

EMISSION FACTOR DOCUMENTATION FOR AP-42 SECTION 8.17
Perlite Processing

1. INTRODUCTION

The document Compilation of Air Pollutant Emission Factors (AP-42) has been published by the U.S. Environmental Protection Agency (EPA) since 1972. Supplements to AP-42 have been routinely published to add new emission source categories and to update existing emission factors. AP-42 is routinely updated by EPA to respond to new emission factor needs of EPA, State and local air pollution control programs, and industry.

An emission factor relates the quantity (weight) of pollutants emitted to a unit of activity of the source. The uses for the emission factors reported in AP-42 include:

1. Estimates of areawide emissions;
2. Estimates of emissions for a specific facility; and
3. Evaluation of emissions relative to ambient air quality.

The purpose of this report is to provide background information from test reports and other information to support preparation of AP-42 Section 8.17, Perlite Processing.

This background report consists of five sections. Section 1 includes the introduction to the report. Section 2 gives a description of the perlite processing industry. It includes a characterization of the industry, an overview of the different process types, a description of emissions, and a description of the technology used to control emissions resulting from perlite processing. Section 3 is a review of emissions data collection and analysis procedures. It describes the literature search, the screening of emission data reports, and the quality rating system for both emission data and emission factors. Section 4 details the development of pollutant emission factors for the draft AP-42 section. It includes the review of specific data sets and the results of data analysis. Section 5 presents the AP-42 Section 8.17, Perlite Processing.

2. INDUSTRY DESCRIPTION¹⁻³

Perlite is a glassy volcanic rock with a pearl-like luster. It usually exhibits numerous concentric cracks that cause it to resemble an onion skin. A typical perlite sample is composed of 71 to 75 percent silicon dioxide, 12.5 to 18.0 percent alumina, 4 to 5 percent potassium oxide, 1 to 4 percent sodium and calcium oxides, and trace amounts of metal oxides. The Standard Industrial Classification (SIC) code for perlite mining is 1499 (miscellaneous nonmetallic minerals, except fuels), and the SIC code for perlite processing is 3295 (minerals and earths, ground or otherwise treated). The six-digit Source Classification Code (SCC) for perlite processing is 3-05-018.

Expanded perlite usually has a density in the range of 112 to 240 kilograms per cubic meter (kg/m^3) (7 to 15 pounds per cubic foot [lb/ft^3]). Because of this low density, it is not economical to ship the finished product long distances. Therefore, many small perlite expansion plants are located near industrial areas.

Perlite is used by industry in many different ways. Construction-related uses (acoustical ceiling tile, pipe insulation, roof insulation board, etc.), which are the major market for expanded materials, increased 5 percent to 336,600 tons in 1989. Expanded perlite used as a filter aid, as fillers, and in agricultural markets (horticultural aggregate and fertilizer carriers) totaled 148,600 tons, an increase of 7 percent from 1988. Other uses for perlite include concrete aggregate, masonry and cavity fill insulation, plaster aggregate, low- and high-temperature insulation, paint texturizers, and refractories. Table 2-1 shows the amount of expanded perlite sold and used by producers in the United States in 1988 and 1989, by use.

2.1 CHARACTERIZATION OF THE INDUSTRY

In 1989, perlite mined for processing totaled 656,000 megagrams (Mg) (722,000 tons) and came from nine companies with 10 operations in 6 western States. A large majority of the total tonnage of perlite was mined in New Mexico. The rest was mined in Arizona, California, Colorado, Idaho, and Nevada. Apparent domestic consumption (production plus imports minus exports) of processed perlite increased 6 percent from 1988 consumption to 583,000 Mg (641,000 tons). Table 2-2 shows the amount of perlite mined, processed, expanded, and sold and used by producers in the United States from 1985 to 1989.

In 1989, the producers of perlite ore included Harborlite Corp. and Nord Perlite Co. in Arizona; American Perlite Co. in California; Persolite Products, Inc., in Colorado; National Perlite Co. in Idaho; Delamar Perlite Co. in Nevada; and Grefco, Inc., Manville Products Corp., and USG Corp. in New Mexico.

The quantity of expanded perlite sold and used in 1989 by 61 plants in 33 States increased about 8 percent from 1988, while the value of expanded perlite decreased about 9 percent in 1989. Leading States, in descending order of sales, were Mississippi, Pennsylvania, Illinois, California, Georgia, Arizona, Kentucky, Virginia, and Minnesota. Table 2-3 shows the amount of expanded perlite produced and sold and used by producers in the United States, by State, for 1988 and 1989.

TABLE 2-1. EXPANDED PERLITE SOLD AND USED BY PRODUCERS
IN THE UNITED STATES, TONS²

Use	1988	1989
Formed products ^a	283,100	291,200
Filter aid	62,900	70,800
Fillers	27,100	28,200
Horticultural aggregate ^b	49,300	49,600
Concrete aggregate	10,400	11,100
Masonry and cavity-fill insulation	10,400	10,200
Plaster aggregate	10,800	18,000
Low-temperature insulation	6,200	6,100
Other ^c	18,800	32,000
TOTAL	479,000	517,000 ^d

^aIncludes acoustic ceiling tile, pipe insulation, roof insulation board, and unspecified formed products.

^bIncludes fertilizer carriers.

^cIncludes fines, high-temperature insulation, paint texturizer, refractories, and various nonspecified industrial uses.

^dData do not add to total shown because of independent rounding.

