

**Pre-Feasibility Study for**

**Nano-silica powder production plan**



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**Abstract:**

Silicon dioxide or silica is the most abundant material which constitute the earth crust. This composite having the chemical formula of SiO2 has a structure resembling diamond. It is a crystal and white-colored material which has a high melting and boiling point. It can be found in the nature as crystals or in an amorph (having no shape) form. Its important application is in concrete production. The quality and properties of the resulting production is highly dependent on the kind and grain sizes of silica. The nano-silica solution consists of particles which are in the form of grains having a diameter of less than 100 nm. They can also be in the form of dry powder particles or as a suspension in a dispersible solvable solution. Its liquid which is the most common kind of suspension nano-silica solution, has multipurpose applications such as non-abrasive properties, anti-fire, and anti-reflex properties.

The required land area is 40,000 square meters. The required electricity power is 3.840.000 kWh annually, the water required is 2700 cubic meters annually and the fuel required is 800.000 cubic meters of gas annually. The project is expected to employ 45 people.

# **Project Title: Production of Nanosilica Powder**

## **Product introduction:**

Due to the rapid growth of scientific and practical research in nanoscience and nanotechnology in all sciences and industries, very little attention has been paid to the applications of this phenomenon in the construction industry and in construction in general, but recently due to nano amplifiers and strengtheners in construction materials, a new wave is gaining momentum in the construction industry.

Silicon dioxide or silica is the most abundant constituent of the earth's crust. This compound with the chemical formula SiO2 has a structure similar to diamond, it is a crystalline and white material, its melting and boiling point is relatively high, and it is found in nature in both crystalline and amorphous forms. Important application of nanosilica is in the production of concrete, where the quality and properties of the product depends on the type and size of silica particles. Here we emphasize the importance and exceptional effects of silicon in concrete.

Nanosilica is a solution of silica (Sio2) with a particle size of nanometers. Nanosilica solution consists of particles that can be dispersed in the form of pellets with a diameter of less than 100 nm or as dry powder particles or suspended in a liquid solution. The liquid form is the most common type of nanosilica solution and has multi-purpose applications, Such as abrasion, fireproof, anti-reflective surfaces.

The flexural and compressive strength of cement mortar with the addition of silica nanoparticles (Nano-Sio2) is higher than that of ordinary cement mortar. The addition of nanosilica increases the strength of one day by up to 30% and the strength of 28 days of concrete by up to 15%. Nanoparticles, as a filler, fill cement cavities and, like silica foam, increase the strength of concrete.

## **Explanation of consumption and application of the desired product in domestic and foreign markets:**

1) Execution of concrete on the sea shores, piers and bridges

2) Making high strength concretes

3) Construction of concrete dams, canals, tunnels, reservoirs and water sources

4) Flooring and facade construction

5) Manufacture of concrete subject to corrosion

## **Improved cement and concrete using nanotechnology**

Today, cement plays an important role in human life due to its various uses and applications. On the other hand, the issue of time is also an important economic issue for industry owners and reducing construction time will lead to significant economic savings.

## **Import and export conditions of the product:**

The conditions of export and import of goods in Iran are based on the export and import regulations of Iran. Most of the imported silica in the country is mostly in powder form, dried and cleaned of impurities, most of which are used in the glass and casting industry, etc., and since no special conditions are considered for nanosilica, Silica ores and its products are considered as permitted goods, therefore its import is not prohibited by law in accordance with customs and trade laws.

## **Review of alternative goods, competitors and analysis and its effects on product consumption:**

Nanosilica is found in abundance in foreign markets and is available to consumers. On the other hand, its unique properties have led to its consumption in various fields of industry. These properties, along with the lack of suitable products for their replacement, has caused us to boldly introduce the product under review as a product without a serious and effective replacement at the moment.

## **Strategic importance of goods in Iran and foreign markets**

Due to the fact that there is a lot of sand in desert areas and most of the area of our country is desert, sio2 is abundant in our country in the form of quartz and sand. Considering that the uses of silica in the industry range from mass production, concrete, and paint and plastics industries to food additives and medicine, as an important commodity, it must be considered in the development plan for the construction of industrial units.

