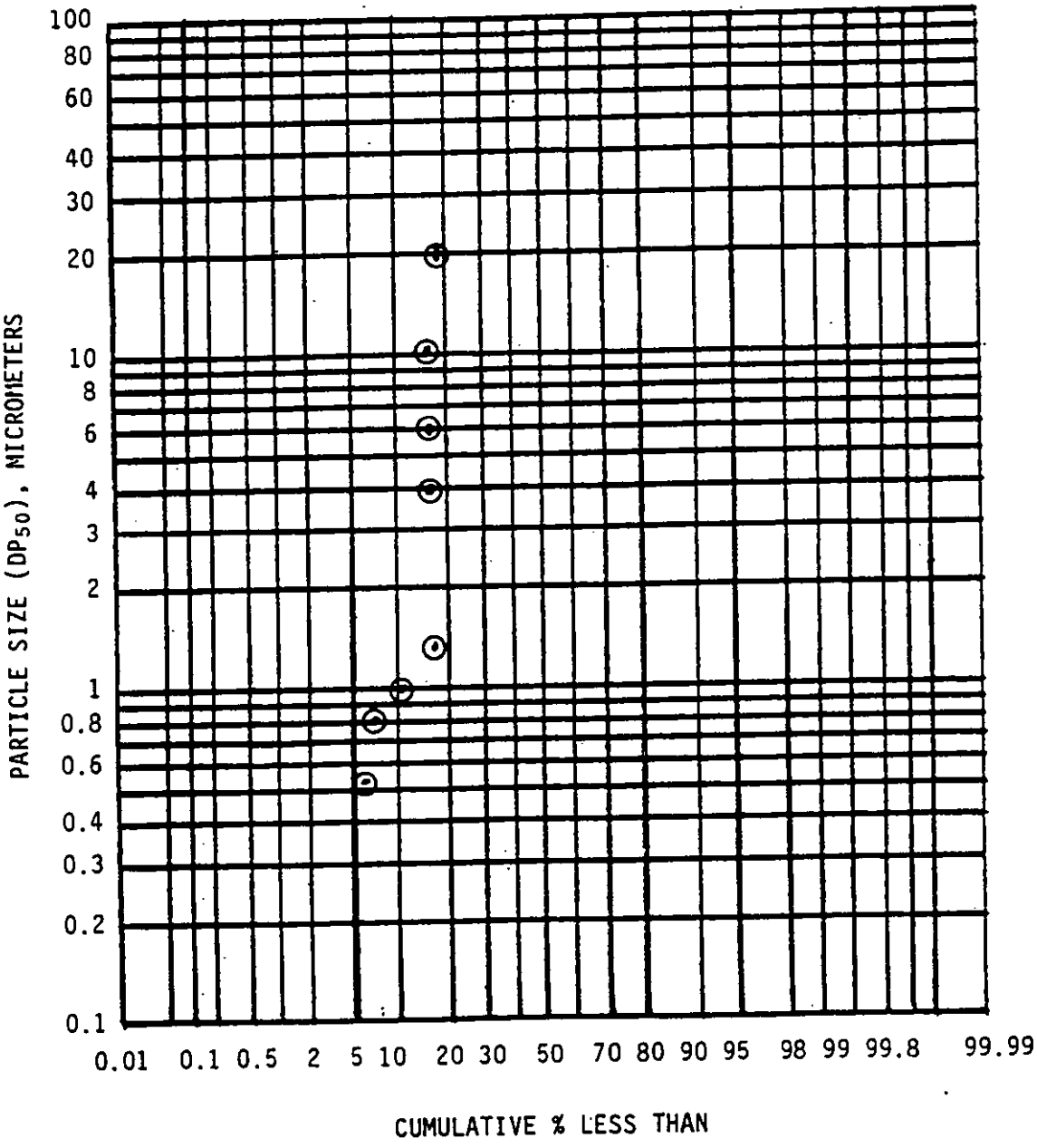


Figure C-55. Particle size distribution data: rotary calciner scrubber outlet (Run 4)--Plant K1.