TABLE 2-2. PERLITE MINED, PROCESSED, EXPANDED, AND SOLD AND USED BY
PRODUCERS IN THE UNITED STATES^a

Year	Perlite mined tons ^b	Processed perlite				Expanded perlite			
		Sold to expanders		Used at own plant to make expanded material		Total quantity sold and used, tons	Quantity produced, tons	Sold and used	
		Quantity, tons	Value, \$	Quantity, tons	Value, \$			Quantity, tons	Value, \$
1985	678	309	10,714	209	6,821	518	461	459	81,000
1986	735	303	9,536	204	6,110	507	480	479	83,700
1987	778	333	10,471	200	6,023	533	464	466	81,800
1988	830	375	11,588	201	6,064	576	480	479	88,900
1989	722	406	11,426	195	4,875	601	518	517	88,014

^aReference 2. Quantities in 1,000 tons, values in \$1,000.

TABLE 2-3. EXPANDED PERLITE PRODUCED AND SOLD AND USED BY PRODUCERS
IN THE UNITED STATES^a

State	1988				1989			
	Quantity produced, tons	Sold to expanders			Quantity produced, tons	Sold and used		
		Quantity, tons	Value, \$1,000	Average value per ton, \$ ^b		Quantity, tons	Value, \$1,000	Average value per ton, \$ ^b
California	40,700	41,600	7,841	188	41,200	44,700	8,363	187
Florida	26,600	26,600	5,509	206	23,200	23,100	4,817	208
Indiana	19,400	19,400	5,499	283	22,200	22,200	5,839	263
Kansas	1,100	1,100	380	354	W	W	W	365
Pennsylvania	50,300	50,200	9,776	194	50,900	50,900	10,461	205
Texas	16,000	15,600	4,108	263	25,900	24,700	5,424	219
Utah	900	900	239	274	4,500	4,500	1,234	274
Other ^c	324,900	323,290	55,548	172	349,800	347,300	51,876	149
TOTAL ^d	480,000	479,000	88,900	186	518,000	517,000	88,014	170

W = withheld to avoid disclosing company proprietary data; included with "Other".

^aReference 2.

^bAverage value based on unrounded data and rounded to nearest dollar.

^cIncludes Alabama, Arizona, Arkansas, Colorado, Georgia, Idaho, Illinois, Iowa, Kentucky, Louisiana, Maine, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, Nevada, New Jersey, New York, North Carolina, Ohio, Oregon, Tennessee, Virginia, Wisconsin, and Wyoming.

^dData may not add to totals shown because of independent rounding.

2.2 PROCESS DESCRIPTION

Crude perlite ore is mined, crushed, dried in a rotary dryer, ground, screened, and shipped to expansion plants. Horizontal rotary or vertical stationary expansion furnaces are used to expand the processed perlite ore.

The normal size of crude perlite expanded for use in plaster aggregates ranges from plus 250 micrometers (μm) (60 mesh) to minus 1.4 millimeters (mm) (12 mesh). Crude perlite expanded for use as a concrete aggregate ranges from 1 mm (plus 16 mesh) to 0.2 mm (plus 100 mesh). Ninety percent of the crude perlite ore expanded for horticultural uses is greater than 841 μm (20 mesh).

Crude perlite is mined using open-pit methods and then is moved to the plant site, where it is stockpiled. Figure 2-1 is a flow diagram of crude ore processing. The first processing step is to reduce the diameter of the ore to approximately 1.6 centimeters (cm) (0.6 inch [in.]) in a primary jaw crusher. The crude ore is then passed through a rotary dryer, which reduces the moisture content from between 4 and 10 percent to less than 1 percent.

After drying, secondary grinding takes place in a closed-circuit system using screens, air classifiers, hammer mills, and rod mills. Oversized material produced from the secondary circuit is returned to the primary crusher. Large quantities of fines, produced throughout the processing stages, are removed by air classification at designated stages. The desired size processed perlite ore is stored until it is shipped to an expansion plant.

At the expansion plants, the processed ore is either preheated or fed directly to the furnace. Preheating the material to approximately 430°C (800°F) reduces the amount of fines produced in the expansion process, which increases usable output and controls the uniformity of product density. In the furnace, the perlite ore reaches a temperature of 760° to 980°C (1400° to 1800°F), at which point it begins to soften to a plastic state where the entrapped combined water is released as steam. This causes the hot perlite particles to expand 4 to 20 times their original size. A suction fan draws the expanded particles out of the furnace and transports them pneumatically to a cyclone classifier system to be collected. The air-suspended perlite particles are also cooled as they are transported to the collection equipment. The cyclone classifier system collects the expanded perlite, removes the excessive fines, and discharges gases to a baghouse or wet scrubber for air pollution control.

The grades of expanded perlite produced can also be adjusted by changing the heating cycle, altering the cutoff points for size collection, and blending various crude ore sizes. All processed products are graded for specific uses and are usually stored before being shipped. Most production rates are less than 1.8 megagrams per hour (Mg/hr) (2 tons/hr), and expansion furnace temperatures range from 870° to 980°C (1600° to 1800°F). Natural gas is typically used for fuel, although No. 2 fuel oil and propane are occasionally used. Fuel consumption varies from 2,800 to 8,960 kilojoules per kilogram (kJ/kg) (2.4 to 7.7 x 10⁶ British thermal units per ton [Btu/ton]) of product.