According to the study, there are no active units in the production of nanosilica in the country and of course the production process for the nanosilica is not yet available. Due to this issue, which has been done according to field studies, it is necessary to build several nanosilica production units in the country.

In the case of machinery manufacturers, China, the United States and Korea are the major manufacturers of nanomaterial machineries, most of which are based on the crushing of raw materials according to the milling process.

## **Review of the trend of export and import of the product during the last five years**

Given that nanosilica has recently entered the field of industry and is an unknown product, no statistics on the import of this product are available.

## **Examine the need for the product with export priority**

Considering the huge dam and construction projects in the country and the standards related to construction and considering that Nano-SiO2 is an additive to concrete (of course, if the use of this material in other industries is omitted), the amount of consumption of this material can be Predicted with respect to cement produced in the country.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Year** | **2021** | **2022** | **2023** | **2024** | **2025** |
| **Cement production (tons)** | 70,000,000 | 65,000,000 | 59,000,000 | 55,000,000 | 53,000,000 |
| **Nano Silica Required (Tons)** | 1,400,000 | 1,300,000 | 1,180,000 | 1,100,000 | 1,060,000 |

Of course, the above calculated value is an approximate value that shows only nanosilica used in concrete, which due to the fact that nanosilica is also used in leather and food, etc., the calculated amount can be calculated with 5% considered overhead.

**Analysis and determination of the minimum economic capacity**

## **1- project's fixed costs**

|  |  |  |
| --- | --- | --- |
| # | Description | Amount in Million Rials |
| 1 | Land | 28000 |
| 2 | Landscaping and Buildings | 130370 |
| 3 | Facilities | 16104 |
| 4 | Vehicles | 5950 |
| 5 | Equipment and machinery | 152560 |
| 6 | Office and workshop equipment | 720 |
| 7 | Miscellaneous and unforeseen costs (2% above total) | 3338 |
| 8 | Pre-operation costs | 5272 |
|  | Total | 342312 |

## Equipment and Machinery

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| # | Machinery | Quantity | Currency cost  (Rials) | Total Costs (Million Rials) |
| 1 | Crusher line with class sieve and conveyor belt | 1 | 72,000,000,000 | 72000 |
| 2 | Vertical storage silos equipped with evacuation ogre | 1 | 6,400,000,000 | 6400 |
| 3 | Reactor equipped with mixer and temperature control jacket | 1 | 9,600,000,000 | 9600 |
| 4 | Filter | 1 | 7,700,000,000 | 7700 |
| 5 | Dynamic mixer | 1 | 3,240,000,000 | 3240 |
| 6 | Heat exchanger | 1 | 1,800,000,000 | 1800 |
| 7 | Water circulating pump | 4 | 360,000,000 | 1440 |
| 8 | cooling tower | 2 | 1,800,000,000 | 3600 |
| 9 | centrifuge | 1 | 2,520,000,000 | 2520 |
| 10 | Dryer | 1 | 11,760,000,000 | 11760 |
| 11 | Smoke and dust collection system | 1 | 2,880,000,000 | 2880 |
| 12 | water refinery | 1 | 2,160,000,000 | 2160 |
| 13 | Metallurgy Laboratory | 1 | 360,000,000 | 360 |
| 14 | 20 ton overhead crane | 2 | 5,400,000,000 | 10800 |
| 15 | Bag filling line | 1 | 5,000,000,000 | 5000 |
| 16 | Cost of transportation, installation and commissioning of equipment (8% of it | 1 |  | 11300 |
| Total | | | | 152560 |

## **2- Estimation of project's working expenses**

|  |  |  |
| --- | --- | --- |
| # | Description | Costs in Million Rial |
| 1 | Raw materials | 326800 |
| 2 | Salary | 20380 |
| 3 | Fuel and energy | 17442 |
| 4 | Repair and maintenance | 8524 |
| 5 | depreciation | 31846 |
| 6 | Unforeseen (2% of rows 1 to 4) | 3732 |
| 7 | Administrative and sales costs (1% of sales) | 5800 |
|  | Total | 414526 |

