Iran Small Industries and Industrial Parks Organizations Company of industrial towns of Chaharmahal and Bakhtiari Province

Feasibility study of Calcined Dolomite Factory

Produced by
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Scheme summary	
Feasibility study	Project title
1396/03	Data entry time
2018/12-2017-12	Construction Phase
1 year	The term
2019/01-2023/12	Operation phase
5 year	The term
Rial	Accounting currency
Absolute	Unit
Thousand Rials	Domestic currency
1 euro=4200Rial	Expedited currency rate

Investment costs			
Total Investment	Total Phase Production	Total phase of construction	
47409146	0	47409146	Total fixed investment costs
3020220	0	3020220	Total pre-production costs
3020220	0	3020220	Pre-production expenditures (net of interest)
0	0	0	Interest
6305011.272	0	7212285.36	Increase in net working capital
53714157.27	-6864275.279	54621431.36	Total investment costs

Financial resources			
Total Investment	Total Phase Production	Total phase of construction	
54621431.4	0	54621431.4	Total equity
0	0	0	Foreign
54621431.4	0	54621431.4	Internal
0	0	0	Total long-term loans
0	0	0	Foreign
0	0	0	Internal
0	0	0	Total short-term loans
0	0	0	Foreign
0	0	0	Internal
3714257.332	3714257.332	0	Paid accounts
58335688.69	3714257.332	54621431.36	Total funding sources

Income and operating costs			
Year 2023	Reference year 2021	First year 2019	
170601257.2	163976602.5	112090500.0	Came in sales
101121003.0	101121003.0	76851962.3	Cost of factory production
7530000.0	7530000.0	5722800.0	Administrative charge
108651003.0	108651003.0	82574762.3	operational cost
10899766.0	10899766.0	8283822.2	Depreciation
0.0	0.0	0.0	The cost of financing
119550769.0	119550769.0	90858584.4	Total production cost
1195507.7	1195507.7	908585.8	Marketing costs
2824.5	2824	2824.5	The cost of the product
0	0	0	Interest on short-term deposits

49854980.6	43230325.8	20323329.7	Gross operating profit
0	0	0	Unearned income
0	0	0	Unexpected losses
0	0	0	Depreciation reserves
49854980.6	43230325.8	20323329.72	Gross profit
0	0	0	Investment reserves
49854980.6	43230325.8	20323329.72	Taxable profit
12463745.14	10807581.45	5080832.429	income tax
37391235.41	32422744.36	15242497.29	Net profit

Relations						
2023	2022	2021	2020	2019	2018	
37391235.41	34882393.4	32422744.36	19159930.92	15242497.29	-61503189.1	Annual profit
29.00%						IRR sensitivity IRR return rate
The current value of 3191729.9 Rials is 18%						
126%						ROR
2.18						Return of capital

Series-to-sales analysis					
2023	2022	2021	2020	2019	
170601257.2	167256134.6	163976602.5	146292851.3	112090500	Sales revenue
128551519	128551519	128551519	116981882.3	97699154.44	Variable costs
42049738.24	38704615.55	35425083.5	29310968.96	14391345.56	profit margin
25%	23%	22%	20%	13%	Profit margin ratio
11541829.2	11541829.2	11541829.2	11541829.2	11541829.2	Fixed costs

46826702.25	49876266.96	53425136.99	57605980.36	89896347.81	Sales value is on sale
27%	30%	33%	39%	80%	Head to head ratio
3.643247315	3.353421271	3.069278092	2.539542775	1.246886027	Fixed cost coverage ratio
11541829.2	11541829.2	11541829.2	11541829.2	11541829.2	Fixed costs
46826702.25	49876266.96	53425136.99	57605980.36	89896347.81	Sales value is in effect
27%	30%	33%	39%	80%	Pipeline ratio
3.643247315	3.353421271	3.069278092	2.539542775	1.246886027	Fixed cost coverage ratio

Introduction of the process:

The principal uses of industrial dolomite, firstly as a refractory and later as a flux, have been linked with iron and steelmaking since the latter part of the 19th century. For this reason industrial dolomite has been regarded as of vital importance to the iron and steel industry. The other major markets for dolomite are in glassmaking and for agricultural use (Figure 1). Raw dolomite and calcined dolomite have a number of different uses in the iron and steel industry. However, changes in iron and steel making technology during the 20th century have had a marked effect on the demand for dolomite for specific uses and the market continues to evolve. The principal uses of dolomite are those that utilise the mineral in the calcined form (dolomitic lime).

The most important of these is as a steelmaking slag flux, where the dolomitic lime replaces some of the quicklime (CaO) used in slag production. In addition to increasing slag fluidity, the presence of magnesia also helps to protect, and thus improve the life of, the steel vessel's refractory linings, which are made of magnesia. The total quantity used has been declining in line with a fall in iron and steel production. Some 260 000 tonnes of calcined dolomite were used for this purpose in 2004.