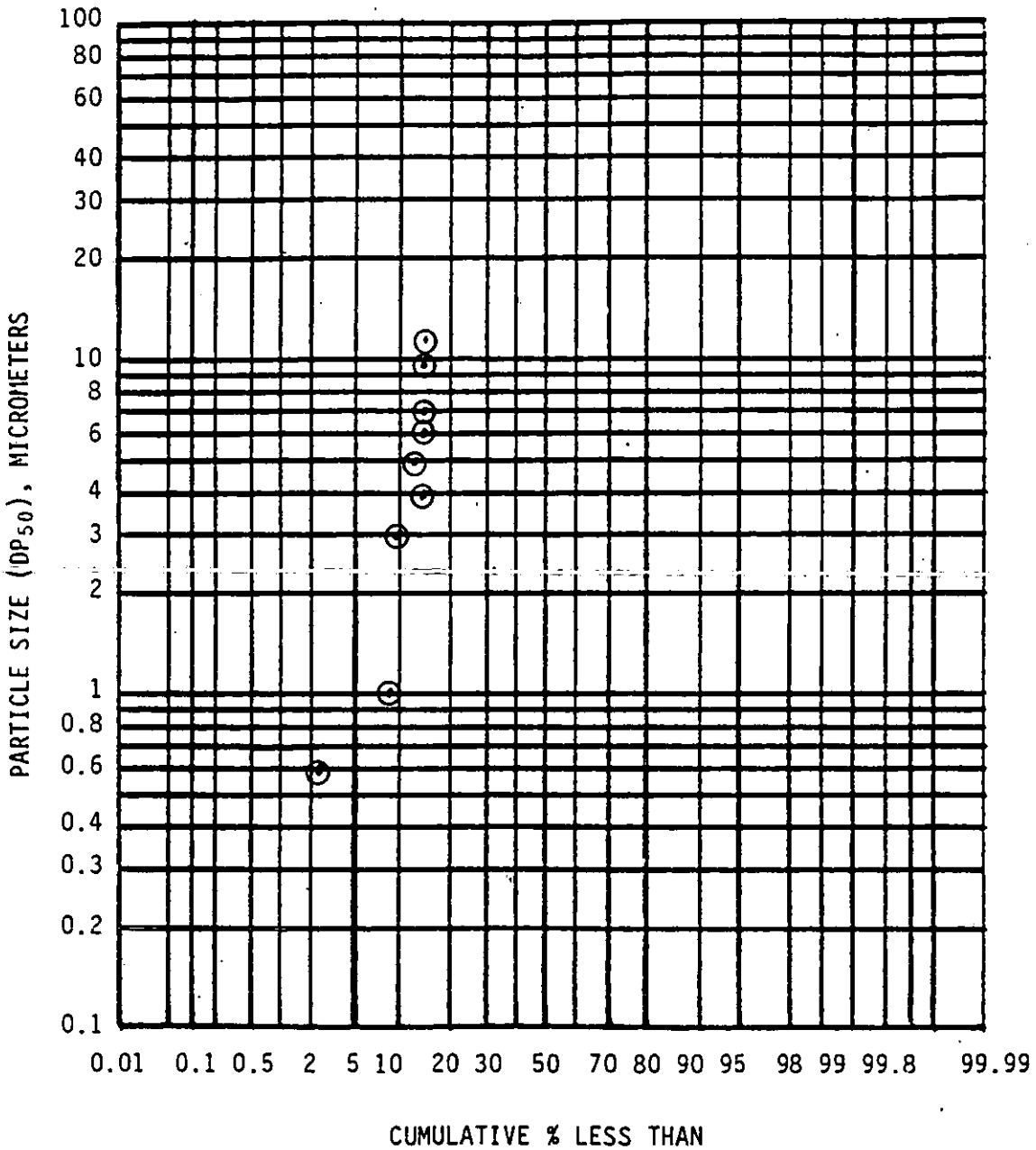


Figure C-56. Particle size distribution data: rotary calciner scrubber outlet (Run 5)--Plant K1.

TABLE C-81. SUMMARY OF VISIBLE EMISSIONS--PLANT K1

Date	7/14/81
Industry	Lightweight aggregate
Process unit	Rotary calciner
Location of discharge	Scrubber outlet
Height of observation point, ft	8
Height of point of discharge, ft	150
Distance from observer to discharge point, ft	400
Direction of observer from discharge point	E
Description of background	Sky
Description of sky	Scattered
Wind direction	NW
Wind velocity, mph	0-5
Color of plume	White
Duration of observation, min	90
Period of observation	1035-1129 1135-1153 1159-1229 1240-1310 1316-1334
Highest single reading, percent	5
Highest 6-minute average, percent	1.5

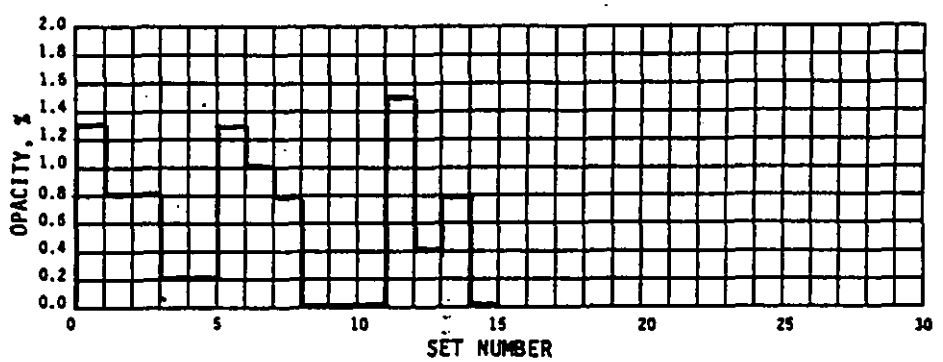


TABLE C-82. SUMMARY OF VISIBLE EMISSIONS--PLANT K1

Date	7/15/81
Industry	Lightweight aggregate
Process unit	Rotary calciner
Location of discharge	Scrubber outlet
Height of observation point, ft	8
Height of point of discharge, ft	150
Distance from observer to discharge point, ft	400
Direction of observer from discharge point	E
Description of background	Sky
Description of sky	Clear
Wind direction	NE
Wind velocity, mph	0-3
Color of plume	White
Duration of observation, min	84
Period of observation	0900-0954 1000-1054 1100-1142
Highest single reading, percent	5
Highest 6-minute average, percent	3.8

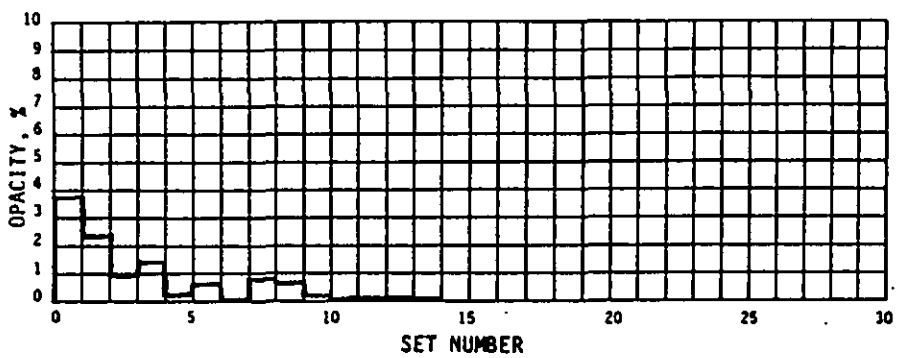


TABLE C-83. SUMMARY OF VISIBLE EMISSIONS--PLANT K1

Date	7/15/81
Industry	Lightweight aggregate
Process unit	Rotary calciner
Location of discharge	Scrubber outlet
Height of observation point, ft	10
Height of point of discharge, ft	150
Distance from observer to discharge point, ft	200
Direction of observer from discharge point	SE
Description of background	Sky
Description of sky	Scattered
Wind direction	S
Wind velocity, mph	0-5
Color of plume	White
Duration of observation, min	72
Period of observation	1355-1613[a]
Highest single reading, percent	5
Highest 6-minute average, percent	1.5

[a]12 sets of 6-minute observations were made during this period.

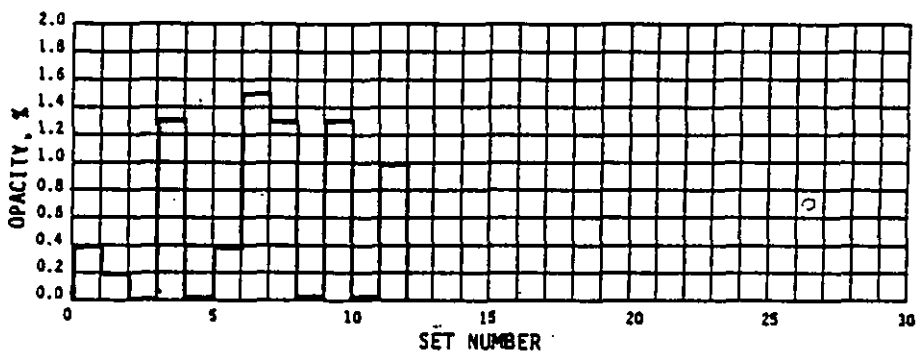


TABLE C-84. SUMMARY OF SULFUR DIOXIDE EMISSIONS DATA--PLANT K1
Industry: Lightweight aggregate
Process unit: Rotary calciner
Location of discharge: Scrubber inlet and outlet