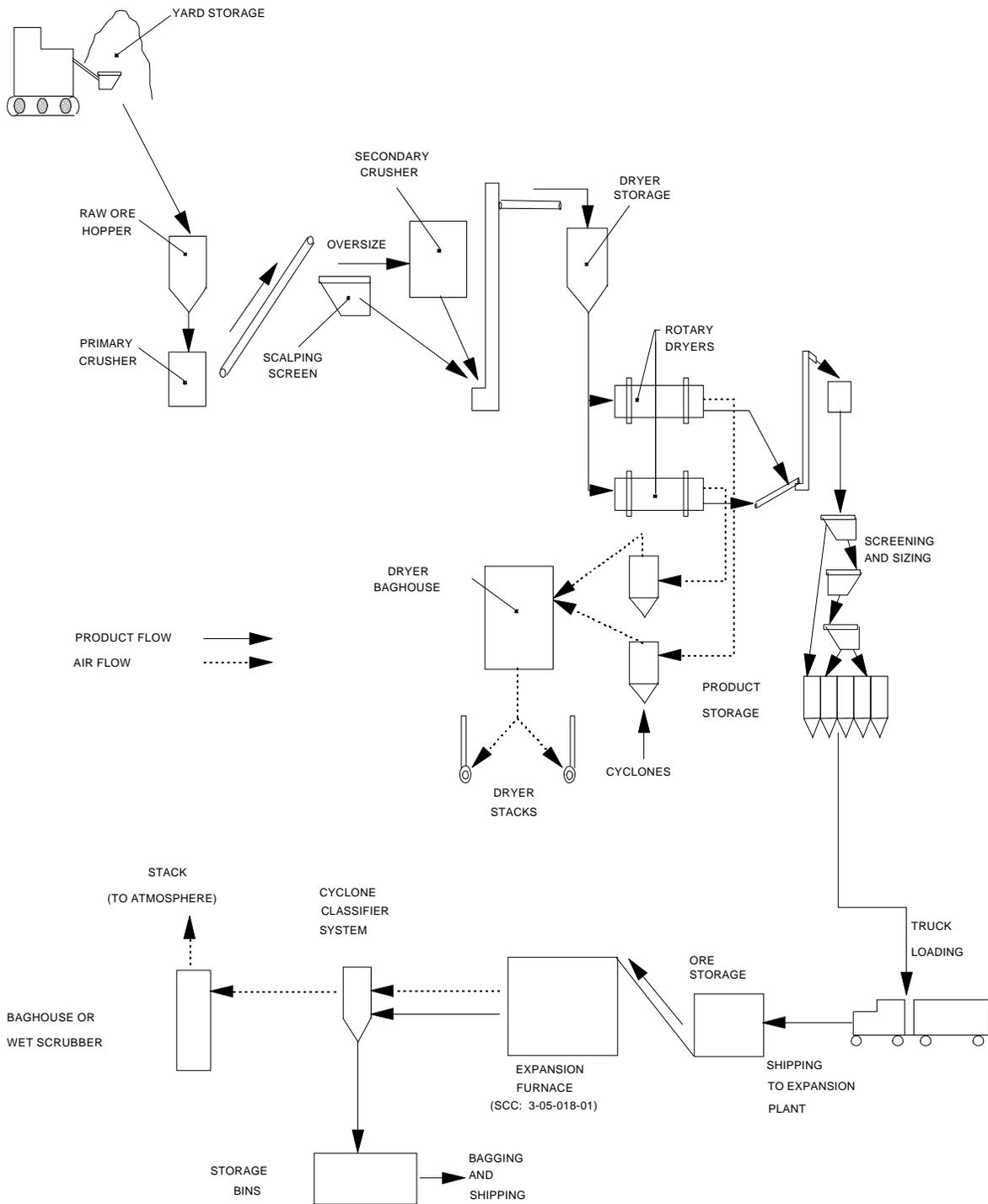


Figure 2-1. Flow diagram for perlite processing.¹

2.3 EMISSIONS⁴

The major pollutant of concern emitted from perlite processing facilities is particulate matter (PM). The dryers, expansion furnaces, and handling operations can all be sources of PM emissions. Emissions of nitrogen oxides from perlite expansion and drying generally are negligible. When sulfur-containing fuels are used, sulfur dioxide (SO₂) emissions may result from combustion sources. However, the most common type of fuel used in perlite expansion furnaces and dryers is natural gas, which is not a significant source of SO₂ emissions.

Test data from one perlite plant indicate perlite expansion furnaces emit a number of trace elements, including aluminum, calcium, chromium, fluorine, iron, lead, magnesium, manganese, mercury, nickel, titanium, and zinc. The sample also was analyzed for beryllium, uranium, and vanadium, but these elements were not detected.

2.4 CONTROLS

To control PM emissions from both dryers and expansion furnaces, the majority of perlite plants use baghouses, some use cyclones either alone or in conjunction with baghouses, and a few use scrubbers. Frequently, PM emissions from material handling processes and from dryers are controlled by the same device. Large plants generally have separate fabric filters for dryer emissions, whereas small plants often use a common fabric filter to control emissions from dryers and materials handling operations. In most plants, fabric filters are preceded by cyclones for product recovery. Wet scrubbers are also used in a small number of perlite plants to control emissions from perlite milling and expansion sources.

REFERENCES FOR SECTION 2

1. 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.
2. Bolen, W.P. "Perlite," U.S. Minerals Yearbook 1989, Volume I: Metals and Minerals, U.S. Department of the Interior, Bureau of Mines, Washington, DC, pp. 765 - 767.
3. Perlite Industry Source Category Survey, EPA-450/3-80-005, U.S. Environmental Protection Agency, Research Triangle Park, NC, February 1980.
4. Emission Test Report (Perlite): W.R. Grace and Company, Irondale, Alabama, EMB Report 83-CDR-4, U.S. Environmental Protection Agency, Research Triangle Park, NC, February 1984.