Hard burnt dolomite, which is subsequently formed into pellets and fired again to achieve a higher bulk density, is used in the manufacture of dolomite refractory bricks. Dolomite refractory bricks are no longer produced in the UK but calcined dolomite is exported to Germany and Turkey for this purpose. Low levels of silica and iron oxides are required for this use. Another form of calcined dolomite with added iron oxide is used to repair furnace linings. Dolomitic lime was formerly used on a substantial scale for the manufacture of seawater magnesia principally for refractory use at a plant in Hartlepool. However, the production of refractory magnesia ceased in 2002. Production of chemical grade magnesium oxide powders and magnesium hydroxide suspensions continued until June 2005, when the seawater plant completely closed. The use of raw dolomite as part of the flux burden in ironmaking has been replaced by an igneous rock containing a high proportion of the mineral olivine [$(Mg,Fe)_2SiO_4$], which in addition to supplying magnesia, also contributes silica. However, raw dolomite may be introduced as a flux directly into the Basic Oxygen Steelmaking vessel where it also replaces steel scrap as a coolant. For many of the applications in the iron and steel industry there are strict limits on the chemistry of the dolomite used, which mainly needs to be low in silica (often <0.55% SiO_2) or <0.3% for some applications, with low iron (<0.55% Fe_2O_3), sulphur (<0.1%) and phosphorus (<0.02%). Another important market for industrial dolomite is in glassmaking.

Most commercial glasses consist essentially of silica together with soda (Na_2O) and lime (CaO), the lime being partly replaced by magnesia (MgO) for some purposes. Lime is introduced into the glass melt as limestone ($CaCO_3$) and magnesia by adding dolomite [$CaMg(CO_3)_2$]. However, in the flat glass industry most lime is introduced with the dolomite and only a little limestone is used to balance the CaO/MgO ratio.

Lime and magnesia improve the durability of the glass but magnesia also inhibits the devitrification process, which is particularly important in the manufacture of flat glass. Dolomite is also used in container glass. A critical factor in the supply of any glassmaking raw material, including dolomite, is iron content as this is a serious impurity in the manufacture of colourless glasses. In contrast to silica sand, mineral processing cannot effectively lower the iron content of dolomite (or limestone).

Product introduction and applications in various industries

Most (89%) of the dolomite used in the world is for construction use where chemistry and magnesium content is not important. Magnesium oxide content and the levels of impurities pres-

ent are important for industrial and agricultural uses. Total consumption for these applications has declined significantly in recent years and is about 1.4 million tonnes, although this figure is believed to be somewhat underestimated. No major increases in demand are anticipated.

Economic importance

The long association of dolomite with the iron and steel industry has meant that the mineral has been regarded as of considerable economic importance. Despite a decline in usage, steel-making remains the major market for dolomite both for use as a flux and refractory raw material. Because of the restricted distribution of suitable quality dolomite for these applications, certain sites will remain of considerable eco nomic importance. In addition, dolomite is an important raw material in the glass industry where it is used notably as an essential constituent of flat glass.

processing

Dolomite is extracted by surface quarrying using drill and blast techniques although breaking by impact hammer is used at one operation. The dolomite is selectively quarried at several distinct levels, known as 'benches', to manage the stone quality, which may vary considerably in chemistry and hardness. Lower quality dolomite is sold for construction use, although the dolomite forming the top bench atThrislington Quarry is soft and mainly waste rock. Processing can be simply divided into crushing, screening, grading and storage prior to loading and transportation. However, various grades of dolomitic lime are produced at Thrislington and Whitwell quarries by burning the stone in rotary kilns at very high tempera tures in the range 1450°C-2000°C. Residence times in the kiln are between 3.5 and 6 hours. At such high temperatures the dolomite is transformed from the double carbonate ($CaCO_3.MgCO_3$) to the oxide form (CaO.MgO), with carbon dioxide being driven off as a gas. Depending on the product being produced, additives, mainly iron, are also injected into the kiln. For refractory brick manufacture the dolomite goes through a second sintering (firing) stage after being pelletised to achieve the high bulk densities necessary for refractory use. Lower temperature calcination produces a more reactive, dolomitic lime suitable for use as flux. Distinct size fractions (typically 38 mm19 mm and 19 mm-8 mm) are required for burning. This is a factor of some practical importance in that the yield from crushing to achieve suitably sized stone for burning can be as low as 45% because of losses into the fines. These fines, including fines generated in the kiln, are sold for agricultural use.

A critical factor in dolomite used for glassmaking is consistency in quality and notably in iron content. A major feature of processing is, therefore, achieving a consistent product by carefully controlled blending.

All industrial dolomite quarries also produce significant quantities of crushed rock aggregates. The largest quarries producing industrial dolomite are Thrislington and Whitwell and each quarry produces over 1.2 million tonnes annually. The proportion of dolomite going for industrial use is generally less than 50% of the total. The fines from quarrying dolomite both for industrial and construction use are typicallysold as aglime.

In Durham the Permian Yellow Sands crop out intermittently at the base of the Permian escarpment and dip to the east beneath the dolomite. They consist of fine to medium-grade sand and comprise a resource of fine aggregatemainly used as building sand. The sand is mainly worked in association with the overlying dolomite, for example where they are exposed in the base of Thrislington Quarry.

Permian limestones overlie concealed coalbearing strata and some coal extraction has taken place in the floors of large dolomite quarries in Durham.

Dolomite is valued for its magnesia (MgO) content and it is this, which distinguishes it from limestone. It can be partly substituted for bylimestone for certain applications, although in practice it is dolomite that tends to replace limestone. Dolomite and limestone both neutralise soil acidity but only dolomite can correct magnesium deficiencies in the soil.

Magnesium, like calcium, is a plant nutrient. As a flux in steelmaking, dolomitic lime also contributes magnesia and this imparts additional benefits, notably protection of the steel vessel linings from chemical wear. In ironmaking however, olivine has largely replaced dolomite as a lime-free source of magnesia for use as a flux and slag conditioner. In glassmaking both lime and magnesia improve durability, but magnesia is essential inimproving the devitrification properties of some glasses (e.g. float glass). Dolomite is an essential raw material for float glass manufacture and there is normally no economic alternative.

