INDUSTRY PROFILE #13

PORTLAND CEMENT

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INDUSTRY PROFILES

Introduction

This Industry Profile is one of a series briefly describing small or medium-sized industries. The Profiles provide basic information for starting manufacturing plants in developing nations. Specifically, they provide general plant descriptions, financial, and technical factors for their operation, and sources of information and expertise. The series is intended to be useful in determining whether the industries described warrant further inquiry either to rule out or to decide upon investment. The underlying assumption of these Profiles is that the individual making use of them already has some knowledge and experience in industrial development.

Dollar values are listed only for machinery and equipment costs, and are primarily based on equipment in the United States. The price does not include shipping costs or import-export taxes, which must be considered and will vary greatly from country to country. No other investment costs are included (such as land value, building rental, labor, etc.) as those prices also vary. These items are mentioned to provide the investor with a general checklist of considerations for setting up a business.

IMPORTANT

These profiles should not be substituted for feasibility studies. Before an investment is made in a plant, a feasibility study should be conducted. This may require skilled economic and engineering expertise. The following illustrates the range of questions to which answers must be obtained:

*** What is the extent of the present demand for the product, and how is it now being satisfied?**

*** Will the estimated price and quality of the product make it competitive?**

*** What is the marketing and distribution plan and to whom will the product be sold?**

*** How will the plant be financed?**

*** Has a realistic time schedule for construction, equipment, delivery, obtaining materials and supplies, training of personnel, and the start-up time for the plant been developed?**

*** How are needed materials and supplies to be procured and machinery and equipment to be maintained and repaired?**

*** Are trained personnel available?**

*** Do adequate transportation, storage, power, communication, fuel, water, and other facilities exist?**

*** What management controls for design, production, quality control, and other factors have been included?**

*** Will the industry complement or interfere with development plans for the area?**

*** What social, cultural, environmental, and technological considerations must be addressed regarding manufacture and use of this product?**

**Fully documented information responding to these and many other questions should be
determined before proceeding with implementation of an industrial project.**

Equipment Suppliers, Engineering Companies

**The services of professional engineers are desirable in the design of industrial plants even though
the proposed plant may be small. A correct design is one that provides the greatest economy in
the investment of funds and establishes the basis of operation that will be most profitable in the
beginning and will also be capable of expansion without expensive alteration.**

Professional engineers who specialize in industrial design can be found be

**referring to the
published cards in various engineering magazines. They may also be reached through their
national organizations.**

**Manufacturers of industrial equipment employ engineers familiar with the design and installation
of their specialized products. These manufacturers are usually willing to give prospective
customers the benefit of technical advice by those engineers in determining the suitability of their
equipment in any proposed project.**

VITA

**Volunteers in Technical Assistance (VITA) is a private, non-profit, volunteer organization
engaged in international development. Through its varied activities and services, VITA fosters
self-sufficiency by promoting increased economic productivity. Supported by a volunteer roster
of over 5,000 experts in a wide variety of fields, VITA is able to provide high quality technical
information to requesters. This information is increasingly conveyed through low-cost advanced
communication technologies, including terrestrial packet radio and low-earth-orbiting satellite.
VITA also implements both long- and short-term projects to promote enterprise development and**

transfer technology.

PORTLAND CEMENT

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DESCRIPTION

The Product. To make Portland cement, a crushed mixture of limestone and clay is heated to form "clinker," which is mixed with gypsum and ground to a fine, dehydrated powder. Quality control is essential during manufacture. The cement is shipped in moisture-resistant bags or other containers, or in bulk.

When mixed with sand, gravel, and water in proportions that depend upon the application, it sets to a dense, rock-like material, called concrete or mortar. Additives may accelerate or retard the set, increase strength, or make it resistant to acid, sulphate, shrinkage, or freeze-thaw cracking.

The Facility. This Profile describes a small plant producing 35,000 metric tons of cement a year.

GENERAL EVALUATION

In most developing countries, concrete is an increasingly important construction material. It is basic to the construction of roads, dams, canals, water and sewer ducts, houses and factories. Since the raw materials are often readily available, cement production can improve a country's living standards and decrease its dependence on imports.

Economic and Technical Outlook

Economic. Starting a cement industry depends on the availability of power, fuel, and water. Sufficient raw materials must be available to justify investment in even the smallest plant. Because cement manufacture is a continuous process and consumes much energy, access to a reliable supply of fuel or electric power is required.

Depending on local conditions, the running costs of a small plant may be higher than those of a much larger plant of exactly the same type, per ton of cement produced. Potential local demand and cost of transport of cement from outside the region are important in deciding whether to build a new plant and what size it should be.