3. GENERAL DATA REVIEW AND ANALYSIS

3.1 LITERATURE SEARCH AND SCREENING

Data for this investigation were obtained from a number of sources within the Office of Air Quality Planning and Standards (OAQPS) and from outside organizations. The docket for the development of new source performance standards (NSPS) for dryers in the mineral industries was reviewed for information on the industry, processes, and emissions. The Crosswalk/Air Toxic Emission Factor Data Base Management System (XATEF) and VOC/PM Speciation Data Base Management System (SPECIATE) data bases were searched by Source Classification Code (SCC) to identify the potential pollutants emitted and emission factors for those pollutants.

Information on the industry, including number of plants, plant location, and annual production capacities, was obtained from the Minerals Yearbook and Calciners and Dryers in Mineral Industries.

A number of sources of information were investigated specifically for emission test reports and data. A search of the Test Method Storage and Retrieval (TSAR) data base was conducted to identify test reports for sources within the perlite processing industry. Copies of these test reports were obtained from the files of the Emission Measurement Branch (EMB). The EPA library was searched for additional test reports. Using this information and information obtained on plant location from the Minerals Yearbook and Calciners and Dryers in Mineral Industries, State and Regional offices were contacted about the availability of test reports. However, the information obtained from these offices was limited. Publications lists from the Office of Research and Development (ORD) and Control Technology Center (CTC) were also searched for reports on emissions from the perlite processing industry.

Because of the limited amount of information available on emissions from perlite processing, the following criteria were used in assessing the usefulness of the data:

1. Emissions data should be from a primary reference. However, secondary references were used if the document included emission data by run, rather than data averaged for the entire test. In such cases, the data was downrated to account for the fact that a secondary reference was used.

2. The referenced report should contain more than one test run. When only one valid test run was conducted, the emission factors developed from the data were not incorporated into the AP-42 section.

A final set of reference materials was compiled after a thorough review of the pertinent reports, documents, and information (according to these criteria).

3.2 EMISSION DATA QUALITY RATING SYSTEM

As part of the analysis of the emission data, the quantity and quality of the information contained in the final set of reference documents were evaluated. The following data were excluded from consideration:

1. Test series averages reported in units that cannot be converted to the selected reporting units;
2. Test series representing incompatible test methods (e.g., comparison of EPA Method 5 front half with EPA Method 5 front and back half);
3. Test series of controlled emissions for which the control device is not specified;

4. Test series in which the source process is not clearly identified and described; and
5. Test series in which it is not clear whether the emissions were measured before or after the control device.

Test data sets that were not excluded were assigned a quality rating. The rating system used was that specified by the Emission Inventory Branch (EIB) for preparing AP-42 sections. The data were rated as follows:

A--Multiple tests that were performed on the same source using sound methodology and reported in enough detail for adequate validation. These tests do not necessarily conform to the methodology specified in EPA reference test methods, although these methods were used as a guide for the methodology actually used.

B--Tests that were performed by a generally sound methodology but lack enough detail for adequate validation.

C--Tests that were based on an untested or new methodology or that lacked a significant amount of background data.

D--Tests that were based on a generally unacceptable method but may provide an order-of-magnitude value for the source.

Data based on a single test run were not rated.

The following criteria were used to evaluate source test reports for sound methodology and adequate detail:

1. Source operation. The manner in which the source was operated is well documented in the report. The source was operating within typical parameters during the test.
2. Sampling procedures. The sampling procedures conformed to a generally acceptable methodology. If actual procedures deviated from accepted methods, the deviations are well documented. When this occurred, an evaluation was made of the extent to which such alternative procedures could influence the test results.
3. Sampling and process data. Adequate sampling and process data are documented in the report, and any variations in the sampling and process operation are noted. If a large spread between test results cannot be explained by information contained in the test report, the data are suspect and are given a lower rating.
4. Analysis and calculations. The test reports contain original raw data sheets. The nomenclature and equations used were compared to those (if any) specified by EPA to establish equivalency. The depth of review of the calculations was dictated by the reviewer's confidence in the ability and conscientiousness of the tester, which in turn was based on factors such as consistency of results and completeness of other areas of the test report.

3.3 EMISSION FACTOR QUALITY RATING SYSTEM

The quality of the emission factors developed from the test data was rated utilizing the following general criteria:

A--Excellent: Developed only from A-rated test data taken from many randomly chosen facilities in the industry population. The source category is specific enough so that variability within the source category population may be minimized.

B--Above average: Developed only from A-rated test data from a reasonable number of facilities. Although no specific bias is evident, it is not clear if the facilities tested represent a random sample of the industries. The source category is specific enough so that variability within the source category population may be minimized.

C--Average: Developed only from A- and B-rated test data from a reasonable number of facilities. Although no specific bias is evident, it is not clear if the facilities tested represent a random sample of the industry. In addition, the source category is specific enough so that variability within the source category population may be minimized.

D--Below average: The emission factor was developed only from A- and B-rated test data from a small number of facilities, and there is reason to suspect that these facilities do not represent a random sample of the industry. There also may be evidence of variability within the source category population. Limitations on the use of the emission factor are noted in the emission factor table.

E--Poor: The emission factor was developed from C- and D-rated test data, and there is reason to suspect that the facilities tested do not represent a random sample of the industry. There also may be evidence of variability within the source category population. Limitations on the use of these factors are always noted.

The use of these criteria is somewhat subjective and depends to an extent upon the individual reviewer. Details of the rating of each candidate emission factor are provided in Chapter 4 of this report.

REFERENCES FOR SECTION 3

1. Technical Procedures for Developing AP-42 Emission Factors and Preparing AP-42 Sections (Draft), Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC, March 6, 1992.

4. AP-42 SECTION DEVELOPMENT

4.1 DEVELOPMENT OF SECTION NARRATIVE

The draft AP-42 section is a revised section addressing perlite processing. The draft section is based on information gathered from the references cited and includes a description of the industry, a process flow diagram, and emission factors for expansion furnaces and rotary dryers in the perlite processing industry.