One of the main advantages of dolomite as a raw material is that it is relatively inexpensive. Dolomite, because of its low price, remains the popular choice when available locally. However, the use of dolomite over its limited mineral alternatives is dependent on the mineral's purity and its proximity to the market.

Resources of higher purity dolomite and dolomitic limestone are more scarcely distributed than high purity limestone. However, the demand for dolomite is significantly lower. Industrial dolomite is currently produced at only thirteen sites in the iran but constraints on quality mean that indigenous dolomite is not of sufficient purity for all applications and imports

are required. The close association of the uses of dolomite with iron and steelmaking, both as a flux and refractory, has meant that the mineral is considered to be of considerable national importance.

Consequently, in allocating reserves, Mineral Planning Authorities, have wished to see these maximized for industrial end uses. However, all sites also produce substantial amounts of aggregate from inferior quality dolomite unsuitable for industrial use. In addition, because of particle size requirements for kiln feed material, the yield of calcined product can be as low as 50%. Processing dolomite, and particularly high temperature calcination, requires substantial capital investment in plant. Longer-term security of supply issues are, therefore, of concern to the industry.

Processes Induced through Calcination

Calcination often uses heat, sometimes in the absence of oxygen, to induce one or more of the following things:

•Phase Transition/Change

•Removal of a Volatile Fraction

•Decomposition

•Removal of Crystalline Water

•Chemical Separation (Dissociation)

Materials

Rotary kilns are extremely flexible thermal processing devices, and are capable of processing a wide variety of materials. Some of the materials commonly calcined in a rotary kiln include:

•Ceramics and Refractories

•Alumina

•Ores

•Coal

•Calcium Carbonate

Calcination Process

Calcinations is the process of subjecting a substance to the action of heat, but without fusion, for the purpose of causing some change in its physical or chemical constitution. The objects of calcination are usually: (1) to drive off water, present as absorbed moisture, as "water of crystallization," or as "water of constitution"; (2) to drive off carbon dioxide, sulphite dioxide, or other volatile constituent; (3) to oxidize a part or the whole of the substance. 'there are a few other purposes for which calcination is employed in special cases, and these will be mentioned in their propel' places. The process is often called "roasting," "firing," or "burning," by the workmen. It is carried on in furnaces, retorts, or kilns, and very often the material is raked over or stirred, during the process, to secure uniformity in the product. The furnaces used for calcining substances very much in their construction, but there are three general classes: muffle, reverberator, and shaft furnaces or kilns.

Muffle furnaces (below picture) are so constructed that neither the fuel nor the fire gases come in direct contact with the material to be calcined. A retort (A) of iron, brickwork, or fire-clay, is placed over the fire grate (G). Flues (F. F) are built around the retort and through these the hot gases from the fire pass on their way to the chimney (E).

Reverberatory furnaces are built in many forms, but in all cases the flames and hot gases from thefire come in direct contact with the material to be calcined, but the fuel is separated from it. Thesimplest and most common form is shown in below picture. The fire burns on the grate at (G), and theflames, passing over the bridge at (E), are deflected down ward by the low sloping roof of the furnace, and pass directly over the surface of the charge in the bed of the furnace at (B), finally escaping through the throat (F) into the chimney. The charge is spread out in a thin layer on the bed (B), and may be either oxidized or reduced according to the method of firing and the amount of air admitted. The revolving furnace (Figs. 3 and 39) is a very important modification of the reverberatory furnace. This consists of a horizontal or slightly inclined cylinder (B) of iron or steel plates, lined with fire-brick or other suitable fire-resisting material, and open at each end. The flames from a grate (A) at one end pass through it on their way to the chimney (D). The cylinder is revolved about its. *longitudinal axis* by means of a gear. It is turned until a manhole in the side is brought directly under a hole in the floor above, the bolted cover is removed, and the charge dumped in. The revolution of the cylinder stirs the charge thoroughly, and brings it into intimate contact with the flame. To discharge the contents, the cylinder is stopped when the manhole is on the under side, the cover is removed, and the material drops out upon the floor or into a car placed for it. To facilitate discharging, the lining usually slopes from all sides towards the manhole. The speed varies from about two revolutions a minute to one revolution in five or ten minutes. These furnaces are now extensively used, their advantages being the intimate mixing and even heating of the charge, and the large quantities, amounting often to several tons, which can be worked at one time.

Shaft furnaces and kilns are of two general classes, periodic and continuous. After a charge has been calcined, the periodic furnace (p. 149) or kiln is allowed to cool before it is emptied and recharged. In the continuous variety (p. 148) this is not necessary, and the calcined substance is withdrawn and fresh material added without loss of time or waste of heat. The furnaces may be charged with alternate layers of fuel and material to be calcined. By this method, known as "burning with short flame," the material to be calcined is in close contact with the fuel, and is of course more or less contaminated with ashes. In other forms of shaft furnaces the fuel is burned on a separate grate, and only the flames and hot gases pass into the shaft; consequently, no ashes are left in the product. This process is called" burning with long flame." Any of the various forms of furnace here mentioned may be heated by natural gas, generator gas, or oil. This is very advantageous in the matter of cleanliness and of regularity of temperature.

Step 1: Pre-extraction testing

Before quarrying a deposit, drill samples need to be carefully analyzed to determine the quality of the deposit in terms of percentage of calcium carbonate present and absence of inert materials like silica and iron oxides.

Some of the quarry deposits are richer in calcium carbonate than others, and for calcination purposes it is essential that that correct grade of 97% calcium carbonate content and above be chosen. Fines from the drill are collected, bagged and labelled and then sent to the on-site lab at the calcination plant for chemical analysis.

