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**Pre-Feasibility Study for**

**Producing Basalt fibers**



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**Abstract:**

The stone paper is a novel kind of paper which has been developed recently by practitioners. 80 percent of this kind of paper material is calcium carbonate, which can be considered as an alternate for trees’ wood in paper production. 15% of the constituents of this paper is propylene and ethylene. This paper has some properties, including waterproofness, it resistance against tearing, the magic presentation of its colors, and finally its reversibility to the soil in a short period.

The required land area is 25,000 square meters. The required electricity power is 2520000 kWh annually, the water required is 105000 cubic meters annually and the fuel required is 535000 cubic meters of gas annually. The project is expected to employ 32 people.

**product introduction :**

Basalt is a hard, black aphanitic (fine-grained) volcanic rock consisting of less than 52% silica (SiO2), and it’s an alkaline rock due to the lack of silica. Basalt rock is a kind of igneous rocks that survives volcanic activity and is abundant in Iran. Basalt is a dense and hard stone found in a variety of colors in nature. It is the most common volcanic rock type on Earth. Basalt rock is used as a processed stone in flooring the sidewalks, curbs, and in the form of leather or levigated for the facade of buildings. Other uses include stone wool and electric pads in physiotherapy.

Basalt rock is crystalline, semi-crystalline and sometimes glassy with aphanitic texture. The low silica content causes the basalt to have low viscosity and therefore basaltic lava on the ground can cover up to 20 km.

**Basalt Fibers**

With the increasing use of synthetic fibers, more and more industries are becoming interested in basalt fibers. The scope of applications becomes more variable and some applications include the production of value-added goods. There has been a significant increase in the production of special industrial fibers such as basalt, carbon, glass, and Kevlar. One of the newest synthetic fibers with industrial applications is Basalt Fiber, which has been well-positioned to specialize in glass and carbon fibers.

The current technology for producing basalt fibers is very similar to the technology used to produce E glass fibers. The major difference in technology is that E glass fibers are made of a complex mixture of materials, while basalt fibers are produced from melting the basalt rocks without any additives. The basic basaltic materials do not cause any harm to the environment and are not dangerous.

**Advantages and Applications of Basalt Fibers**

Basalt fibers have a unique combination of high technical properties including resistance to corrosion and heat. These features, in addition to the low price of basalt fibers, making it possible for basalt fibers to compete with glass fibers such as S-type fibers.

According to their unique features, basalt fibers constitute E glass, high strength glass and other special types of glass fibers. These features include:

* Tensile strength 20-25% higher than E glass
* Tensile strength 10-15% higher than E glass
* Chemical resistance better than common E glass
* Wider temperature ranges up to 580 ° C
* Corrosion and heat resistance
* basalt fiber reinforced plastics (BFRP) are harmless to the environment and easier to recycle compared to GFRPs

The tensile strength of basalt fibers is between E-glass and high-strength glass and are roughly equivalent to high strength glass and even have slightly better modulation. Being harmless to the environment and its better recyclability should also be considered.

Due to the specific characteristics of these fibers, fields of application of basalt fiber products are extremely broad. Including the automotive industry, sports equipment, boating, wind turbine blades, and civil engineering.

In the automotive industry, needle fibers, fabrics, and roving with high-quality basalts are used in the manufacture of CNG capsules, brake pads, exhaust panels, roof covers, and other interior components.

The industry's most important needs include high mechanical properties and easy fiber recycling.

Due to its high mechanical properties, Basalt Roving is well suited to produce a variety of sports equipment, including skiing, snowboarding, and biking.

In boat building applications and wind turbine blades, basalt roving is used to produce woven, unidirectional, and multi-axis fabrics. In this section, high corrosion resistance and high mechanical properties of the basalt play the main role.

The basalt fiber diameter is more than 1-2 micrometers and has no respiratory hazard. The diameter of single fibers of fiberglass and stone wool which are widely used in construction is less than 9 micrometers, so it can only be used in construction by applying certain esters that prevent the diffusion of these fibers into the environment.