4.2 POLLUTANT EMISSION FACTOR DEVELOPMENT¹⁻⁹

A total of nine test reports were documented and reviewed in the process of developing the section on perlite processing. Six of the tests were performed to determine PM emissions from various sources associated with perlite processing. Two of the test reports document the results of State compliance tests. One test was performed as part of the development of background information for the NSPS for calciners and dryers in the mineral industries (Reference 1). Reference 2, which documented compliance test data, was not used for developing emission factors because the test methods used were not valid. Reference 3, which documented a test to determine particulate matter emissions, was not used for developing emission factors because the minimum criteria for selecting the sampling site described in EPA Method 1 were not met.

4.2.1 Review of Specific Data Sets

4.2.1.1 Reference 1. This test measured filterable PM emissions from the expansion furnace baghouse east and west stacks. Perlite to be expanded for horticultural uses goes into an expansion furnace. Exhaust gases are ducted through a cyclone and a baghouse and then exit to the atmosphere via two stacks. EPA Method 5 was used to measure filterable PM emissions from the two baghouse stacks. A trace element analysis of the PM catch (both front and back half of the sampling train) was conducted on one of the test runs. Emission factors calculated from these trace element data were included in this section, but were not used in the AP-42 section because they are based on a single test run.

A rating of A was assigned to the test data for filterable PM and carbon dioxide (CO₂) emissions. The methodology appeared to be sound and no problems were reported. No rating was assigned to the trace element test data because only one test run was conducted.

4.2.1.2 Reference 4. This test measured controlled filterable PM emissions from both the dryer and the mill baghouses. Exhaust gases from the dryer passed through dual cyclones before entering the baghouse. The dryer stack was tested for (1) filterable PM emissions using EPA Method 5 and (2) flue gas concentration using the Fyrite method. The mill stack was tested using a high-volume sampler.

A rating of B was assigned to the test data for filterable PM emissions from the dryer baghouse stack. The test methodology was sound, but there was insufficient background information provided to merit a higher rating. Test data for flue gas concentrations from the baghouse stacks were not used because the test methodology was not valid. The test data for filterable PM emissions from the mill baghouse stack were not used due to insufficient documentation and because only one run was performed for this test.

4.2.1.3 Reference 5. This test measured emissions of filterable PM from an expansion furnace controlled by dual cyclones followed by a baghouse. Particulate matter emissions were measured using

EPA Method 5, and three test runs were performed. An Orsat analysis was performed to determine flue gas composition, but the data from this analysis were not used because only one run was performed.

A rating of B was assigned to the test data for filterable PM emissions. A sound test methodology was used and no problems were reported, but only an average production rate was included in the report.

4.2.1.4 Reference 6. This test measured filterable PM emissions. One baghouse controlled emissions in the kiln dryer exhaust, and one baghouse controlled emissions from miscellaneous plant operations. Exhaust from the kiln dryer passed directly into a baghouse and then was vented to the atmosphere through a stack. On both stacks, EPA Method 5 was used to test for PM emissions, and Orsat was used to perform the gas analysis. The only problem noted was during Run 3 on the dryer stack: the gas flow rate decreased substantially, probably due to material caking on the baghouse fabric.

A rating of B was assigned to the test data for filterable PM emissions from both the dryer stack and the fugitive emissions stack. Both stacks were tested using sound test methodology, but there were insufficient background data to merit a higher rating. The test data for gas analysis from both stacks were not used because only one test was performed on each stack.

4.2.1.5 Reference 7. This test measured filterable PM emissions from the dryer stack. Exhaust from the gas-fired rotary dryer passed through a baghouse and then through a stack to the atmosphere. Filterable PM emissions were quantified using an EPA Method 5 sampling train. Orsat was used to determine flue gas composition.

A rating of B was assigned to these test data for both PM and CO₂ emissions. A sound test methodology was used, but there were insufficient background data to merit a higher rating.

4.2.1.6 Reference 8. This test measured PM emissions from a furnace stack. Exhaust from the expansion furnace went to a modified wet cyclone and then entered the atmosphere via a stack. EPA Method 5 was used to determine PM emissions. Fyrite was used to determine flue gas composition.

A rating of B was assigned to the test data for PM emissions. The test methodology was sound, but the test report lacked adequate detail to merit a higher rating. The test data for CO₂ emissions were not used because of unsound test methodology.

4.2.2 Review of XATEF and SPECIATE Data Base Emission Factors

The XATEF and SPECIATE data bases do not contain emission factors for perlite processing.

4.2.3 Review of Test Data in AP-42 Background File

The previous version of AP-42 Section 8.17, Perlite Processing, includes only one emission factor--for uncontrolled PM emissions from a vertical furnace. The emission factor is based on unpublished test data from 1967, and the test report is not located in the background files. Because of the lack of documentation and the fact that the tests predate the development of EPA reference methods, the test method and representativeness of the data are highly suspect. Therefore, the emission factor based on these data was not incorporated in the revised AP-42 section.

4.2.4 Results of Data Analysis

Emission factors were developed for filterable PM and CO₂ emissions from perlite expansion furnaces and dryers. Trace element emission factors were developed for emissions from perlite expansion furnaces. An emission factor was also developed for filterable PM emissions from miscellaneous plant operations.

For filterable PM emissions from expansion furnaces and dryers, emission factors were developed for emissions controlled by baghouses only, cyclones only, and baghouses and cyclones together. For CO₂ emissions, the emission factor was developed for dryers with cyclones and baghouses and those with baghouses only. However, because none of these devices provide control of CO₂ emissions, these emission factors are considered to represent uncontrolled CO₂ emissions. For trace metals, emission factors were developed for emissions from expansion furnaces controlled by cyclones and baghouses. The miscellaneous plant operations emission factor was developed for filterable PM emissions controlled by a baghouse, but it was not included in the revised AP-42 section because the source was not specific enough to be of any use.