Test location	Date, 1981	Concentration, g/dsm³ (ppm)	Mass emission rate, kg/h (lb/h)	Temp., °C (°F)
Scrubber inlet[a]				
Run No. 1	7/17	1.04 (390)	70.9 (156)	417 (782)
Run No. 2	7/17	1.76 (660)	120 (265)	417 (782)
Average	--	1.40 (525)	95.6 (211)	417 (982)
Run No. 3	7/17	1.67 (628)	114 (252)	417 (782)
Run No. 4	7/17	1.69 (635)	116 (255)	417 (782)
Average	--	1.68 (632)	115 (254)	417 (782)
Run No. 5	7/17	1.61 (603)	110 (242)	417 (782)
Run No. 6	7/17	1.69 (635)	116 (255)	417 (782)
Average	--	1.65 (619)	113 (248)	417 (782)
Scrubber outlet[b]				
Run No. 1	7/17	0.349 (131)	24.5 (54)	64 (147)
Run No. 2	7/17	0.508 (191)	35.7 (78.6)	64 (147)
Average	--	0.429 (161)	30.1 (66.3)	64 (147)
Run No. 3	7/17	0.421 (158)	29.6 (65.2)	64 (147)
Run No. 4	7/17	0.469 (176)	32.9 (72.6)	64 (147)
Average	--	0.445 (167)	31.3 (68.9)	64 (147)
Run No. 5	7/17	0.317 (119)	22.2 (48.9)	64 (147)
Run No. 6	7/17	0.218 (82)	15.2 (33.6)	64 (147)
Average	--	0.268 (101)	18.7 (41.3)	64 (147)

[a]Mass emission rates are based on the average stack gas flow rate determined during the inlet particulate tests (19.234 dsm³/s [40,755 dscfm].
[b]Mass emission rates are based on the average stack gas flow rate determined during the outlet particulate tests (19.721 dsm³/s [41,788 dscfm]).

TABLE C-85. SUMMARY OF NITROGEN OXIDE EMISSIONS DATA--PLANT K1

Industry: Lightweight aggregate
Process unit: Rotary calciner
Location of discharge: Scrubber outlet

Test location	Date, 1981	Concentration, g/dsm³ (ppm)	Mass emission rate, kg/h (lb/h)
Scrubber outlet[a]			
Sample No. 1A	7/17	0.358 (187)	25.4 (56.1)
Sample No. 1B	7/17	0.331 (173)	23.5 (51.8)
Sample No. 1C	7/17	0.365 (191)	26.0 (57.3)
Sample No. 1D	7/17	0.375 (196)	26.6 (58.7)
Average		0.357 (187)	25.4 (56.0)
Sample No. 2A	7/17	0.346 (181)	24.6 (54.2)
Sample No. 2B	7/17	0.365 (191)	25.9 (57.2)
Sample No. 2C	7/17	0.335 (175)	23.9 (52.6)
Sample No. 2D	7/17	0.377 (197)	26.8 (59.0)
Average	--	0.356 (186)	25.3 (55.8)
Sample No. 3A	7/17	0.337 (176)	23.9 (52.8)
Sample No. 3B	7/17	0.362 (189)	25.7 (56.6)
Sample No. 3C	7/17	0.365 (191)	25.9 (57.2)
Sample No. 3D	7/17	0.350 (183)	24.8 (54.7)
Average	--	0.354 (185)	25.1 (55.3)

[a]Mass emission rates are based on the average stack gas flow rate determined during the scrubber outlet particulate tests (19.721 dsm³/s [41,788 dscfm].

TABLE C-86. SUMMARY OF HYDROCARBON EMISSIONS--PLANT K1
Industry: Lightweight aggregate
Process unit: Rotary calciner
Emission source: Scrubber outlet

Test No.	Date, 1981	Sampling time, 24-h Start	Sampling time, 24-h Finish	NMO[a] concentration ppm as CH_4	Gas stream flow rate dscmh	Gas stream flow rate dscfh	Hydrocarbon emission rate expressed as methane[b] kg/h	Hydrocarbon emission rate expressed as methane[b] lb/h
SO-25-1	7/16	1500	1600	134	70,999	2,507,307	6.3	13.9
SO-25-2	7/16	1500	1600	231	70,999	2,507,307	10.9	24.0
SO-25-3	7/17	0905	1035	378	70,999	2,507,307	17.9	39.5
SO-25-4	7/17	1045	1200	128	70,999	2,507,307	6.0	13.2
Average				218	70,999	2,507,307	10.3	22.7

[a]NMO = nonmethane organics measured and expressed as methane (CH_4).
[b]Based on the molecular weight of methane, 16 g/g-mole (16 lb/lb-mole).

TABLE C-87. SUMMARY OF EMISSION TEST RESULTS--PLANT K2
Industry: Lightweight aggregate
Process unit: Rotary calciner
Emission source: Scrubber inlet

Data	Run No. 1	Run No. 2	Run No. 3	Average for test series
General				
Date	2/24/82	2/25/82	2/25/82	--
Sampling time, minutes	120	120	120	--
Isokinetic ratio, percent	106	106	105	--
Production rate, Mg/h	16.5	16.1	16.5	16.4
(tons/h)	(18.2)	(17.7)	(18.2)	(18.0)
Capacity utilization, percent	83	83	83	83
Gas stream data				
Temperature, °C	473	473	478	475
(°F)	(883)	(884)	(893)	(887)
Moisture, percent	5.9	6.7	6.7	6.4
Flow rate, m^3/s	31	33	33	32
(acfm)	(65,000)	(70,400)	(69,600)	(68,300)
Flow rate, dsm^3/s	11	12	12	12
(dscfm)	(23,600)	(25,400)	(25,000)	(25,000)
Particulate emissions				
g/dsm^3	31.5	42.6	45.5	39.8
(gr/dscf)	(13.8)	(18.6)	(19.9)	(17.4)
kg/h	1,300	1,800	1,900	1,700
(lb/h)	(2,800)	(4,000)	(4,300)	(3,700)
kg/Mg	76	110	120	100
(lb/ton)	(150)	(230)	(230)	(200)