## 1-2- Raw materials

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| # | Main Raw Materials | Annual Consumption | Unit | Unit Cost  (Rials) | Total Costs in Million Rials |
| 1 | Silica | 40,165 | Ton | 2,000,000 | 80,330 |
| 2 | Hydrochloric acid | 3,225 | Ton | 2,800,000 | 9,030 |
| 3 | Sodium hydroxide | 1,525 | Ton | 66,000,000 | 100,650 |
| 4 | ethanol | 1,075 | Ton | 68,000,000 | 73,100 |
| 5 | 50 kg envelope | 1,930 | Ton | 33,000,000 | 63,690 |
|  | Total | | | | 326,800 |

2-2- Salary Estimate

Salaries are estimated for two categories; production and non-production personnel. Benefits, bonuses and employer premiums for non-production and production personnel are 70% and 90% of the annual salary, respectively. The following tables depict the estimated salaries.

## Non-production personnel

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| # | Description | Quantity | Monthly Salary (Rial) | Annual Salary (Million Rial) |
| 1 | Project Manager | 1 | 60000000 | 1006 |
| 2 | Financial and administrative employee | 2 | 30000000 | 1006 |
| 3 | Crew | 1 | 22000000 | 368 |
| 4 | Guardian and caretaker | 2 | 22000000 | 738 |
|  | Total | 6 |  | 3118 |
|  | Benefits, bonuses and premiums | | | 886 |
|  | Total | | | 4004 |

## Production personnel

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| # | Description | Quantity | Monthly Salary (Rial) | Annual Salary (Million Rial) |
| 1 | production manager | 1 | 50,000,000 | 838 |
| 2 | technician | 2 | 36,000,000 | 1206 |
| 3 | Laboratory personnel | 2 | 30,000,000 | 1006 |
| 4 | skilled worker | 8 | 28,000,000 | 3754 |
| 5 | worker | 20 | 24,000,000 | 8044 |
| 6 | Driver | 4 | 24,000,000 | 1608 |
| 7 | warehouse keeper | 2 | 24,000,000 | 804 |
| 8 | Total | 39 |  | 17260 |
|  | Benefits, bonuses and premiums | | | 4902 |
|  | Total | | | 22162 |

2-3- Estimating the amount of required energy and water

In a production unit, in addition to the raw materials needed to produce a product, facilities are needed to operate the equipment and machinery. These requirements, also known as utilities, include: electricity, process water, cooling water, and diesel. In this section, the amount of consumption of each of these components is determined in two categories; the process components (required for manufacturing equipment) and the non-process components (utility and general use).

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| # | Description | Unit | Annual Consumption | Unit Cost (Rial) | Total cost (Million Rials) |
| 1 | Gasoline | Liter | 210,000 | 7000 | 1470 |
| 2 | Gasoline | Liter | 4,500 | 20000 | 90 |
| 3 | Electricity | KWh | 2,400,000 | 1500 | 3600 |
| 4 | Water | Cubic meter | 84,000 | 7000 | 588 |
| 5 | Viscosine oil | Liter | 3,000 | 20000 | 60 |
| 6 | Communications | --- | --- | --- | 40 |
|  | Total | | |  | 2924 |

**3- Estimating project's circulating capital**

|  |  |  |
| --- | --- | --- |
| # | Description | Total Costs (Million Rials) |
| 1 | Raw material storing costs | 17908 |
| 2 | Petty cash | 14420 |
| Total | | 49364 |

**4- Investment Table**

|  |  |  |
| --- | --- | --- |
| # | Description | Total Costs (Million Rial) |
| 1 | Fixed investment | 337040 |
| 2 | Pre-operation costs | 5272 |
| 3 | Circulating capital | 16164 |
|  | Total | 358476 |

**5- Annual Production Costs**

The total annual production costs are estimated from the sum of fixed and variable costs.

|  |  |
| --- | --- |
| Description | Total cost |
| Raw material | 326800 |
| Energy and fuel | 17442 |
| Personnel expenses | 20380 |
| Annual wear and tear, repair and maintenance costs | 40372 |
| **Total** | 404994 |