Step 2: At the quarry

After identifying the desirable limestone rock for extraction, a drill and blast method of extraction is used. An excavator loads the loosened limestone into dump trucks for delivery to the on-site crushing plant. This continuous-feed process crushes limestone chip into a range of sizes. Limestone chip 15–50 mm in size is sent to the calcination plant, while other sizes are used in other processes.

Step 3. Arrival at calcination plant

The chip is off-loaded and moved by conveyor belt to an intermediary stockpile.

From here, the chip is then moved to the preheater hopper where the chip needs to be preheated. First, it is loaded into the large hopper, and hot gas from the kiln at about 1000°C percolates through the chip.After 4 hours in the preheater, large plungers push the hot chip into the upper portion of the rotary kiln. This preheating process is essential as it contributes markedly to the efficiency of converting dolomite into calcined dolomite.

Step 4. In the rotary kiln

The rotary kiln is 60 m long and 3 m in diameter. It rotates at 1 rpm.Coal is ground to a fine powder, mixed with air and blown into the rotary kiln, where it ignites, producing the necessary heat.

Theoretically, to convert 1 tonne of dolomite into calcined dolomite, 3.17 GJ of heat energy is required, as the chemical reaction occurring is endothermic. However, due to energy losses through the process, the actual amount per tonne of limestone calcined is between 5 and 6 GJ.

The chip will be in the kiln for 2 hours. The temperature in the kiln ranges from 1200°C at the terminal end to 1000°C at the upper end.Not all of the dolomite is converted to calcined dolomite. A small amount known as 'loss on ignition' (LOI) remains. This is about 0.5–1%.Every hour, a sample of lime chip exiting the kiln is taken and sent to the on-site lab for analysis.

Step 5. Testing in the lab

The main analyses methods used in the lab are X-ray fluorescence and wet-lab titration. A known mass of the sample is mixed with a flux and heated in a platinum crucible to 1030°C for 8 minutes, agitated and then heated for a further 5 minutes. The contents of the crucible are then poured into a preheated mould.

This is allowed to cool. The ceramic disc that results is then loaded into the XRF machine, which is programmed to analyze the sample for 11 elements found in their oxide form and reads out a percentage composition.

Two elements present in the lime are of concern to end-users such as the steel-making industry. High silicon content can cause wear and tear problems in the steel-making process due to the abrasiveness of silica. Sulfur can cause brittleness of the final steel product, so it needs to be very low in the lime used.Samples from the kiln are also analysed for incomplete conversion to calcium oxide or loss on ignition.

Step 6. Calcined dolomite chip processing

The Calcined dolomite chip exiting the rotary kiln falls on to a system of conveyors. Air is blown over the chip to cool it down. The hot air that results from this is blown back into the kiln.The cooled chip is crushed to a powder, known commercially as 'burnt lime', and this is either bagged or loaded into shipping containers. Transport to customers is by either road or rail.

Step 7. Waste management

The gas stream exiting the kiln via the preheater is passed through a venturi water scrubber. This system removes particulate matter from the gas as well as several non-metal oxides such as sulfur dioxide. The remaining wet gas (28% carbon dioxide, 20% water vapor and the remainder mainly nitrogen) from the scrubber is then vented to the air via a 30 m chimney. As the wet gas cools, water condenses, forming a visible cloud of steam. The wastewater is channeled to an on-site settling pond, and the solid material that collects is removed and placed in waste cells at the quarry. Careful monitoring of the waste management systems is enacted to ensure that the calcination plant's operation meet all of the national and local requirements for air, water and waste discharge.

Rotary Kilns. Figure 3 illustrates a rotary kiln system with a preheater. A rotary kiln is a long cylinder, ranging in length from 75 to 500 feet, with a diameter between 4 and 11 feet. This cylinder is set at an incline of 3 to 5 degrees and rotates at a rate of 35 to 80 revolutions per hour. The inner surface of the cylinder is lined with refractory brick. Surrounding the brick is a layer of insulation, then an outer casing of steel boiler plate. Before entering the kiln, the limestone passes through the preheater, where it is heated with hot exhaust gases from the kiln. Preheaters improve thermal efficiency by using heat from the kiln that might otherwise be lost (Boynton, 1980). Burning fuel enters the cylinder from the lower end, and pre-heated limestone is delivered into the upper end. As the limestone passes through the cylinder that is filled with flame and hot combustion gases, it calcines into lime, which is discharged at the lower end of the cylinder (Boynton, 1980).

Lime must be cooled after exiting the rotary kiln. Various types of coolers are used, including contact coolers, satellite coolers, rotary coolers, and grate coolers. These coolers operate under different principles, but they serve the same two purposes: to cool the lime for further handling and to recapture heat. The first two types listed are the most commonly used because they are the most effective at heat recuperation (Boynton, 1980). Most rotary kilns are fired by coal; however, with the correct adaptations, coke, oil, and natural gas can also be used (Gutschick, 1994).

The refractory brick linings in all kilns must be replaced periodically, because heat, abrasion, and temperature changes cause them to disintegrate. Plants try to avoid cooling and reheating lime kilns as much as possible because this hastens disintegration. When plants need to stop production, they will often slow-fire the kilns, or maintain their heat until production resumes. It is generally less costly to keep the kilns hot than it is to replace the linings or to restart the kilns (Boynton, 1980).