The production of fireproof products has begun with this material, and unidirectional basalt tapes for wind turbine blades are a booming energy sector worldwide, and wind energy plays an important role in the development of renewable energy. Wind energy is by far the most widely used form of renewable energy and its expansion has been accelerated. New wind turbine generating units are being established and blades install each year to increase the amount of energy generated by the turbines.

Nowadays, manufacturers of wind turbine blades are currently using E glass fibers. The wind energy industry is constantly looking for inexpensive, readily available materials with higher mechanical properties to increase the efficiency of existing turbines. The high-quality basalt fibers have a modulus and tensile strength of 15-20% higher, so they are similar to high-strength glass and other specialty fibers and even more efficient but not expensive. The superior mechanical properties of the basalt fibers compared to standard E glass have made it possible to produce longer blades with the same amount of fibers, which means increased energy efficiency.

**Applications of basalt fibers**

Basalt fibers can constitute Type E glass fibers with much better mechanical, thermal and chemical properties. For this reason, the applications of these fibers are almost identical.

Basalt fibers are used as roving and rope in wind turbine blades, high-pressure tanks with high strength (oil and gas industries), chemical transmission pipes, and chemical storage tanks. Fabrics of different textures (plain, satin, etc.) are also used in the manufacture of car bodies, boats, ships, and so on. Basalt ropes and strings made of woven yarn have excellent thermal resistance, low thermal coefficient, and high flexibility and are therefore used in concrete panels and power plant pipes as well as in the chemical, aerospace and shipbuilding industries.

Basaltic felts with high absorption of sound and acoustic energy, coated with fabric are very good sound insulation used in manufacturing plants, aircraft, turbines, etc.

The most important advantage of fiberglass over basalt fibers is the ability to modify the number of its constituents, which has a direct effect on optimizing the properties of the final fibers and adapting them to consumer needs.

**A Plan for producing papers from Calcium Carbonate**

Product name and code (ISIC[[1]](#footnote-1) 3):

The ID code of this product (ISIC 3 code) named as a variety of papers and paperboards made from Carbonate Calcium, is 21091118, and its evaluation unit is ton.

**Consumption cases and application of the product in domestic and foreign markets:**

Stone paper is produced in different grammages ranged from 50 microns to 400 microns in order for different applications, and it is used for providing the adhesive labels with different grammages, high value of coefficient of adhesion, and water resistance feature. Applications of stone paper are not restricted to industries of publishing, packaging and advertisements, and it is similar to coated papers in terms of facing with publishing and bookbinding machines, and does not require any distinct ink.

Thin grammages of this type of paper are appropriate for applications such as food packaging. Its moderate grammages are appropriate for publish tasks such as valuable books, maps with different applications, hand bags, magazines, brochures, and pockets, and its thick grammages are appropriate for cases in which paperboards are used for providing them, such as credit cards.

In general, the product has a wide application in the area of publishing and advertisements. One of the important applications of making papers from stones is regarding cement packaging. In order to produce cement packages, 5 papers covered by a polyethylene layer is used. A polyethylene layer is applied to prevent cement from infiltrating into outside, but because polyethylene is used to make stone papers, it requires no covering.

Investigations represent that currently, the annual consumption level of writing paper in our country is 400k tons which will face a significant raise according to the post-sanctions economic development. On one hand, based on the statistics of Ministry of Industry, Mine and Trade as well as Iranian chamber of commerce and association of Iran wood industry in year 2017, more than one million tons of paper, paste and offal have entered the country. This is while the production of paper in the country (Chooka and Pars companies) provides less than 10 percent of the domestic demands.