The emission factors for filterable PM and CO₂ emissions are rated D. No more than two B-rated tests were used to develop any of these emission factors, and because the industry is relatively large, tests from two facilities are probably not representative of the industry. Emission factors for trace element emissions from expansion furnaces are not rated because they are based on a single test run.

Table 4-1 summarizes the emission data and emission factors developed from References 1, 4, and 6 through 9. Table 4-2 summarizes the emission factors to be included in the draft AP-42 section for perlite processing.

TABLE 4-1. SUMMARY OF TEST DATA FOR PERLITE PROCESSING

Equipment	Type of control	Pollutant	No. of runs	Data rating	Emission factor ^a		Ref. No.
					Range, kg/Mg (lb/ton)	Average, kg/Mg (lb/ton) ^a	
Expansion furnace	Cyclone, baghouse	Filterable PM	3	A	0.29-0.36 (0.58-0.71)	0.32 (0.64)	1
Expansion furnace	Cyclone, baghouse	CO ₂ (uncontrolled)	3	A	399-460 (798-919)	423 (847)	1
Expansion furnace	Cyclone, baghouse	Aluminum	1	NR	0.017 (0.033)	0.017 0.033	1
Expansion furnace	Cyclone, baghouse	Beryllium	1	NR	b	b	1
Expansion furnace	Cyclone, baghouse	Calcium	1	NR	0.044 (0.087)	0.044 (0.087)	1
Expansion furnace	Cyclone, baghouse	Chromium	1	NR	9.3x10 ⁻⁵ (1.9x10 ⁻⁴)	9.3x10 ⁻⁵ (1.9x10 ⁻⁴)	1
Expansion furnace	Cyclone, baghouse	Fluorine	1	NR	0.0088 (0.018)	0.0088 (0.018)	1
Expansion furnace	Cyclone, baghouse	Iron	1	NR	0.019 (0.037)	0.019 (0.037)	1
Expansion furnace	Cyclone, baghouse	Lead	1	NR	2.6x10 ⁻⁵ (5.2x10 ⁻⁵)	2.6x10 ⁻⁵ (5.2x10 ⁻⁵)	1
Expansion furnace	Cyclone, baghouse	Magnesium	1	NR	0.0023 (0.0045)	0.0023 (0.0045)	1
Expansion furnace	Cyclone, baghouse	Manganese	1	NR	1.7x10 ⁻⁴ (3.4x10 ⁻⁴)	1.7x10 ⁻⁴ (3.4x10 ⁻⁴)	1
Expansion furnace	Cyclone, baghouse	Mercury	1	NR	4.7x10 ⁻⁶ (9.4x10 ⁻⁶)	4.7x10 ⁻⁶ (9.4x10 ⁻⁶)	1
Expansion furnace	Cyclone, baghouse	Nickel	1	NR	3.8x10 ⁻⁴ (7.5x10 ⁻⁴)	3.8x10 ⁻⁴ (7.5x10 ⁻⁴)	1
Expansion furnace	Cyclone, baghouse	Titanium	1	NR	2.0x10 ⁻⁴ (3.9x10 ⁻⁴)	2.0x10 ⁻⁴ (3.9x10 ⁻⁴)	1
Expansion furnace	Cyclone, baghouse	Uranium	1	NR	b	b	1
Expansion furnace	Cyclone, baghouse	Vanadium	1	NR	b	b	1
Expansion furnace	Cyclone, baghouse	Zinc	1	NR	4.3x10 ⁻⁴ (8.5x10 ⁻⁴)	4.3x10 ⁻⁴ (8.5x10 ⁻⁴)	1
Dryer	Dual cyclones, baghouse	Filterable PM	3	B	0.018-0.027 (0.036-0.054)	0.023 (0.046)	4

TABLE 4-1. (continued)

Equipment	Type of control	Pollutant	No. of runs	Data rating	Emission factor ^a		Ref. No.
					Range, kg/Mg (lb/ton)	Average, kg/Mg (lb/ton) ^a	
Expansion furnace	Cyclones, baghouse	Filterable PM	3	B	0.10-0.17 (0.20-0.34)	0.13 (0.27)	5
Dryer	Cyclone, baghouse	Filterable PM	3	B	0.17-0.28 (0.34-0.57)	0.23 (0.46)	6
Misc. plant operations	Baghouse	Filterable PM	3	B	0.22-0.23 (0.44-0.46)	0.22 (0.45)	6
Dryer	Baghouse	Filterable PM	3	B	0.60-0.68 (1.21-1.35)	0.64 (1.28)	7
Dryer	Baghouse	CO ₂ (uncontrolled)	3	B	14.1-18.1 (28.3-36.2)	15.7 (31.4)	7
Expansion furnace	Wet cyclone	Filterable PM	3	B	0.86-1.16 (1.72-2.32)	1.06 (2.12)	8

NR = not rated.

^aEmission factor in units of pollutant weight per weight of perlite dried or expanded.

^bConcentration below the detection limit.

TABLE 4-2. SUMMARY OF EMISSION FACTORS FOR PERLITE PROCESSING

Equipment	Type of control	Pollutant	No. of tests	Average emission factor, kg/Mg (lb/ton) ^a	Emission factor rating	Ref. Nos.
Expansion furnace	Cyclone, baghouse	Filterable PM	2	0.15 (0.29)	D	1,5
Expansion furnace	Cyclone, baghouse ^b	CO ₂	1	423 (847)	D	1
Expansion furnace	Wet cyclone	Filterable PM	1	1.1 (2.1)	D	8
Dryer	Cyclones, baghouse	Filterable PM	2	0.13 (0.25)	D	4,6
Dryer	Baghouse	Filterable PM	1	0.64 (1.28)	D	7
Dryer	Baghouse ^b	CO ₂	1	16 (31)	D	7

^aEmission factor in units of pollutant weight per weight of perlite dried or expanded.