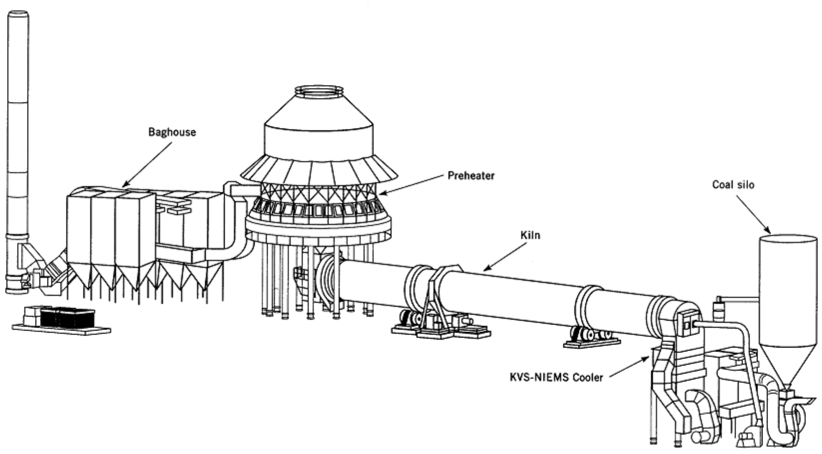

Figure1. Preheater rotary kiln system for calcined dolomite production

Vertical Kilns. The vertical kiln has many different variations, but all operate under the same general premise. Figure 4 is a diagram of a vertical kiln. Vertical kilns are large vertical cylinders that are completely filled from the top with large chunks of limestone. These kilns have four zones, or sections: the preheating zone, the calcining zone, the finishing zone, and the cooling zone. These zones are not physically separated from one another. They are terms used to indicate areas within the kiln, which is a continuous cylinderBurning fuel is injected into the cylinder just beneath the calcining zone, causing the limestone in this zone to calcine. Hot gasses from the calcining zone migrate upward, warming the stone in the preheating zone. Finished lime drops into the cooling zone, where cool air is blown through it. Air blown into the cooling zone carries recovered heat upward into the calcining zone, where it also provides air for combustion. Cooled lime is removed from the bottom, making room for the limestone and lime in the upper levels to descend. Some vertical kilns require an attendant to determine when calcining is complete. The attendant must open “poke holes” in the kiln and dislodge the mass of hot lime with a long iron bar, allowing it to drop down into the cooling zone (Boynton, 1980). The predominant fuels for vertical kilns are natural gas and fuel oil (Boynton, 1980). Vertical kilns require large stones (6 to 8 inches in diameter) to allow for the circulation of combustion gases. Stones that are too small to be used are called “spalls.” Large quantities of spalls can accumulate at plants with vertical kilns and can be difficult or impossible to dispose of profitably. Depending on the source of limestone, spalls can constitute from 30 to 70 percent of the limestone intended for use as kiln feed. Rotary kilns can use small stones that calcine faster and lead to fewer spalls. To solve the problem of spalls, some plants have installed rotary kilns in addition to vertical kilns. European researchers have developed vertical kilns that can use small stones, but this technology has not been implemented in the U.S. (Boynton, 1980). For a number of reasons, rotary kilns have largely replaced vertical kilns in the U.S. They dominate the industry because they can be fired with coal, require less labor, lead to fewer spalls, and have the highest output and quality of all kilns (Boynton, 1980; Gutschick, 1994). In contrast, vertical kilns are preferred in many other parts of the world. They require smaller capital investment and have greater fuel efficiency than rotary kilns. Miscellaneous Kiln Types.

Parallel-flow kilns are beginning to gain acceptance in the U.S. These kilns are made up of two side-by-side vertical shafts that are similar to vertical kilns (see Figure 5). The two shafts are connected in the middle, allowing gases to 2-9 flow from one shaft to the other. The shafts alternate functions: while one is acting as the calcining shaft, the other serves as the preheating shaft. Limestone fills the shafts from the top. Hot combustion gases are fired down the first shaft, calcining the lime. The exhaust then flows across and up through the second shaft, preheating the lime. Every 12 to 14 minutes, the flow is reversed. The lime is cooled in the bottom section of each shaft with a countercurrent flow of air. Finished lime exits from the bottom of each shaft. Parallel-flow kilns can be fired with natural gas or oil. They are energy-efficient and produce high-quality lime (Wood, 1996; Sauers, Beige, and Smith, 1993b).

The Fluo-Solids kiln, which is a fluidized-bed system, looks like a vertical kiln on the outside but operates on a different principle (see Figure 2-6). It calcines tiny (0.23 to 2.38 m) particles of limestone. These tiny particles are “fluidized,” or suspended in air in the preheating and calcining zones of the kiln.

These kilns require external cooling equipment, as described in the section on rotary kilns. Because small particles will burn at lower temperatures, these kilns have relatively low fuel consumption. They also produce consistently high-quality lime.

However, the cost of providing such finely ground limestone as kiln feed prohibits the use of these kilns in most areas (Boynton, 1980). The calcimatic kiln (also called a rotary hearth kiln) consists of a circular hearth that rotates through a kiln (see Figure 7).

Preheated limestone is loaded onto the hearth. It rotates through the kiln, and finished lime is removed from the hearth after one complete rotation.

External cooling equipment is also used. These kilns have not been widely accepted because they can only operate with gas and oil and have poor fuel efficiency (Boynton, 1980).