**6- Sales Forecast**

It is calculated based on the finished product price, taking into account the market price and deduction of overhead expenses. So the selling price of the product is estimated as follows:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| # | Description | Amount (ton) | Unit Value  (Rial) | Total costs (Million Rial) |
| 1 | Nano Silica | 5,000 | 58,000,000 | 580000 |
|  | Total | 5,000 |  | 580000 |

**7- Plan’s Financial Indicators**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Special profit and loss | The rate of return on investment | The period of return on investment | Per capita fixed investment | Per capita total investment |
| 98402 | 0.27 | 3.64 | 7606 | 7966 |

**8- Profit and Loss Calculation Table**

\* All figures are in million rials

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Profit and Loss Forecast Table | | | | | |
| Description | 1st year | 2nd year | 3rd year | 4th year | 5th year |
| Production Amount | 7000 | 8000 | 9000 | 10000 | 10000 |
| net sales | 406000 | 464000 | 522000 | 580000 | 580000 |
| Production Costs | | | | | |
| Raw material | 228760 | 261440 | 294120 | 326800 | 326800 |
| Production staff salaries | 12084 | 13810 | 15536 | 17262 | 17262 |
| Energy Consumption | 12210 | 13954 | 15698 | 17442 | 17442 |
| Maintenance | 5968 | 6820 | 7672 | 8524 | 8524 |
| Unexpected | 2612 | 2986 | 3358 | 3732 | 3732 |
| Wear and Tear | 22292 | 25478 | 28662 | 31846 | 31846 |
| Total production costs | 283926 | 324486 | 365046 | 405608 | 405608 |
| The finished price of the sold product | 283926 | 324486 | 365046 | 405608 | 405608 |
| Gross profit | 122074 | 139514 | 156954 | 174392 | 174392 |
| Operation Costs | | | | | |
| Office staff salaries | 3118 | 3118 | 3118 | 3118 | 3118 |
| Administrative and sales costs | 4060 | 4640 | 5220 | 5800 | 5800 |
| Total operating costs | 7178 | 7758 | 8338 | 8918 | 8918 |
| Operating Profit | 114898 | 131756 | 148616 | 165474 | 165474 |
| Non-operation Costs | | | | | |
| Depreciation before operation | 1054 | 1054 | 1054 | 1054 | 1054 |
| Fixed asset insurance | 684 | 684 | 684 | 684 | 684 |
| Total non-operating costs | 34272 | 34272 | 34272 | 34272 | 34272 |
| Pre-tax profits | 80624 | 97484 | 114344 | 131202 | 131202 |
| Special Profit | 60468 | 73112 | 85758 | 98402 | 98402 |
| Yearly profit | 0 | 60468 | 133582 | 219338 | 317740 |
| Unprofitable to sell | 0/21 | 0/3 | 0/3 | 0/3 | 0/3 |
| Special Profit to Sell | 0.10 | 0.16 | 0.16 | 0.17 | 0.17 |

**Pre-Feasibility Summary**

|  |
| --- |
| **General Specification** |
| Project Name: Nano-silica powder production plan |
| Project Capacity: 5000 ton |
| Number of Personnel: 45 |
| Working Days: 300 |
| Product Usage: Concrete construction of dams, canals, tunnels, reservoirs and water sources, flooring and facade construction, Manufacture of concrete exposed to corrosion. |
| Technical Study |
| Land Area: 40,000 square meters |
| Building Area: 8050 square meters |
| Main Raw Materials: Silica - hydrochloric acid |
| Supplying Method of Raw Materials: internal resources |
| Power Requirement: 3840,000 kwh annually |
| Water Requirement2,700 cubic meters annually |
| Fuel Requirement: 800,000 Cubic meters of gas annually |
| Economical & Financial Study |
| Fixed Investment Cos: 342,31 million rials |
| Working Capital: 16164 million rials |
| Total Investment: 358476 million rials |
| Annual Sale: 580000million rials |
| Net Present Value(NPV): 70871 million rials |
| Break Even Point(BEP): 24% |
| Internal Rate of Return(IRR): 27% |
| Investment Return Period: 3.64 years |