^bThese devices provide no control of CO₂ emissions.

REFERENCES FOR SECTION 4

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5. Stack Test Report, Perlite Process: National Gypsum Company, Roll Road, Clarence Center, New York, Buffalo Testing Laboratories, Buffalo, NY, December 1972.
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8.17 PERLITE PROCESSING

8.17.1 Process Description^{1,2}

Perlite is a glassy volcanic rock with a pearl-like luster. It usually exhibits numerous concentric cracks that cause it to resemble an onion skin. A typical perlite sample is composed of 71 to 75 percent silicon dioxide, 12.5 to 18.0 percent alumina, 4 to 5 percent potassium oxide, 1 to 4 percent sodium and calcium oxides, and trace amounts of metal oxides.

Crude perlite ore is mined, crushed, dried in a rotary dryer, ground, screened, and shipped to expansion plants. Horizontal rotary or vertical stationary expansion furnaces are used to expand the processed perlite ore.

The normal size of crude perlite expanded for use in plaster aggregates ranges from plus 250 micrometers (μm) (60 mesh) to minus 1.4 millimeters (mm) (12 mesh). Crude perlite expanded for use as a concrete aggregate ranges from 1 mm (plus 16 mesh) to 0.2 mm (plus 100 mesh). Ninety percent of the crude perlite ore expanded for horticultural uses is greater than 841 μm (20 mesh).

Crude perlite is mined using open-pit methods and then is moved to the plant site, where it is stockpiled. Figure 8.17-1 presents emission factors for filterable PM and CO₂ emissions from the expanding and drying processes.

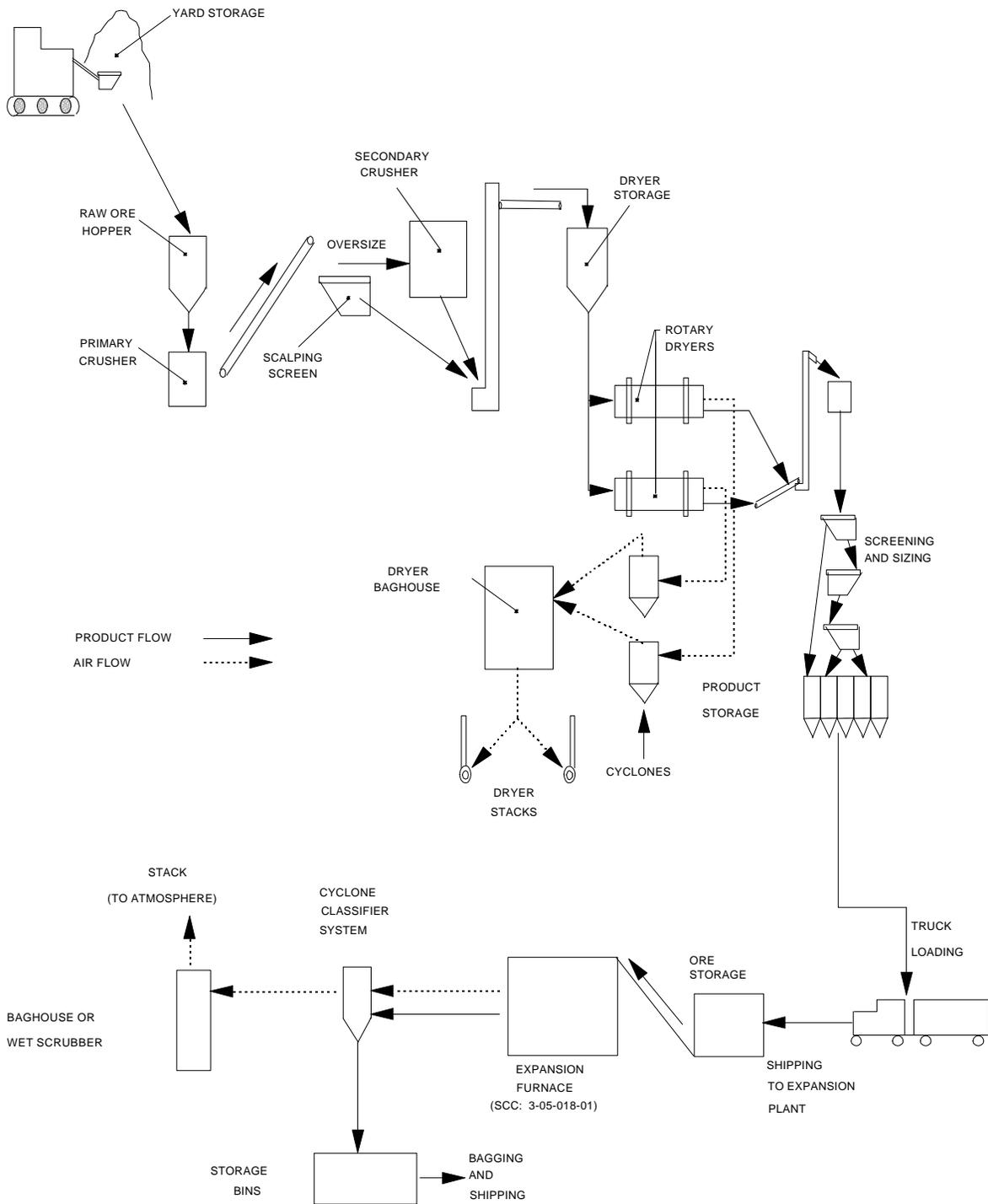


Figure 8.17-1. Flow diagram for perlite processing.¹

is a flow diagram of crude ore processing. The first processing step is to reduce the diameter of the ore to approximately 1.6 centimeters (cm) (0.6 inch [in.]) in a primary jaw crusher. The crude ore is then passed through a rotary dryer, which reduces the moisture content from between 4 and 10 percent to less than 1 percent.