**Examining the replaced goods, competitors, and analysis and its effects on product consumption:**

The main goods replacing this product are the conventional papers which their source is wood. Hence, according to the point that preserving the trees is critical and vital, this technology would surely be an appropriate replacement for the conventional papers, and it would play a significant role in preserving the environment. The next replaced products are recycled papers which may not be recognized easily as appropriate replacements due to the limitations of technology in the country and low quality of its recycling.

The difference between typical papers and stony ones is that typical papers cause suction in the ink due to existence of short and long fibers, so that there is no favorable quality in multicolor printing. In order to have a print with a higher quality, coated papers are used and stony papers deliver us a lower-priced coated paper. The printability of a stony paper is much better than a traditional paper, and it consumes ink about 20 percent of a traditional paper.

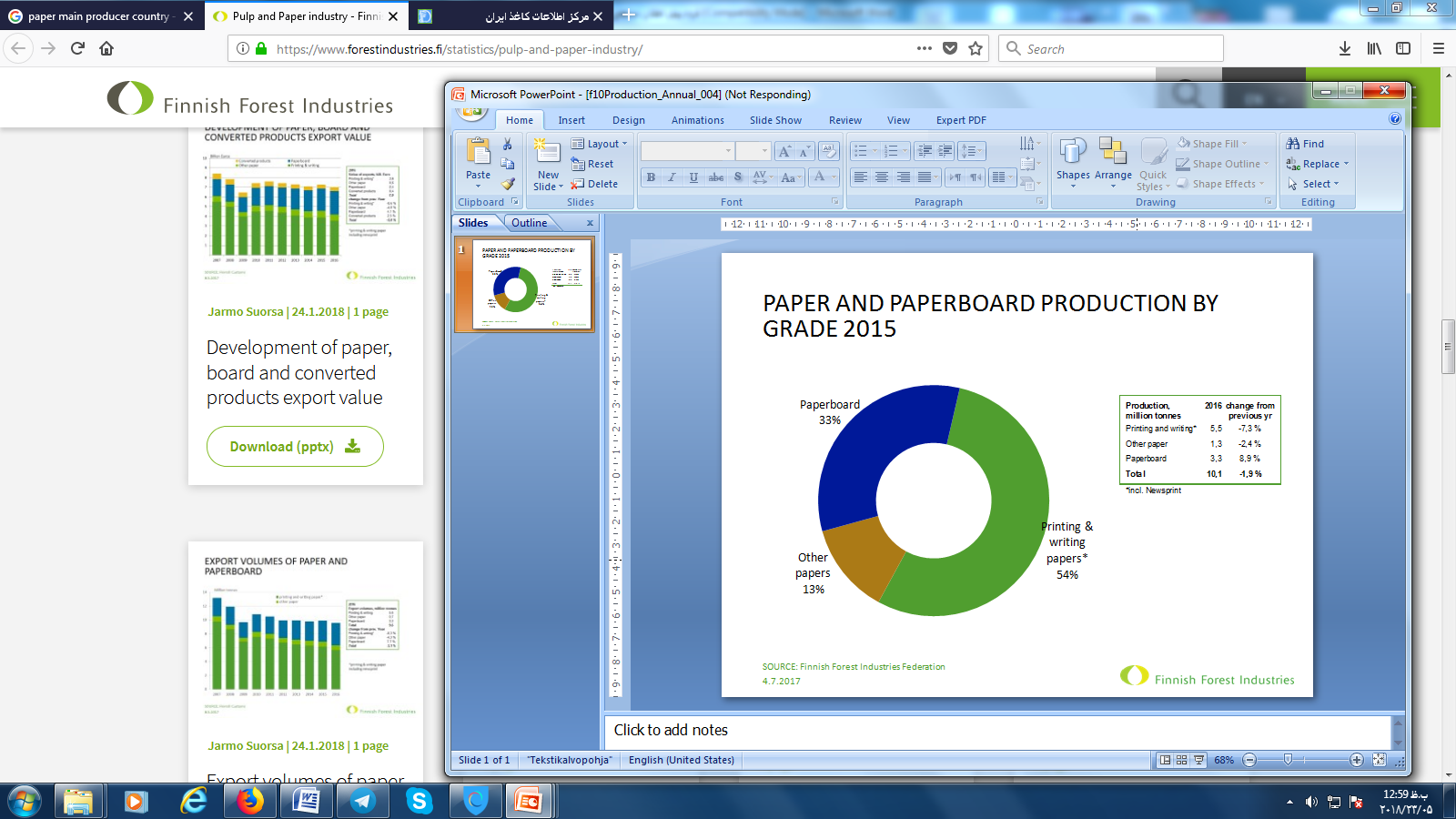
Based on the estimations, we require 2 million tons of cellulose substances annually for consumption in Iran. These products also include grayish back paperboards and paper tissues. Of this level, almost a capacity for one million tons has been created, but in practice, the operable level in country is not more than 700 thousand tons and the remainder should be supplied through imports. In other words, we require supplication of 1 million and 300 thousand tons of papers.