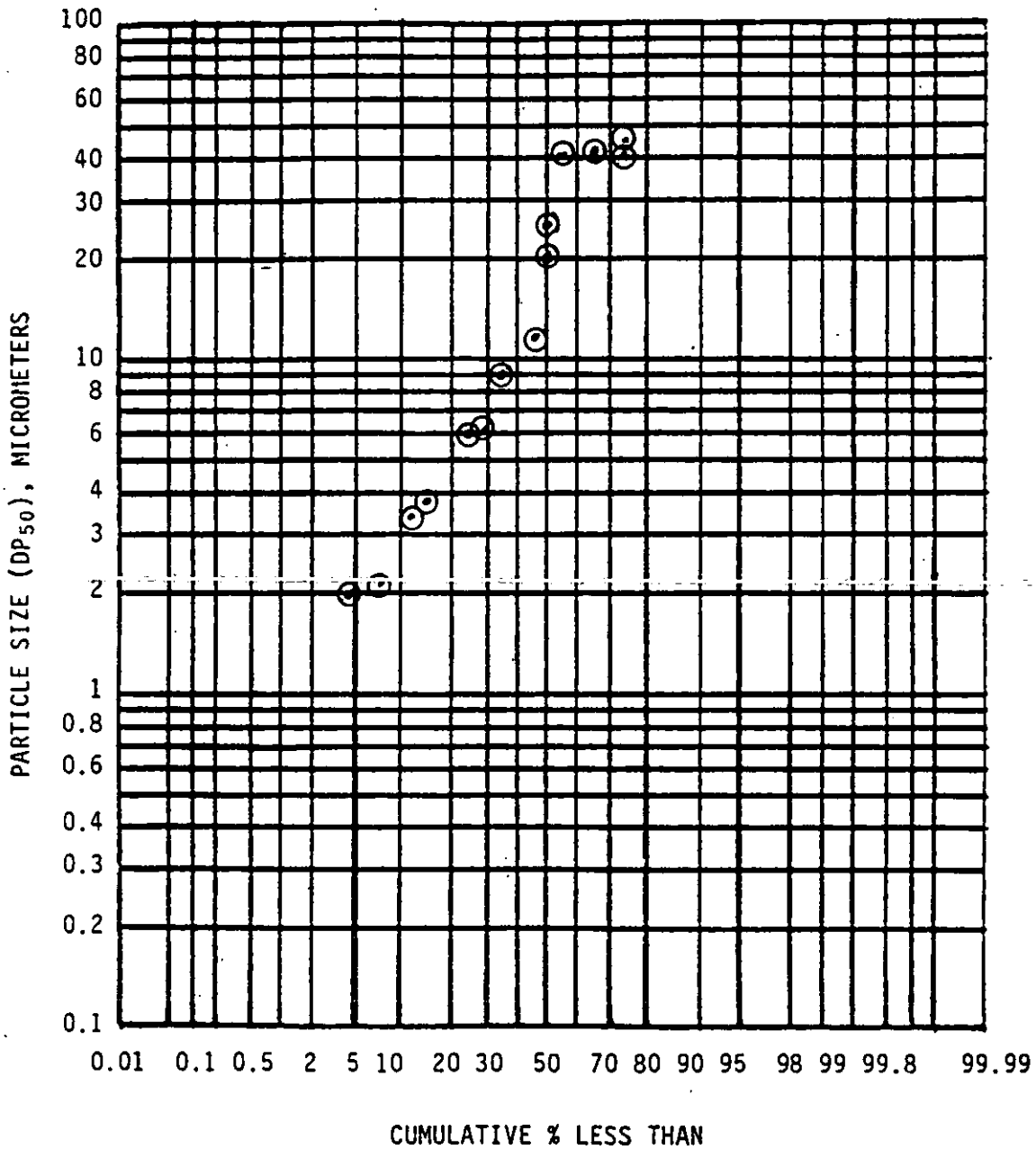
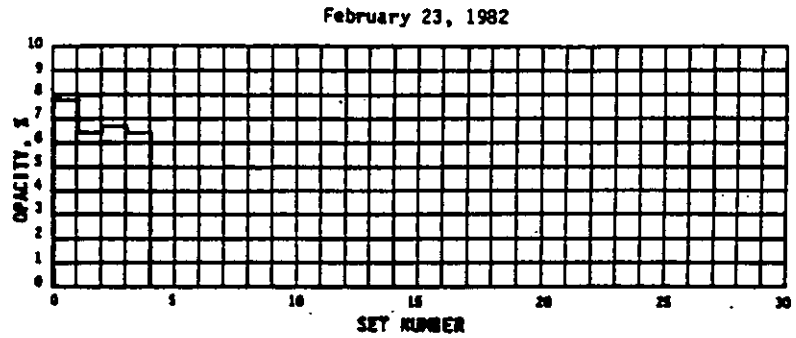


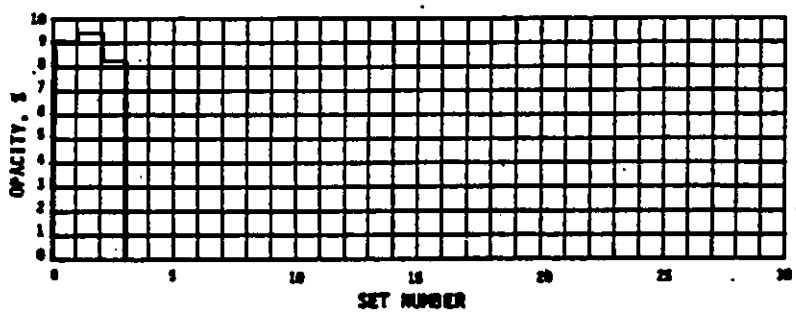
Figure C-57. Particle size distribution data: rotary calciner scrubber inlet--Plant K2.

TABLE C-88. SUMMARY OF PROCESS FUGITIVE EMISSIONS--PLANT K2

Date	2/23-25/82
Industry	Lightweight aggregate
Process unit	Rotary calciner
Period of observation	(2/23) 12:34-15:41; (2/24) 14:10-15:46; (2/25) 10:53-11:05; 12:49-13:00
Location of discharge point	Calciner inlet
Highest single reading, percent	10
Highest 6-minute average, percent[a]	10

[a]Six-minute averages taken during testing were all 0 percent opacity unless noted below.