Technical. The basic process is age-old; no technological breakthroughs are expected. Raw-material costs can be reduced if the plant is built where limestone can be quarried. Limestone quarries can be used by a small plant even if their yield is only

moderate. Coral dredged from a nearby underwater source can be used instead.

Manufacturing Equipment Flexibility. Some of the equipment and machines required for this operation, such as the crushers, grinders, batchers, and kiln, are used in other industries and may be purchased secondhand.

Large, complex cement plants in industrial countries are designed for automation and high energy efficiency. They require specially qualified staff. In developing countries, small and medium sized plants can be planned using modern knowledge. Such plants use less automation and staff that is less specially qualified. Process and maintenance should be simple and reliable.

Knowledge Base. Cement technology requires knowledge and skills, some of which may best be acquired by working for a time in an industry outside the home country. Market analysts should determine whether the potential growth of the country is likely to support the industry. Geologists should determine the adequacy of the mineral resources; power and water supplies must be investigated.

The technical staff required to operate a cement plant includes an operating engineer and a manager. Quality control requires training in analytical chemistry. Successful continuous operation depends on mechanics, trained technicians, and plant operators who have some understanding of chemical processing.

Quality Control. Sampling for quality control may be needed

several times per hour. A test lab must be part of the plant. It should be furnished with sampling, curing, and test equipment to ensure uniformity at each stage of production and to meet international standards. A well-run lab is essential to keeping a competitive market position and maintaining confidence in the product.

Constraints and Limitations. These are as follows: high investment in equipment and land; limited range of product output; high cost of transport of raw materials to plant and product to market; the need to use the product in a short time after manufacture, because it is unavoidably damaged by high humidity and moisture; and the need for a reliable source of power to maintain continuous and efficient operation, thus lowering the high costs of start-up and shut-down.

MARKET ASPECTS

Users. Small users need bagged cement. Cement can be bulk shipped in tank, truck, or railroad cars, and sold to precasters of large structural parts (pipes, posts, blocks, railroad ties, etc.), and builders of industrial, commercial, or residential structures.

Cement may be sold directly to public-sector organizations, private contractors in the largest urban areas, and local distributors. If nearby countries need the material and the plant has excess capacity, it may export a portion of its production. However, most export sales are either spot sales or by short-term contract.

Suppliers. If a country or region now depends on imported cement supply, a first step may be to improve the efficiency of local distribution, whether by land or water. If the expected market demand justifies a larger plant than that described here, a next step may be the importation of clinker, to be pulverized and mixed with gypsum; then bagged for distribution. Or, depending on resources and market conditions, local planners may want to build a plant for complete manufacture.

Sales Channels and Methods. Producers and/or suppliers are directly contacted, or through advertising in local technical publications and other channels. Generally, cement companies sell directly to the users.

Geographic Extent of Market. If the market area is extended too far, transport costs make the cement noncompetitive with the cement from other sources or with other materials. This may be up to 300 km from the plant by land, and farther by water.

Competition. Competition from other materials will depend on relative costs. In regions of high rainfall, lumber will be competitive. Close to industrial centers or major ports, steel and other structural metals will compete. Brick, soil cement or adobe, sometimes traditionally used in housing, may compete because of their low cost.

Market Capacity. Market capacity depends on local purchasing power, potential for growth (including new businesses and tourism),

availability of competing materials, and attitudes toward acquiring new technologies. Therefore, annual per capita consumption of cement may vary from 5 to 150 kg for an agrarian society and from 300 to 700 kg for an industrial society.

The cement market follows the downturns and booms of the construction industry. Prices of cement can fall and rise, often dramatically.

PRODUCTION AND PLANT REQUIREMENTS: SMALL PLANT (Note 1)

Requirements Amount

Annual Output 35,000 T

1. Infrastructure, Utilities

Land (not including quarry) 2 ha

Building and structures (Note 2) 4,600 sq m
Power (can be hydro) 2 - 3 Mw
Fuel (expressed as coal) 20 T/d
Water 400 T/d
Materials input 4,000 T/mo.
(Road access required; rail or waterway access desirable.)