According to the existing records, the first active factory in the country has been operated by Pishgaman company with a nominal capacity of 5000 tons in the special economic zone of Yazd province in year 2016.

120 establishment permits have been issued until April 2017 which the total number of their nominal production capacity equals to 163000 tons.

**Strategic importance of goods in Iranian and foreign markets**

Limitation of the area of global jungles and their severe destruction on one hand, and increasingly raise of consumption of paper and paper products along with raise in population and progression in technology on other hand, have made the establishment of paper-making industries important and essential. The existing demand status in the area of paper types in the world are also as the below chart:

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Global Forest, Paper & Packaging Industry Survey: 2016 edition – survey of 2015 results

**Examining the product import and export trend**

According to the information obtained from customs of Islamic republic of Iran, the rates of import and export of all types of papers in previous years are as below table:

|  |  |  |
| --- | --- | --- |
| **Year** | **Paper imports (Ton)** | **Paper exports (Ton)** |
| 2013 | 306407 | 14 |
| 2014 | 238,151 | 429 |
| 2015 | 318,947 | 221 |
| 2016 | 323,504 | 1,006 |
| 2017 | 336,207 | 1,359 |

**Prediction of the product sale market in the next 5 years**

According to the available information, the paper consumption per capita in Iran is 22 Kgs annually which of course, this rate is very low in comparison to the advanced countries. Now, according to the rate of population growth in the country, the paper consumption in the country may be examined in the next 5 years. Also, if only 1 percent of the paper required for the country is supplied through the paper produced from stone, the level of product demand in the next years is estimated.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Prediction of the level of contribution obtained from calcium carbonate (tons) | | | | | |
| Description | Year | | | | |
| 1399 | 1400 | 1401 | 1402 | 1403 |
| Paper consumption per capita in country (Kgs) | 22 | 22 | 22 | 22 | 22 |
| Population of country | 80,992,000 | 81,996,301 | 83,013,055 | 84,042,417 | 85,084,543 |
| Paper consumption in country | 1,781,824 | 1,803,919 | 1,826,287 | 1,848,933 | 1,871,860 |
| The contribution obtainable from paper market for the studied product | 17,818 | 18,039 | 18,263 | 18,489 | 18,719 |
| Internal offer of papers made from stone | 3,000 | 3,000 | 3,000 | 6,570 | 7,080 |

According to the point that the internal offer of paper made from calcium carbonate is estimated as very low in the next years, establishment of this unit would be economical.