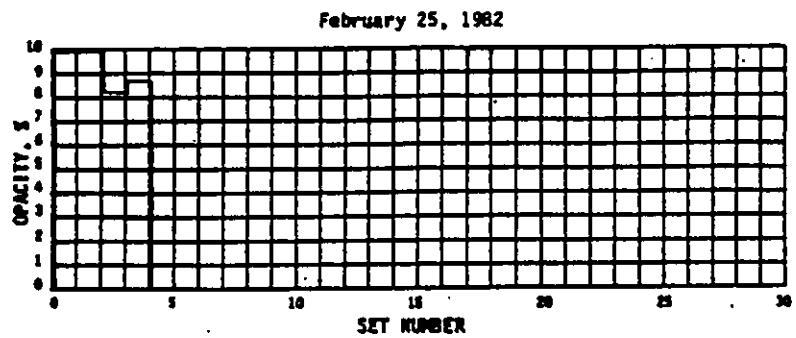


TABLE C-89. SUMMARY OF SULFUR DIOXIDE EMISSIONS DATA--PLANT K2
Industry: Lightweight aggregate
Process unit: Rotary calciner
Location of discharge: Scrubber inlet

Test location	Date, 1982	Concentration, g/dsm³ (ppm)	Mass emission rate, kg/h (lb/h)	Temp., °C (°F)
Scrubber inlet[a]				
Run No. 1	2/26	4.91 (1,862)	205 (452)	519 (968)
Run No. 2	2/26	6.09 (2,314)	255 (562)	530 (988)
Average	--	5.50 (2,088)	230 (507)	525 (978)
Run No. 3	2/26	6.17 (2,342)	258 (569)	524 (977)
Run No. 4	2/27	5.63 (2,135)	235 (519)	511 (954)
Average	--	5.90 (2,239)	247 (544)	518 (966)
Run No. 5	2/27	5.52 (2,095)	231 (509)	525 (979)
Run No. 6	2/27	5.40 (2,052)	226 (499)	527 (981)
Average	--	5.46 (2,074)	228 (504)	526 (980)

[a]Mass emission rates are based on the average stack gas flow rate determined during the inlet particulate tests (11.638 dsm³/s [24,659 dscfm].

TABLE C-90. SUMMARY OF NITROGEN OXIDE EMISSIONS DATA--PLANT K2

Industry: Lightweight aggregate
Process unit: Rotary calciner
Location of discharge: Scrubber outlet

Test location	Date, 1982	Concentration, g/dsm³ (ppm)	Mass emission rate, kg/h (lb/h)
Scrubber outlet[a]			
Sample No. 1A	2/27	0.363 (189)	30.4 (67.1)
Sample No. 1B	2/27	0.468 (244)	39.3 (86.6)
Sample No. 1C	2/27	0.399 (208)	33.5 (73.8)
Sample No. 1D	2/27	0.439 (229)	36.8 (81.2)
Average	--	0.417 (218)	35.0 (77.2)
Sample No. 2A	2/27	0.396 (207)	33.2 (73.3)
Sample No. 2B	2/27	0.394 (206)	33.0 (72.8)
Sample No. 2C	2/27	0.575 (300)	48.2 (106)
Sample No. 2D	2/27	0.386 (201)	32.3 (71.3)
Average	--	0.392 (205)	36.7 (72.5)
Sample No. 3A[b]	2/27	0.295 (154)	24.7 (54.5)
Sample No. 3B	2/27	0.411 (215)	34.5 (76.1)
Sample No. 3C	2/27	0.380 (198)	31.9 (70.3)
Sample No. 3D	2/27	0.367 (192)	30.8 (67.8)
Average	--	0.386 (202)	32.4 (71.4)

[a]Mass emission rates are based on the average stack gas flow rate determined during the scrubber outlet particulate tests (23.321 dsm³/s [49,414 dscfm].
[b]Outlier not used in average.

TABLE C-91. SUMMARY OF HYDROCARBON EMISSIONS--PLANT K2
Industry: Lightweight aggregate
Process unit: Rotary calciner
Emission source: Scrubber outlet

Test No.	Date, 1982	Sampling time, 24-h Start	Sampling time, 24-h Finish	NMO[a] concentration ppm as CH_4	Hydrocarbon emission rate expressed as methane[b] kg/h	Hydrocarbon emission rate expressed as methane[b] lb/h
SO-VC-1[c]	2/26	--	--	--	--	--
SO-VC-2	2/26	1032	1120	60	3.6	7.4
SO-VC-3	2/26	1127	1215	141	8.5	17.4
SO-VC-4	2/27	0900	1010	68	4.1	8.4
Average				90	5.4	11.1

[a]NMO = nonmethane organics measured and expressed as methane (CH_4).
[b]Based on the molecular weight of methane, 16 g/g-mole (16 lb/lb-mole). Mass emission rates are calculated using the average gas flow rate measured during the particulate tests (2,964,856 dscfh).
[c]SO-VC-1 voided due to plug in sampling probe.

TABLE C-92. SUMMARY OF EMISSION TEST RESULTS--PLANT K3
Industry: Lightweight aggregate
Process unit: Rotary calciner No. 1
Emission source: Scrubber outlet

Data	Run No. 1	Run No. 2	Run No. 3	Average for test series
General				
Date	11/12/81	11/12/81	11/12/81	--
Sampling time, minutes	96	96	96	--
Isokinetic ratio, percent	97	98	99	--
Production rate, Mg/h	29.8	29.8	29.8	29.8
(tons/h)	(32.8)	(32.8)	(32.8)	(32.8)
Capacity utilization, percent	109	109	109	109
Gas stream data				
Temperature, °C	59	59	59	59
(°F)	(138)	(138)	(138)	(138)
Moisture, percent	17.5	17.7	17.6	17.5
Flow rate, m^3/s	17	27	28	27
(acfm)	(58,000)	(57,400)	(58,400)	(57,900)
Flow rate, dsm^3/s	20	20	20	20
(dscfm)	(42,400)	(41,700)	(42,500)	(42,200)
Particulate emissions				
g/dsm^3	0.101	0.116	0.111	0.109
(gr/dscf)	(0.044)	(0.051)	(0.049)	(0.048)
kg/h	7.3	8.2	8.1	7.9
(lb/h)	(16)	(18)	(18)	(17)
kg/Mg	0.24	0.28	0.27	0.26
(lb/ton)	(0.49)	(0.55)	(0.54)	(0.53)

TABLE C-93. SUMMARY OF EMISSION TEST RESULTS--PLANT K3[a]
Industry: Lightweight aggregate
Process unit: Rotary calciner No. 2
Emission source: Scrubber outlet

Data	Run No. 1	Run No. 2	Run No. 3	Average for test series
General				
Date	11/11/81	11/11/81	11/11/81	--
Sampling time, minutes	96	96	96	--
Isokinetic ratio, percent	97	96	97	--
Production rate, Mg/h	36.3	36.3	36.3	36.3
(tons/h)	(40)	(40)	(40)	(40)
Capacity utilization, percent	100	100	100	100
Gas stream data				
Temperature, °C	58	59	59	59
(°F)	(136)	(138)	(139)	(138)
Moisture, percent	17.2	17.8	18.4	17.8
Flow rate, m^3/s	32	33	34	33
(acfm)	(67,800)	(69,100)	(71,100)	(69,300)
Flow rate, dsm^3/s	24	24	24	24
(dscfm)	(49,800)	(50,300)	(51,200)	(50,400)
Particulate emissions				
g/dsm^3	0.178	0.158	0.179	0.172
(gr/dscf)	(0.078)	(0.069)	(0.078)	(0.075)
kg/h	15	13	16	15
(lb/h)	(33)	(30)	(34)	(32)
kg/Mg	0.42	0.37	0.44	0.41
(lb/ton)	(0.83)	(0.74)	(0.86)	(0.81)

[a]The multiclone that precedes the wet scrubber was bypassed during the particulate test series. Therefore, the test results do not represent typical operating conditions.