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2. Major Equipment and Machinery

Production tools and equipment
Including principal items: air drills, compressor, shovels, crushers, hammer mill, conveyor & elevator, rough mill & slurry tanks, kiln, feed tank, clinker cooler, conveyors, silos, finish mill elevator, bagging equipment, lab equipment, pumping equipment, water storage, maintenance equipment, power plant; other tools and equipment, furniture and fixtures. (Note 3) $5 million

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3. Materials & Supplies

Raw Materials
limestone & clay 175 T/d
gypsum 5 T/d

Supplies
grinding balls varies

Packaging
bags @ 50% sales in bags 3,800/d

4. Labor (varies with local conditions)

Skilled

plant operators, instrument technicians 10
Semiskilled
mechanics, equipment operators 20

Unskilled
general labor 20

Indirect
administration, manager, supervisors, chemist,
sales/marketing 20

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5. Distribution/Supply flow

Materials in per day 180 T/d
Materials out per day 100 T/d

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6. Market Requirements

Market area population varies

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7. Other Requirements

Raw material reserves 15 years

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Notes:

1. These estimates refer to the 35,000 T/y plant. To build and operate a plant twice as large may require a little less than

twice as much in space and financial resources. The amount of the saving will depend on local conditions.

2. Buildings need to be designed for the specific process selected. Silo height may be 8 - 12 m. Stack height will depend on local safety and environmental rules.

3. Estimated US$ cost in the United States in 1985, based on 1965 prices and an inflation multiplier of 4 for the elapsed period. The actual cost in the country of use may vary considerably from this figure, depending on local conditions and and process requirements. Used production tools and equipment from reliable sources can often be obtained at much lower prices.