After drying, secondary grinding takes place in a closed-circuit system using screens, air classifiers, hammer mills, and rod mills. Oversized material produced from the secondary circuit is returned to the primary crusher. Large quantities of fines, produced throughout the processing stages, are removed by air classification at designated stages. The desired size processed perlite ore is stored until it is shipped to an expansion plant.

At the expansion plants, the processed ore is either preheated or fed directly to the furnace. Preheating the material to approximately 430°C (800°F) reduces the amount of fines produced in the expansion process, which increases usable output and controls the uniformity of product density. In the furnace, the perlite ore reaches a temperature of 760° to 980°C (1400° to 1800°F), at which point it begins to soften to a plastic state where the entrapped combined water is released as steam. This causes the hot perlite particles to expand 4 to 20 times their original size. A suction fan draws the expanded particles out of the furnace and transports them pneumatically to a cyclone classifier system to be collected. The air-suspended perlite particles are also cooled as they are transported to the collection equipment. The cyclone classifier system collects the expanded perlite, removes the excessive fines, and discharges gases to a baghouse or wet scrubber for air pollution control.

The grades of expanded perlite produced can also be adjusted by changing the heating cycle, altering the cutoff points for size collection, and blending various crude ore sizes. All processed products are graded for specific uses and are usually stored before being shipped. Most production rates are less than 1.8 megagrams per hour (Mg/hr) megagrams (2 tons/hr), and expansion furnace temperatures range from 870° to 980°C (1600° to 1800°F). Natural gas is typically used for fuel, although No. 2 fuel oil and propane are occasionally used. Fuel consumption varies from 2,800 to 8,960 kilojoules per kilogram (kJ/kg) (2.4×10^6 to 7.7×10^6 British thermal units per ton [Btu/ton]) of product.

8.17.2 Emissions and Controls^{1,3-11}

The major pollutant of concern emitted from perlite processing facilities is particulate matter (PM). The dryers, expansion furnaces, and handling operations can all be sources of PM emissions. Emissions of nitrogen oxides from perlite expansion and drying generally are negligible. When sulfur-containing fuels are used, sulfur dioxide (SO₂) emissions may result from combustion sources. However, the most common type of fuel used in perlite expansion furnaces and dryers is natural gas, which is not a significant source of SO₂ emissions.

Test data from one perlite plant indicate that perlite expansion furnaces emit a number of trace elements, including aluminum, calcium, chromium, fluorine, iron, lead, magnesium, manganese, mercury, nickel, titanium, and zinc. However, because the data consist of a single test run, emission factors were not developed for these elements. The sample also was analyzed for beryllium, uranium, and vanadium, but these elements were not detected.

To control PM emissions from both dryers and expansion furnaces, the majority of perlite plants use baghouses, some use cyclones either alone or in conjunction with baghouses, and a few use scrubbers. Frequently, PM emissions from material handling processes and from the dryers are controlled by the same

device. Large plants generally have separate fabric filters for dryer emissions, whereas small plants often use a common fabric filter to control emissions from dryers and materials handling operations. In most plants, fabric filters are preceded by cyclones for product recovery. Wet scrubbers are also used in a small number of perlite plants to control emissions from perlite milling and expansion sources.

TABLE 8.17-1 (METRIC UNITS). EMISSION FACTORS FOR PERLITE PROCESSING^a

All Emission Factors in kg/Mg Perlite Expanded
Ratings (A-E) Follow Each Factor

Process (SCC)	Filterable PM ^b		CO ₂	
Expansion furnace (3-05-018-01)	ND		420 ^c	D
Expansion furnace with wet cyclone (3-05-018-01)	1.1 ^d	D	NA	
Expansion furnace with cyclone and baghouse (3-05-018-01)	0.15 ^e	D	NA	
Dryer (3-05-018-__)	ND		16 ^f	D
Dryer with baghouse (3-05-018-__)	0.64 ^f	D	NA	
Dryer with cyclones and baghouses (3-05-018-__)	0.13 ^g	D	NA	

TABLE 8.17-1 (ENGLISH UNITS). EMISSION FACTORS FOR PERLITE PROCESSING^a

All Emission Factors in lb/ton Perlite Expanded
Ratings (A-E) Follow Each Factor

Process (SCC)	Filterable PM ^b		CO ₂	
Expansion furnace (3-05-018-01)	ND		850 ^c	D
Expansion furnace with wet cyclone (3-05-018-01)	2.1 ^d	D	NA	
Expansion furnace with cyclone and baghouse (3-05-018-01)	0.29 ^e	D	NA	
Dryer (3-05-018-__)	ND		31 ^f	D
Dryer with baghouse (3-05-018-__)	1.28 ^f	D	NA	
Dryer with cyclones and baghouses (3-05-018-__)	0.25 ^g	D	NA	

ND = no data available. NA = not applicable.

^aAll emission factors represent controlled emissions.

^bFilterable PM is that PM collected on or prior to the filter of an EPA Method 5 (or equivalent) sampling train.

^cReference 4.

^dReference 11.

^eReferences 4, 8.

^fReference 10.

^gReferences 7, 9.

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