TABLE C-94. SUMMARY OF SULFUR DIOXIDE EMISSIONS DATA--PLANT K3
Industry: Lightweight aggregate
Process unit: Rotary calciner
Location of discharge: Multiple cyclone collector inlet

Test location	Date, 1979	Concentration, g/dsm³ (ppm)	Mass emission rate, kg/h (lb/h)	Temp., °C (°F)
Multiple cyclone inlet				
Run No. 1	6/5	2.60 (N/A)[a]	281 (619)	146 (295)
Run No. 2	6/5	2.71 (N/A)	171 (377)	164 (328)
Run No. 3	6/6	3.14 (N/A)	195 (429)	166 (330)
Average	--	2.82 (N/A)	216 (475)	159 (318)

[a]N/A = Information not available.

TABLE C-95. SUMMARY OF EMISSION TEST RESULTS--PLANT K4
Industry: Lightweight aggregate
Process unit: Rotary calciner
Emission source: Scrubber outlet

Data	Run No. 1	Run No. 2	Run No. 3	Average for test series
General				
Date	10/29/82	10/29/82	10/29/82	--
Sampling time, minutes	60	60	60	--
Isokinetic ratio, percent	101	99	100	--
Production rate, Mg/h	6.4	6.4	6.4	6.4
(tons/h)	(7)	(7)	(7)	(7)
Capacity utilization, percent	92	92	92	92
Gas stream data				
Temperature, °C	61	58	125	81
(°F)	(142)	(137)	(143)	(141)
Moisture, percent	15	16.3	17.8	16.4
Flow rate, m^3/s	8.4	8.3	8.6	8.4
(acfm)	(17,800)	(17,500)	(18,100)	(17,800)
Flow rate, dsm^3/s	6.3	6.2	6.2	6.2
(dscfm)	(13,400)	(13,100)	(13,200)	(13,200)
Particulate emissions				
g/dsm^3	0.063	0.076	0.071	0.070
(gr/dscf)	(0.027)	(0.033)	(0.031)	(0.031)
kg/h	1.4	1.7	1.6	1.8
(lb/h)	(3.2)	(3.8)	(3.5)	(3.5)
kg/Mg	0.22	0.27	0.25	0.25
(lb/ton)	(0.45)	(0.54)	(0.50)	(0.50)

TABLE C-96. SUMMARY OF EMISSION TEST RESULTS--PLANT K5
Industry: Lightweight aggregate
Process unit: Rotary calciner
Emission source: Baghouse inlet

Data	Run No. 1	Run No. 2	Run No. 3	Average for test series
General				
Date	4/29/80	4/29/80	4/29/80	--
Sampling time, minutes	63	71	62	--
Isokinetic ratio, percent	95	100	99	--
Production rate, Mg/h	21	21	21	21
(tons/h)	(23)	(23)	(23)	(23)
Capacity utilization, percent	100	100	100	100
Gas stream data				
Temperature, °C	173	169	161	168
(°F)	(344)	(336)	(321)	(334)
Moisture, percent	5.5	6.6	7.1	6.4
Flow rate, m^3/s	8.2	8.3	8.5	8.3
(acfm)	(17,300)	(17,600)	(17,900)	(17,600)
Flow rate, dsm^3/s	4.9	4.9	5.1	5.0
(dscfm)	(10,400)	(10,500)	(10,900)	(10,600)
Particulate emissions				
g/dsm^3	20.3	17.2	17.6	18.4
(gr/dscf)	(8.87)	(7.50)	(7.67)	(8.01)
kg/h	360	310	320	330
(lb/h)	(790)	(670)	(710)	(720)
kg/Mg	17	15	15	16
(lb/ton)	(34)	(29)	(31)	(32)

TABLE C-97. SUMMARY OF EMISSION TEST RESULTS--PLANT K5
Industry: Lightweight aggregate
Process unit: Rotary calciner
Emission source: Baghouse outlet

Data	Run No. 1	Run No. 2	Run No. 3	Average for test series
General				
Date	4/29/80	4/29/80	4/29/80	--
Sampling time, minutes	67	72	67	--
Isokinetic ratio, percent	105	97	105	--
Production rate, Mg/h (tons/h)	21 (23)	21 (23)	21 (23)	21 (23)
Capacity utilization, percent	100	100	100	100
Gas stream data				
Temperature, °C (°F)	83 (181)	78 (173)	76 (169)	79 (174)
Moisture, percent	2.6	2.4	3.2	2.7
Flow rate, m^3/s (acfm)	19 (39,800)	19 (39,500)	19 (40,300)	19 (39,900)
Flow rate, dsm^3/s (dscfm)	15 (30,900)	15 (31,200)	15 (31,700)	15 (31,300)
Particulate emissions				
g/dsm^3 (gr/dscf)	0.048 (0.021)	0.083 (0.036)	0.091 (0.040)	0.074 (0.032)
kg/h (lb/h)	2.5 (5.6)	4.4 (9.7)	4.9 (11)	3.9 (8.7)
kg/Mg (lb/ton)	0.12 (0.24)	0.21 (0.42)	0.23 (0.47)	0.19 (0.38)

TABLE C-98. SUMMARY OF EMISSION TEST RESULTS--PLANT K6
Industry: Lightweight aggregate
Process unit: Rotary calciner
Emission source: Scrubber outlet

Data	Run No. 1	Run No. 2	Run No. 3	Average for test series
General				
Date	2/23/81	2/23/81	2/24/81	--
Sampling time, minutes	136	134	124	--
Isokinetic ratio, percent	99	99	101	--
Production rate, Mg/h[a]	12.0	12.0	12.0	12.0
(tons/h)	(13.3)	(13.3)	(13.3)	(13.3)
Capacity utilization, percent	100	100	100	100
Gas stream data				
Temperature, °C	78	78	81	79
(°F)	(172)	(173)	(178)	(174)
Moisture, percent	17.5	15.2	19.3	17.3
Flow rate, m^3/s	14	15	15	14
(acfm)	(30,300)	(30,700)	(30,800)	(30,600)
Flow rate, dsm^3/s	10	10	10	10
(dscfm)	(21,100)	(22,000)	(20,700)	(21,300)
Particulate emissions				
g/dsm^3	0.090	0.090	0.108	0.096
(gr/dscf)	(0.040)	(0.040)	(0.047)	(0.042)
kg/h	3.2	3.4	3.8	3.5
(lb/h)	(7.1)	(7.4)	(8.4)	(7.6)
kg/Mg[a]	0.27	0.28	0.32	0.29
(lb/ton)	(0.54)	(0.57)	(0.64)	(0.58)

[a]Based on "average operating rate" of the rotary calciner at Plant K6. Actual production rate data were not monitored during tests.