PROCESS DESCRIPTION

1. Diagrams
A. Flow sheet/plan

<FIGURE>

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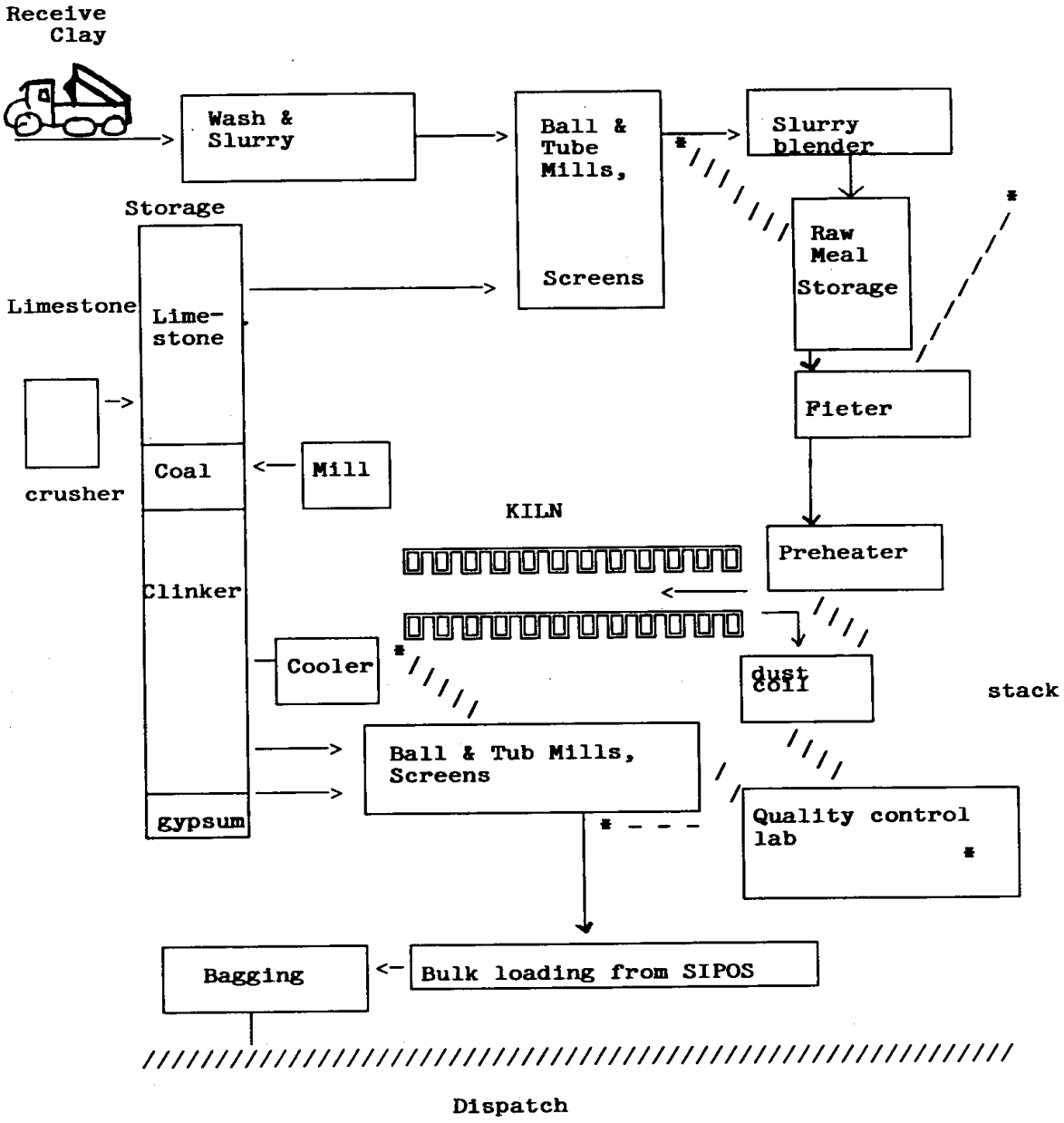
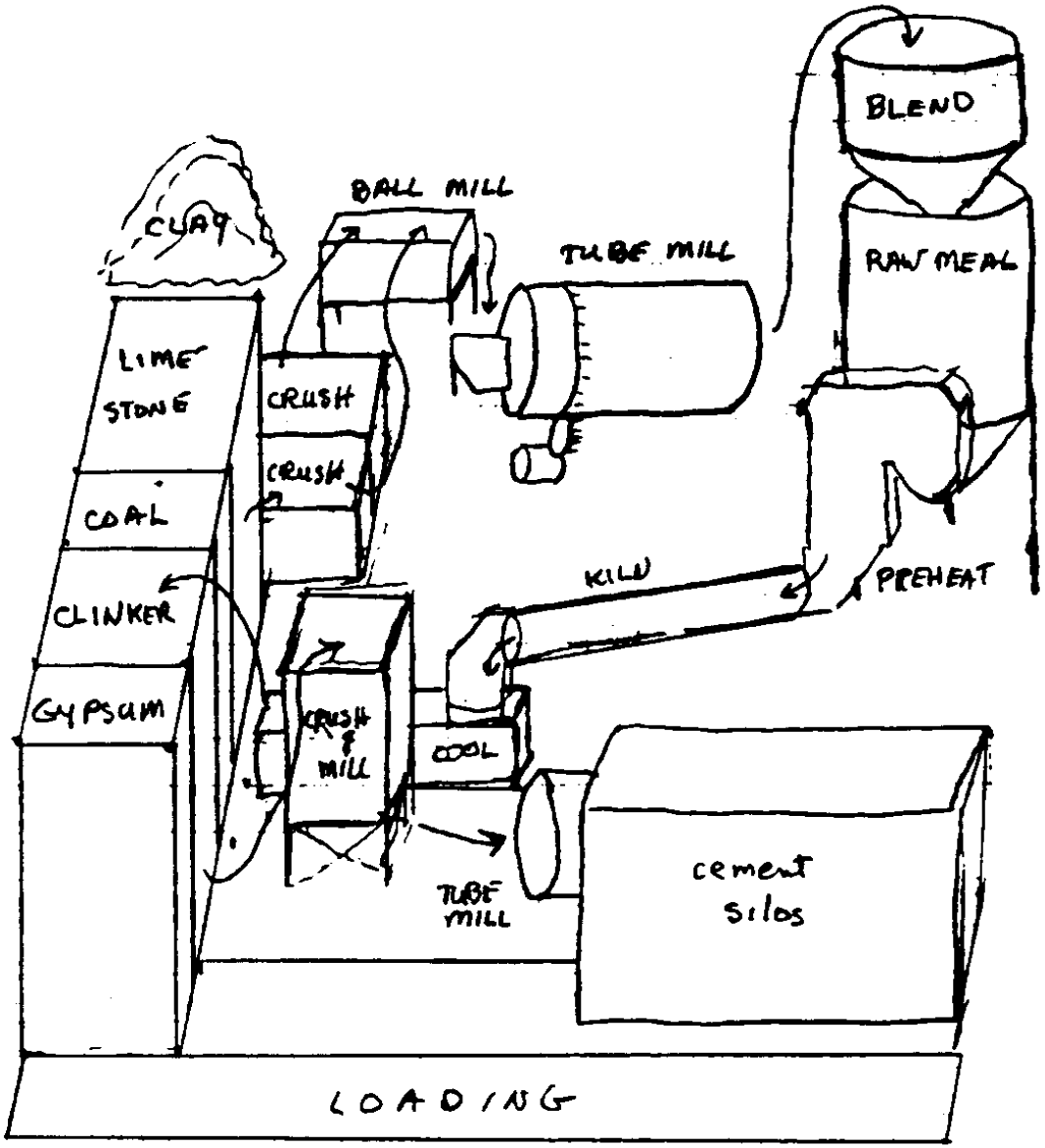