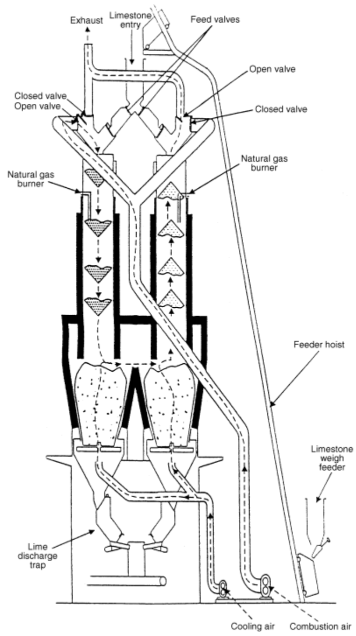

Figure 2. Parallel flow kiln with left shaft calcining and right shaft preheating

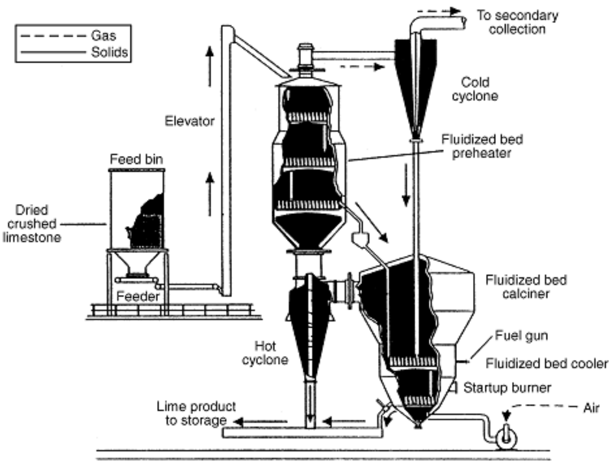

Figure 3. Fluidized bed kiln

The attachment
Investments and Economic Review

Plan fixed costs

Table (1) fixed investment plan				
Total price (Thousand Rials)			Table number and cost statement	Row
Total	Required	Paid		
7176000	7176000	0	Table (1-1) Ground	1
2957186	2993186	0	Table (1-2) Cost of landscaping	2
2264600	2264600	0	Table (1-3) For accommodations and services	3
1551280	1551280	0	Table (1-4) Machinery	4
3898000	3898000	0	Table (1-5) Facilities	5
7400000	7400000	0	Table (1-6) vehicles	6
700000	700000	0	Table (1-7) Service Equipment and Workshop Equipment, Laboratory Equipment	7
1248500	1248500	0	Table (1-8) Furniture and office equipment	8
2020220	2020220	0	Table (1-9) Pre-production expenditures	9
4257360	4257360	0	Unpredictable costs, except land and costs before operation (3%)	10
33509146	33509146	0	Total	

Land Estimated Plan Requirements

Table (1-1) Ground							
(Total price (Thousand Rials			Amounts			Description	Row
Total	Needed	Bought	Unit price	Unit	Area	Land of Shahrekord Industrial Towns	1
7176000000	7176000000	0	598000	Square meters	12000		
7176000	7176000	0	12000			Total price (Thousand Rials	

Landscaping costs

Table (1-2) Cost of landscaping							
(Total price (Thousand Rials			Amounts			Describe	Row
Total	Needed	Bought	Unit price	Unit	Area		
72000	72000	0	18000	m^2	6000	Leveling	1

						and excavating	
273450	273450	0	150000	m^2	1823	green space	2
270000	270000	0	2250000	m^2	12	Parking	3
1105000	1105000	0	650000	m^2	1700	Walking and pedestrian pavement	4
934736	934736	0	710400	m^2	960	Fencing and lying	5
50000	50000	0	25000000	piece	2	Door	6
252000	252000	0	6300000	piece	40	Lighting (Vertical Light Base)	7
2957186	2957186	0				total	

Construction costs

Table (1-3) Production, Administrative and Service Buildings							
(Total price (Thousand Rials			Amounts			Description	Row
Total	Needed	Bought	Unit price	Sub-basement (area (m²	Technical specification and type of building		
7500000	7500000	0	5000000	1500	Niches to a height of 10 meters	Production Hall	1
2000000	2000000	0	4000000	500	Niches to a height of 6 meters	Primary warehouse	2
2600000	2600000	0	4000000	650	Niches to a height of 6 meters	Product Stores	3
3600000	3600000	0	4500000	800	Nave height 8 meters	Downstream of manufactured products	4
1225000	1225000	0	7000000	175	Room up to 3 meters	Production hall control rooms	5
1250000	1250000	0	5000000	250	Niches to a height of 10 meters	Product space requirements - downstream production	6
2975000	2975000	0	8500003500	350	Concrete	Office	7

					double floor building	Building and Laboratory	
1300000	1300000	0	6500000	200	Concrete double floor building	Cloakroom and dining room	8
192000	192000	0	600000320	32	Concrete buildings	Guard	9
2264600	2264600	0	4457			Total	

The cost of machinery and technical knowledge

Table (1-4) Machinery

(Total price (Thousand Rials			Unit price	Amounts	Specifications		Supplier	machinery Vertical furnace	Row
Total	Needed	Bought			Model	brand			
140000	140000	0	140000	1				Horizontal furnace	1
140000	140000	0	140000	1				Upgrade	2
30000000	30000000	0	10000000	3				The drawer	3
20000000	20000000	0	4000000	5				The cost of opening a credit and a financial item	4
500000000	500000000	0	500000000	1				The cost of packing and loading machines from the seller	5
800000000	800000000	0	800000000	1				Insurance of machinery	6
1000000	1000000	0	1000000	1				Shipping charge	7
200000000	200000000	0	200000000	1				machinery	8
1551280000	1551280000	0		Total					