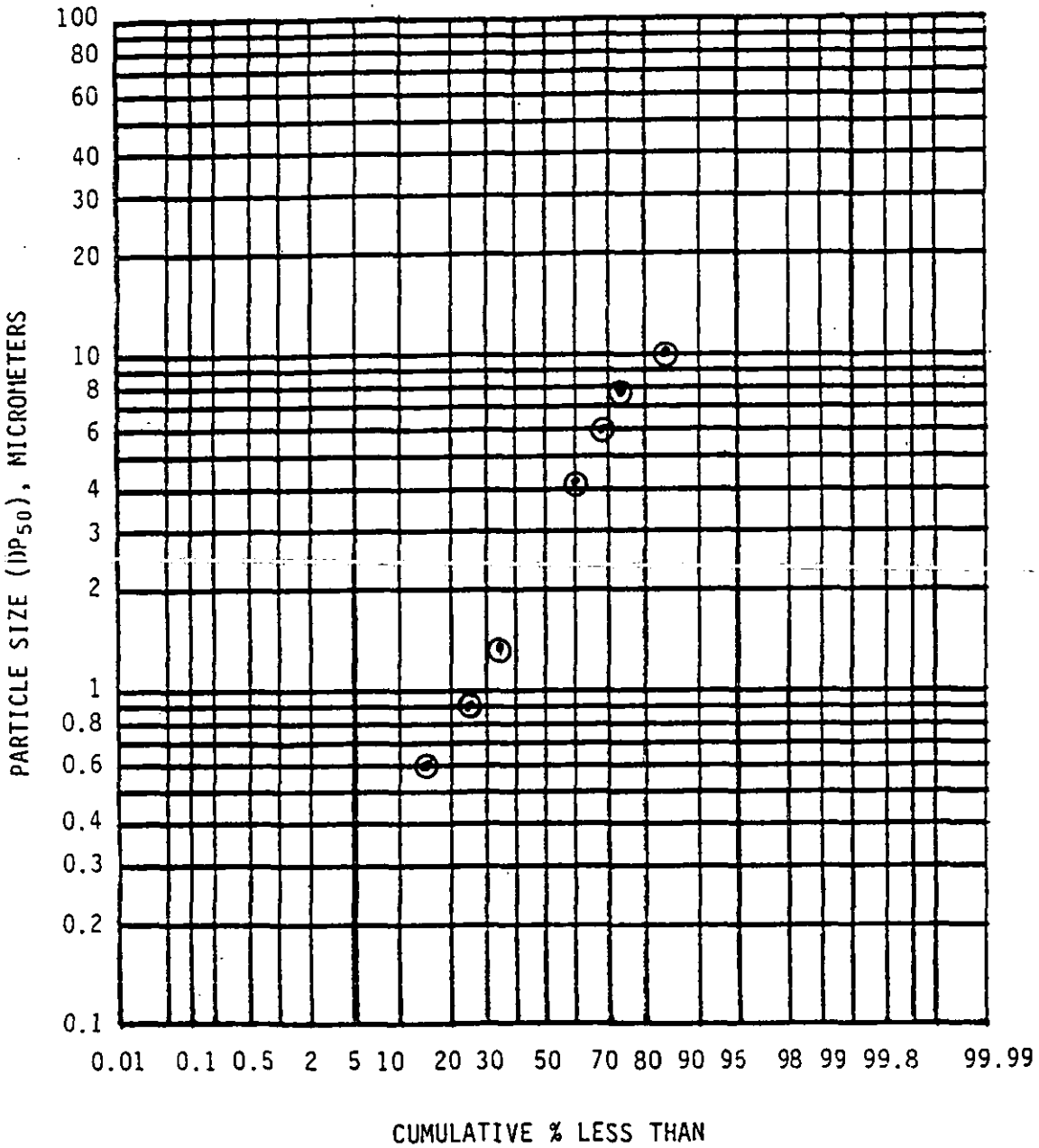


Figure C-58. Particle size distribution data: rotary calciner scrubber outlet--Plant K6.

TABLE C-99. SUMMARY OF VISIBLE EMISSIONS--PLANT K6

Date	2/23/81
Industry	Lightweight aggregate
Process unit	Rotary calciner
Location of discharge	Scrubber outlet
Height of observation point, ft	Ground
Height of point of discharge, ft	100
Distance from observer to discharge point, ft	200, 100
Direction of observer from discharge point	E, SW
Description of background	Clear sky
Description of sky	Clear
Wind direction	SW
Wind velocity, mph	10-15
Color of plume	White
Duration of observation, min	84
Period of observation	1030-1709[a]
Highest single reading, percent	15
Highest 6-minute average, percent	10.0

[a]14 sets of 6-minute observations were made during this period.

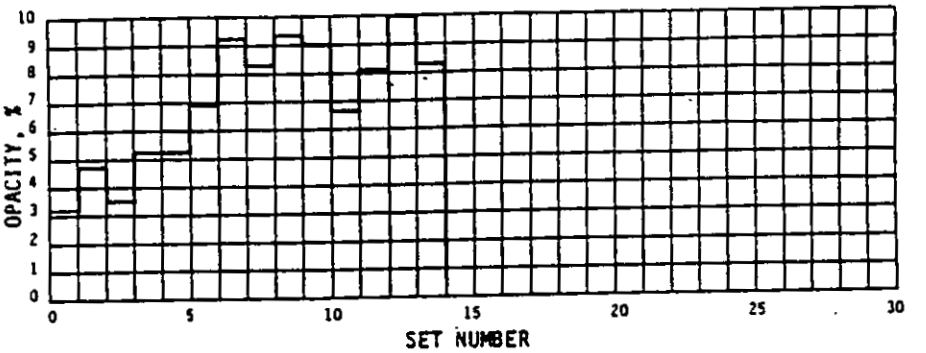


TABLE C-100. SUMMARY OF VISIBLE EMISSIONS--PLANT K6

Date	2/24/81
Industry	Lightweight aggregate
Process unit	Rotary calciner
Location of discharge	Scrubber outlet
Height of observation point, ft	Ground
Height of point of discharge, ft	100
Distance from observer to discharge point, ft	200, 100
Direction of observer from discharge point	E, SW
Description of background	Clear sky
Description of sky	Scattered, broken
Wind direction	SW, S
Wind velocity, mph	5
Color of plume	White
Duration of observation, min	78
Period of observation	0912-1526[a]
Highest single reading, percent	15
Highest 6-minute average, percent	9.8

[a]13 sets of 6-minute observations were made during this period.