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

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

|  |  |  |
| --- | --- | --- |
| # | Description | Amount in Million Rials |
| 1 | Land | 5000 |
| 2 | Landscaping and Buildings | 52614 |
| 3 | Facilities | 11,749 |
| 4 | Vehicles | 2,990 |
| 5 | Equipment and machinery | 951316 |
| 6 | Office and workshop equipment | 630 |
| 7 | Pre-operation costs | 10243 |
| 8 | Miscellaneous costs | 4,660 |
|  | Total | 1039202 |

## 1-1- Equipment and Machinery

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| # | Machinery | Quantity | Unit | Unit cost in  Euro | Acceleration rate  (Million Rials) | Total Costs (Million Rials) |
| 1 | Crusher | 2 | Device | 260000 | 31200 | 31200 |
| 2 | Magnetic separator | 3 | Device |
| 3 | Spiral classifier for washing and drying basalt particles | 1 | Device |
| 4 | Collection of equipment for handling crumbs for raw materials storage | 1 | Device |
| 5 | Basalt crumb storage compartment | 10 | Device |
| 6 | pump | 8 | Device | 196000 | 23520 | 23520 |
| 7 | Water distillation machine | 1 | Device |
| 8 | Emulsifier | 2 | Device |
| 9 | Batch Weighing Machine | 4 | Device |
| 10 | mixer | 4 | Device |
| 11 | Reactor | 6 | Device |
| 12 | Storage tank | 6 | Device |
| 13 | Technical scale | 4 | Device |
| 14 | Lab scale | 2 | Device |
| 15 | Melting furnace | 22 | Device | 47000 | 5640 | 124080 |
| 16 | Winding device | 22 | Device | 3900000 | 468000 | 468000 |
| 17 | Transformers | 22 | Device |
| 18 | Cup boards | 3 | Device |
| 19 | Bushing system | 22 | Device | 44,700 | 5364 | 118008 |
| 20 | Water circulation system with pump and tank and control tools | 1 | Device | 100,000 | 12000 | 12000 |
| 21 | Water softener | 1 | Device | 32,000 | 3840 | 3840 |
|  | Distilled water production machine | 1 | Device |
| 22 | Shelves | 2 | Device | 270,000 | 32400 | 32400 |
| 23 | Drying chamber | 1 | Device |
| 24 | Backwind device | 10 | Device | 170,000 | 20400 | 20400 |
| 25 | Bobbin-winding machine | 10 | Device |
| 26 | Twisting machine | 1 | Device | 320,000 | 38400 | 38400 |
| 27 |  | 1 | Device | 65,000 | 7800 | 7800 |
| 28 | Laboratory equipment (thermal, mechanical and physical properties measuring device) | 4 | Device | 2,500 | 300 | 1200 |
|  | **Total** | 177 |  | 5407200 | 648864 | 880848 |
| 29 | Customs, shipping and installation cost (equivalent to 8% above) | | | | | 70468 |
| **Total** | | | | | | 951316 |

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

|  |  |  |
| --- | --- | --- |
| # | Description | Costs in Million Rial |
| 1 | Raw materials | 4,117 |
| 2 | Salary | 15,637 |
| 3 | Fuel and energy | 7,470 |
| 4 | Repair and maintenance | 12,871 |
| 5 | Wear and tear | 37,501 |
| 6 | Unexpected expenses (1% of the sum of rows 1 to 4) | 401 |
| 7 | Office & Sales Cost (1% of Sales) | 2,213 |
|  | Total | 80,210 |

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## **2-1- Raw materials**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| # | Main Raw Materials |  | Annual Consumption | Unit | Unit Cost  (Rials) | Total Costs in Million Rials |
| 1 | Basaltic crumbs  (Including waste) |  | 3400 | ton | 624000 | 2,122 |
| 2 | LUBRICANT Resin |  | 1200 | Liters | 460000 | 552 |
| 3 | Cardboard bobbin |  | 424200 | number | 2400 | 1018 |
| 4 | Bag |  | 10908 | Square meters | 6300 | 69 |
| 5 | Carton |  | 72720 | Square meters | 4900 | 356 |
|  | **Total** | | | | | 4117 |