Facilities

Table (1-5) Facilities

Total price (Thousand Rials)			Unit price	Unit	number	Description	Row
Total	Needed	Bought					
250000	250000	0	250000000	Set	1	Cooling system	1
450000	450000	0	450000000	Set	1	Heating system	2
550000	550000	0	550000000	Set	1	Fire extinguishing system	3
45000	45000	0	30000000	Inch	1/5	Water split	4
1110000	1110000	0	3700000	KW	300	Power branch	5
78000	78000	0	600000	m^2	130	Gas split	6
35000	35000	0	35000000	line	1	Telephony and communications branching	7
210000	210000	0	350000	m	600	Sewage system	8
810000	810000	0	450000	m	1800	Domestic plumbing (wage and salary)	9
360000	360000	0	Special facilities of this project				
30000000	30000	0	30000000	system		Central Telecommunication System	10
250000000	250000	0	250000000	Set		kitchen appliances	11
50000000	50000	0	50000000	Number		Gasoline storage tank	12
30000000	30000	0	30000000	Number		Diesel Fuel Reservoir	13
3898000	3898000	0	Total				

Vehicles

Table (1-6) Vehicles

Total price (Thousand Rials)			Unit price	Number	Application	Vehicle type	Row
Total	Needed	Bought					
2600000	2600000	0	1300000000	2	Product displacement	Forklift	1
3200000	3200000	0	3200000000	1	Material handling	loader	2
1600000	1600000	0	800000000	2	Product displacement	Crane	3
7400000	7400000	0	Total				

Environmental laboratory equipment

Table (1-7) Service equipment and workshop equipment, Outfitting tools						
(Total price (Thousand Rials			Unit price	Needed number	Description	Row
Total	Needed	Bought				
0	0	0	0	0	Laboratory equipment and supplies	1
700000000	700000000	0	700000000	1	Environmental protection, environmental protection, protection	2
700000000	700000000	0				

Administrative requirements

Table (1-8) Furniture and office equipment							
(Total price (Thousand Rials			Unit price	Number	Technical Specifications	Description	Row
Total	Needed	Bought					
550000	550000	0	22000000	25	Computer system with required specifications		1
108000	108000	0	12000000	9	To equip the managers of the company	Computer and accessories	2
16000	16000	0	16000000	1	To equip the kitchen	Office Desks	3
52500	52500	0	750000	70	Classification of documents and personnel personal equipment	Dining equipment	4
75000	75000	0	25000000	3	official services	File and file	5
30000	30000	0	30000000	1	Staffing Essentials	Refrigerator	6
30000	30000	0	30000000	1	official services	Accredited Accounts Manager	7
90000	90000	0	45000000	2	---	Supplies of cleaning and	8

						sanitation	
75000	75000	0	75000000	1	---	Copying machin	9
22000	22000	0	22000000	1	---	Network equipment	10
45000	45000	0	45000000	1	---	Phone - Fax - Central Machine	11
5000	5000	0	5000000	1	---	Health and safety equipment	12
150000	150000	0	150000000	1	A complete quality medium	CCTV system	13
1248500	1248500	0	Total				

Prepaid expenses

The cost of producing a test is equivalent to 1% of the first year production cost.

Table (1-9) Pre-production expenditures				
(Total price (Thousand Rials			Description	Row
Total	Needed	Bought		
100000	100000	0		1
450000	450000	00	The cost of consulting and engineering services before capitalization	2
220000	220000	0	Project management, project management, and construction rights	3
70000	70000	0	The cost of monitoring the plan	4
130000	130000	0	Travel and more	5
120000	120000	0	Get licenses and permissions	6
54500	54500	0	Administrative expenses, including registration of loans and loans and ...	7
875720	875720	0	Pre-operational costs (5% of total pre-production costs)	8
2020220	2020220	0	Total	

Unforeseen costs

Table (1-10) Possible Costs				
total cost	Unpredictable	The fixed cost of investment	the subject	Row
10052743	%3	33509146	Possible Costs	1

Production costs (In plan / operational capacity of the plan)

Table 3) Production / service costs		
Reference year (nominal (capacity production	Description	Row
%100	Proportion of utilization of production capacity	
57428000	Table (3.1) Cost of materials and packaging	1
13912800	Table (2-2) The cost of staffing for the project	2
2135280	Table (3-3) Cost of fuel, water and consumables and telephone	3
6710253	Table (3-4) The cost of repairs and maintenance	4
4189513	Table (3-5) public expenditure	5
84375846	Operating costs	
14143633	Table (3-6) The cost of depreciation of fixed assets	6
98519479	Total production costs	

Raw material cost

Table (3.1) Cost of materials and packaging								
Purchase Cost of Consumables Annual (Thousand (Rials	Unit price		annual consumption	Unit	Place of supply		Name and specifications of raw materials	Row
	Dollar	Rials			Foreign	Internal		
9000000000	40	3750	60000	Ton		Internal	Dolomite	1
750000			5	Ton		Internal	Materials Needed Rolling and Packing	2
9000750000								Total

The cost of manpower

Table (2-2) The personnel and personnel costs of the plan						
Average annual salary of 12 months ((Rials	Monthly average salary ((Rials	Required number of designs	Degree of education	Necessary expertise	Description	Row
Manufacturing personnel						
360000	30000000	1	Master / Bachelor		production manager	1
408000	17000000	2	Masters		Production supervisor	2
360000	15000000	2	Masters		programming expert	3
240000	20000000	1	Master / Bachelor		Maintenance and Repair Manager	4
360000	15000000	2	Masters		Production and repair expert	5
240000	20000000	1	Master / Bachelor		quality control manager	6
360000	15000000	2	Masters		Qualitative Control Expert	7
576000	12000000	4	Masters		Technician	8
240000	20000000	1	Masters		Administrators	9
216000	9000000	2	Diploma		warehouse keeper	10
1836000	850000	18	Diploma		skilled worker	10
264000	11000000	2	Diploma		Forklift driver	11
5460000	192500000	38	Productive Costs Collection			