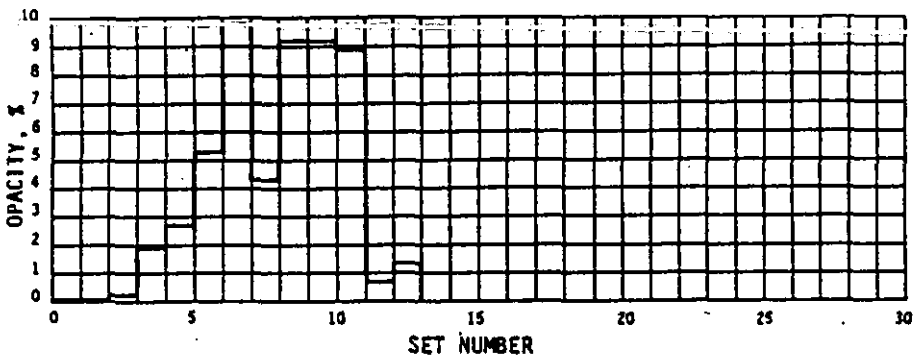


TABLE C-101. SUMMARY OF SULFUR DIOXIDE EMISSIONS DATA--PLANT K6
Industry: Lightweight aggregate
Process unit: Rotary calciner
Location of discharge: Scrubber inlet and outlet

Test location	Date, 1981	Concentration, g/dsm³ (ppm)	Mass emission rate, kg/h (lb/h)	Temp., °C (°F)
Scrubber inlet				
Run No. 1	2/26	0.718 (273)	19.9 (43.9)	338 (640)
Run No. 2	2/26	0.753 (286)	19.8 (43.7)	338 (640)
Average	--	0.736 (280)	19.9 (43.8)	338 (640)
Run No. 3	2/26	0.785 (299)	24.3 (53.6)	338 (640)
Run No. 4	2/26	0.702 (267)	21.7 (48.0)	338 (640)
Average	--	0.744 (283)	23.0 (50.8)	338 (640)
Run No. 5	2/26	0.660 (251)[a]	19.2 (42.2)[a]	338 (640)
Run No. 6	2/26	0.231[a] (88)[a]	6.7[a] (14.7)[a]	338 (640)
Average	--	0.660 (251)	19.2 (42.2)	338 (640)
Scrubber outlet				
Run No. 1	2/26	0.481 (183)	17.4 (38.3)	77 (170)
Run No. 2	2/26	0.509 (194)	18.4 (40.5)	77 (170)
Average	--	0.495 (189)	17.9 (39.4)	77 (170)
Run No. 3	2/26	0.562 (214)	20.3 (44.8)	77 (170)
Run No. 4	2/26	0.485 (185)	17.5 (38.7)	77 (170)
Average	--	0.524 (200)	18.9 (41.8)	77 (170)
Run No. 5	2/26	0.489 (186)	17.7 (38.9)	77 (170)
Run No. 6	2/26	0.537 (204)	19.4 (42.8)	77 (170)
Average	--	0.513 (195)	18.6 (40.9)	77 (170)

[a]Outlier--not included in averages.

TABLE C-102. SUMMARY OF NITROGEN OXIDE EMISSIONS DATA--PLANT K6

Industry: Lightweight aggregate
Process unit: Rotary calciner
Location of discharge: Scrubber outlet

Test location	Date, 1981	Concentration, g/dsm³ (ppm)	Mass emission rate,[a] kg/h (lb/h)
Scrubber outlet			
Sample No. 1A	2/26	0.282 (147)	10.2 (22.4)
Sample No. 1B	2/26	0.330 (172)	11.9 (26.3)
Sample No. 1C	2/26	0.325 (170)	11.8 (25.9)
Sample No. 1D	2/26	0.266 (139)	9.6 (21.2)
Average	--	0.301 (157)	10.9 (24.0)
Sample No. 2A	2/26	0.268 (140)	9.7 (21.4)
Sample No. 2B	2/26	0.270 (141)	9.7 (21.5)
Sample No. 2C	2/26	0.289 (151)	10.4 (23.0)
Sample No. 2D	2/26	0.300 (157)	10.8 (23.9)
Average	--	0.282 (147)	10.2 (22.5)
Sample No. 3A	2/26	0.302 (158)	10.9 (24.1)
Sample No. 3B	2/26	0.231 (121)	8.3 (18.4)
Sample No. 3C	2/26	0.294 (153)	10.6 (23.4)
Sample No. 3D	2/26	0.287 (150)	10.4 (22.9)
Average	--	0.279 (146)	10.1 (22.2)

[a]Mass emission rate in kilograms per hour (kg/h) and pounds per hour (lb/h) calculated using average measured flow obtained from the particulate tests.

TABLE C-103. SUMMARY OF TRACE METAL ANALYSIS--PLANT K6[a]
(Composite samples per category, ppm of impinger solution [unless noted])
Industry: Lightweight aggregate
Process unit: Rotary calciner
Sample source: Method 5 particulate catch

Element	Coal	Clay	Final product	Scrubber effluent
Calcium	3.1%	0.65%	0.82%	320
Magnesium	0.384%	0.71%	0.79%	33
Potassium	0.568%	0.53%	0.58%	10
Sodium	0.480%	0.40%	0.46%	62
Silicon	9.6%	28%	34%	12
Barium	630	370	360	0.080
Manganese	470	700	430	2.2
Aluminum	4.2%	6.6%	7.4%	<0.05
Chrominum	46	62	70	<0.001
Copper	100	19	24	<0.001
Zinc	540	77	94	0.058
Titanium	0.244%	0.38%	0.490%	<0.005
Strontium	250	66	80	1.1
Vanadium	73	92	110	0.008
Lithium	7.5	40	52	0.18
Yttrium	19	23	25	<0.002
Iron	4.0%	3.2%	3.9%	0.040

[a]Elements not detected in samples: Phosphorus, Tungsten, Platinum, Boron, Mercury, Thallium, Molybdenum, Antimony, Gold, Tellurium, Nickel, Bismuth, Beryllium, Arsenic, Indium, Selenium, Silver, Lead, Cadmium, Cobalt, Tin, and Uranium.