**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 | Number | Monthly Salary (Rial) | 2 months reward | 23% insurance | Annual Salary (Million Rial) |
| 1 | Project Manager | 1 | 30,000,000 | 60 | 83 | 503 |
| 2 | Financial and administrative employee | 6 | 15,000,000 | 180 | 248 | 1,508 |
| 3 | Crew | 2 | 11,000,000 | 44 | 61 | 369 |
| 4 | Guardian and attendant | 3 | 11,000,000 | 66 | 91 | 553 |
|  | Total | 12 |  | 350 | 483 | 2,933 |

## Production personnel

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| # | Description | Number | Monthly Salary (Rial) | 2 months reward | 23% insurance | Annual Salary (Million Rial) |
| 1 | production manager | 2 | 25,000,000 | 100 | 138 | 838 |
| 2 | technician | 2 | 18,000,000 | 72 | 99 | 603 |
| 3 | Laboratory personnel | 4 | 15,000,000 | 120 | 166 | 1,006 |
| 4 | Material Handling Personnel | 6 | 12,000,000 | 144 | 199 | 1,207 |
| 5 | Production Engineer | 4 | 16,000,000 | 128 | 177 | 1,073 |
| 6 | Preparation and Sizing Worker | 6 | 12,000,000 | 144 | 199 | 1,207 |
| 7 | Preparation and Sizing Technician | 2 | 14,000,000 | 56 | 77 | 469 |
| 8 | Continuous fiber and furnace worker | 8 | 12,000,000 | 192 | 265 | 1,609 |
| 9 | Furnace Technician | 4 | 14,000,000 | 112 | 155 | 939 |
| 10 | Continuous Fiber Technician | 2 | 14,000,000 | 56 | 77 | 469 |
| 11 | Drying worker | 4 | 12,000,000 | 96 | 132 | 804 |
| 12 | Roving and Printing Production Technician | 2 | 14,000,000 | 56 | 77 | 469 |
| 13 | Roving and printing production worker | 4 | 12,000,000 | 96 | 132 | 804 |
| 14 | packing worker | 4 | 12,000,000 | 96 | 132 | 804 |
| 15 | warehouse keeper | 2 | 12,000,000 | 48 | 66 | 402 |
| **Total** | | 56 |  | 1516 | 2092 | 12,704 |

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 | Cubic meter | 50,000 | 5,000 | 250 |
| 2 | Gas | Cubic meter | 4,000,000 | 700 | 2,800 |
| 3 | Petrol | Liter | 12,000 | 10,000 | 120 |
| 4 | Electricity | KWh | 2,016,000 | 2,000 | 4,032 |
| 5 | Water | Cubic meter | 4,500 | 4,000 | 18 |
| 6 | Vasquezine oil | Liter | 2,000 | 80,000 | 160 |
| 7 | connections | --- | --- | --- | 90 |
|  | Total | | |  | 7470 |

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

|  |  |  |  |
| --- | --- | --- | --- |
| # | Description | Time (days) | Total Costs (Million Rials) |
| 1 | Raw material storing costs | 30 | 338 |
| 2 | Petty cash | 30 | 6254 |
| Total | | | 6593 |

**4- Investment Table**

|  |  |  |
| --- | --- | --- |
| # | Description | Total Costs (Million Rial) |
| 1 | Fixed investment | 1039202 |
| 2 | Circulating capital | 6593 |
| **Total** | | 1045795 |

**5- Annual Production Costs**

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

|  |  |
| --- | --- |
| Description | Total cost |
| Raw material | 4,117 |
| Energy and fuel | 7,470 |
| Personnel expenses | 15,637 |
| Annual wear and tear, repair and maintenance costs | 50,372 |
| **Total** | 77,596 |

**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 | Production Amount (ton) | Unit Value  (Rial) | Total costs (Million Rial) |
| 1 | Basalt fiber (Roving) | 2,000 | 73,500,000 | 147,000 |
| 2 | Basalt fiber (finely ground) | 900 | 82,600,000 | 74,340 |
|  | Total production capacity | 2,900 |  | 221,340 |