Continued Table (2-2) Cost of Personnel and Workload						
Average annual salary of 12 months (Rials)	Monthly average salary (Rials)	Required number of designs	Degree of education	Necessary expertise	Description	Row
Manufacturing personnel						
600000	50000000	1	Masters / PhD			13
108000	9000000	1	Masters		CEO	14
240000	20000000	1	Master / Bachelor		Secretary	15
240000	20000000	1	Masters		Finance and Administration Manager	16

360000	15000000	2	Masters		Commercial and sales manager	17
360000	15000000	2	Diploma		Bachelor of Commerce	18
324000	9000000	3	Diploma		Accountants	19
204000	8500000				Guardian	20
288000	12000000		Diploma		Juice and services	21
2724000	158500000	15	The total cost of the administrative staff			
8184000	351000000	53	Total personnel costs			
5728800	Employee Benefits ((70%					
13912800	The value of human resources					

Fuel and power

The cost of consuming energy

Table (3-3) Cost of fuel, water, and consumables and telephone						
Total cost per year (Thousand ((Rials	Total cost per month (Thousand (Rials	Unit cost ((Rials	Consumption unit	Daily amount	Description	Row
1080	840	3000	Cubic meter	6	consuming water	1
1892800	155734	1300	Kilowatt hours	10400	Power consumed	2
924	77000	2200	Cubic meter	3000	Fuel (Urban Gas)	3
140000	11667	10000	Liters	50	Gasoline	4
134400	11200	4000	Liters	120	Gasoline	5
369600	30800	60	pulse	22000	connections	6
62720	5227	56000	Gigabyte	4	Others (Internet)	7
2601524		Total				

Repair and Maintenance

The cost of repairing and maintaining fixed assets is calculated in accordance with the following table.

Table (3-4) The cost of repairs and maintenance				
Annual maintenance cost ((thousandril	Rate	Asset value	Description	Row
48177	٪2	2408850	Table (1-2) Cost of landscaping	1
452840	٪2	22642000	Table (1-3) Building Reservations and Services	2
4144586	٪4	103614650	Table (1-4) Machinery	3
389800	٪10	3898000	Table (1-5) Facilities	4
1480000	٪20	7400000	Table (1-6) Vehicles	5
70000	٪10	700000	Table (1-7) Laboratory equipment and laboratory equipment	6
124850	٪10	1248500	Table (1-8) Furniture and office equipment	7
6710253	Total			

Spare parts and factory

In order to replace defective parts during production, we consider the cost of purchasing machinery and equipment (excluding shipping, insurance, technical advice, etc.) as a spare part for 1%.

Insurance Considering the probability of occurrence of accidents, approximately 2,000 pounds of fixed investment is considered as the cost of insurance of fixed assets.

Table (3-5) public expenditure		
Amount to thousand Rials	Description	Row
1605800	Advertising and marketing costs	1
360000	Cost of materials required	2
306067	Insurance of fixed assets	3
10012647	Cost of spare parts	4
405000	The cost of communication and staffing	5
500000	Advice fee	6
4189513	Total per year	

Amortization terms

Table (3-6) The cost of depreciation of fixed assets							
Scrap (٪) value	Many years	Rate (percentage increase)	start date	Depreciation method	Unit	Description	ردیف
100	0	0	2019/01	A linear approach to the value of scrap	TR	Buy land	1
15	28/57	7	2019/01	Accelerator	TR	Landscaping and landscaping	2
20	28/57	7	2019/01	Accelerator	TR	Construction work, construction works	3
Machinery and equipment factory							4
30	10	10	2019/01	A linear approach to the value of scrap	$	Machine	
0	2	50	2019/01	A linear approach to the value of scrap	TR	Other cast for machines supply	
Service equipment and offshore factory							5
10	13/33	15	2019/01	Accelerator	TR	Installations	
25	8	25	2019/01	Accelerator	TR	vehicles	

Sales plan

The currency used is the Thousand Rials, which is indicated by TR in short.

Sales plan						
2023	**2022**	**2021**	**2020**	**2019**		
42750	42750	42750	38902.5	32490	Production amount (tons)	**Calcined dolomite**
3990.672684	3912.4242	3835.71	3760.5	3450	Unit price (assuming a maximum annual increase of 5%)	
170601257.2	167256134.6	163976602.5	146292851.3	112090500	Amount	

	Calcined Dolomite Factory

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2023	2022	2021	2020	2019	
1	1	1	0.91	0.76	Production ratio to production capacity
0.02	0.02	**0.02**	**0.02**	0.09	Ratio of price increases

Total Costs (Thousand Rials)						
2023	2022	2021	2020	2019	2018	
0	0	0	0	0	57709146	Fixed design cost
0	0	0	0	0	2885457.3	Unforeseen cost
98519479	98519479	98519479	89652725.89	74874804.04	0	Cost of production
9000750	9000750	9000750	8190682.5	6840570	0	Raw material cost
7.53E+06	7.53E+06	7.53E+06	6.85E+06	5.72E+06	0	The cost of manpower
2601524	2601524	2601524	2367386.84	1977158.24	0	Cost of energy
6710253	6710253	6710253	6106330.23	5099792.28	0	The cost of repair
4189513	4189513	4189513	3812456.83	3184029.88	0	Cost of spare parts
128551519	128551519	128551519	116981882.3	97699154.44	60594603.3	Total