B. Elevation diagram

<FIGURE>

04p07.gif (600x600)


BLEND
BALL MILL
TUBE MILL
RAW MEAL
CLAY
LIME STONE
CRUSH
CRUSH
COAL
KILN
PREHEAT
CLINKER
GYPSUM
CRUSH & MILL
COOL
TUBE MILL
cement silos
LOADING

2. Remarks

The flow sheet/plan is for the medium plant. It uses a single stage preheater (for fuel economy). Dust collectors are included for pollution abatement; a clinker silo also reduces pollution. Dashed lines show key sampling points for quality control.

REFERENCES

Unless otherwise stated, the addresses are in the United States.

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Kohlhaas, B. Cement Engineers Handbook (4th ed.), 1982, 790 pp., ISBN 0-9915000-2-4. Heyden & Sons, Inc., 247 S. 41st St., Philadelphia, Pennsylvania 19104.

Lea, F. M. Chemistry of Cement and Concrete, 1971, 1100 pp., ISBN 0-8206-0212-4 Chemical Publishing Co., 80 8th Ave., New York, New York 10011

Peray, K. Cement Manufacturer's Handbook, 1979, ISBN 0-8206-0245-0 Chemical Publishing Co., 80 8th Ave., New York, New York 10011

Peray, K. Rotary Cement Kiln (2nd edition) 1986, ISBN 0-8206-0314-7

Chemical Publishing Co., 80 8th Ave., New York, New York 10011

Periodicals

Minerals Yearbook. Bureau of Mines, U.S. Department of Interior, Washington, DC 20241. ISBN 024-004-02024-1 Government Printing Office, Washington, DC 20402

Pit & Quarry (Monthly), Harcourt, Brace, Jovanovich, Inc., 7500 old Oak Boulevard, Cleveland, Ohio 44130

Rock Products (Monthly), 300 W. Adams Street, Chicago, Illinois 60606

Trade Associations

American Concrete Institute, P. O. Box 4754, Redford Station, Detroit, Michigan 48219

American Society for Testing and Materials (ASTM), 1916 Race Street, Philadelphia, Pennsylvania 19103

Portland Cement Association, 420 Old Orchard Road, Skokie, Illinois 60077

Equipment Suppliers, Engineering Companies

Engineering for Improved Distribution Systems/Feasibility Studies:

Bendy Engineering Co., 4260 Shoreline Drive Earth City, Missouri 63045

Independent Process Engineers Kaiser Engineers, Kaiser Center, 300 Lakeside Drive, Oakland, California 94666

Perry Equipment Co., Mt. Laurel Road, Hainesport, New Jersey 08036 [Used equipment.]

Project Services Co., Inc., P. O. Box 24628, Tempe, Arizona 85282
Process Engineers with Major Affiliations:

o Holderbank Consulting, Ltd., 2310 Lakeshore Road West, Mississauga, Ontario, L5J 1K2, Canada

o Lafarge Consultants Ltd., 606 Cathcart Street, Montral, Quebec, H3H 1L7, Canada

o Design, Supply, and Erect Small Scale Cement Plants: Micro Cemtech, S.A., Paseo de la Castellana 42-3', 28046 Madrid, Spain (a GATX-Fuller associate).

o Design, Supply and Erect Full Scale Cement Plants/Grinding Plants: Fuller Company, P.O. Box 2040, Bethlehem, Pennsylvania 18001

o Humboldt Wedag, 3200 Pointe Parkway, Atlanta (Norcross), Georgia, 30092

o Polysius Corp., 180 Interstate, North Atlanta, Georgia 30339

o F.L. Smith & Co., 300 Knickerbocker Road, Cresskill, New Jersey 07626

Directories

American Cement Directory, Bradley Pulverizer Co., 123 South Third Street, Allentown, Pennsylvania 18105 (covers North, South and Central America)

Used Equipment Directory, 70 Sip Avenue, Jersey City, New Jersey 07306-3076

World Cement Directory, Cembureau, 1980, 2 vols., International Publications Service, 242 Cherry Street, Philadelphia, Pennsylvania 19106; or European Cement Association, 2 rue St. Charles, F-75740 Paris, France

VITA Resources

VITA has documents on file and in microfiche dealing with the cement industry.

VITA Venture Services

VITA Venture Services, a subsidiary of VITA, provides commercial services for industrial development. This service-for-fee includes technology and financial information, technical assistance,

marketing, and joint ventures. For further information, contact VITA.

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