**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 |
| 139,032 | 0.24 | 4.24 | 8,571 | 8,668 |

**8- Profit and Loss Calculation Table**

**(**Numbers in million rials**)**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Profit and Loss Forecast Table | | | | | |
| Description | 1st year | 2nd year | 3rd year | 4th year | 5th year |
| Production Amount | 2030 | 2320 | 2610 | 2900 | 2900 |
| net sales | 154,938 | 177,072 | 199,206 | 221,340 | 221,340 |
| Production Costs | | | | | |
| Raw material | 2,882 | 3,293 | 3,705 | 4,117 | 4,117 |
| Production staff salaries | 8,893 | 10,163 | 11,434 | 12,704 | 12,704 |
| Energy Consumption | 5,229 | 5,976 | 6,723 | 7,470 | 7,470 |
| Maintenance | 9,010 | 10,297 | 11,584 | 12,871 | 12,871 |
| Unexpected | 281 | 321 | 361 | 401 | 401 |
| Wear and Tear | 26,251 | 30,001 | 33,751 | 37,501 | 37,501 |
| Total production costs | 52,545 | 60,051 | 67,558 | 75,064 | 75,064 |
| The finished price of the sold product | 52,545 | 60,051 | 67,558 | 75,064 | 75,064 |
| Gross profit | 102,393 | 117,021 | 131,648 | 146,276 | 146,276 |
| Operation Costs | | | | | |
| Office staff salaries | 2,933 | 2,933 | 2,933 | 2,933 | 2,933 |
| Administrative and sales costs | 1,549 | 1,771 | 1,992 | 2,213 | 2,213 |
| Total operating costs | 4,482 | 4,704 | 4,925 | 5,146 | 5,146 |
| Operating Profit | 97,911 | 112,317 | 126,723 | 141,130 | 141,130 |
| Non-operation Costs | | | | | |
| Pre-operation depreciation | 932 | 932 | 932 | 932 | 932 |
| Fixed asset insurance | 1,166 | 1,166 | 1,166 | 1,166 | 1,166 |
| Total non-operating costs | 2,098 | 2,098 | 2,098 | 2,098 | 2,098 |
| Pre-tax net profit and net loss | 95,813 | 110,219 | 124,626 | 139,032 | 139,032 |
| Taxes | 0 | 0 | 0 | 0 | 0 |
| Net profit | 95,813 | 110,219 | 124,626 | 139,032 | 139,032 |
| Annual profit | 0 | 95,813 | 206,033 | 330,658 | 469,690 |
| Gross profit on sale | 0.46 | 0.66 | 0.66 | 0.66 | 0.66 |
| Net profit on sale | 0.43 | 0.62 | 0.63 | 0.63 | 0.63 |

**Pre-Feasibility Summary**

|  |
| --- |
| **General Specification** |
| Project Name: Production of basalt fibers |
| Project Capacity: Basement fibers (Roving) 2000 tons 900 ton basalt fibers |
| Number of Personnel: 68 people |
| Working Days: 300 |
| Product Usage: Replacement of glass fiber, ship and boat industries |
| Technical Study |
| Land Area: 25,000 square meters |
| Building Area: 6400 square meters |
| Main Raw Materials: Basaltic crumbs |
| Supplying Method of Raw Materials: Mines of the province |
| Power Requirement: 2,016,000 kwh annually |
| Water Requirement: 4500 cubic meters annually |
| Fuel Requirement: 4,000,000 cubic meters of gas annually |
| Economical & Financial Study |
| Fixed Investment Cost: 1039202 million rials |
| Working Capital: 6,593 million rials |
| Total Investment: 1045795 million rials |
| Annual Sale: 221,340 million rials |
| Net Present Value(NPV): 61,474 million rials |
| Break Even Point(BEP): 28% |
| Internal Rate of Return(IRR): 24% |
| Investment Return Period: 4.24 years |

1. International Standard Industrial Classification [↑](#footnote-ref-1)