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**Ministry of Economic Affairs and Finance**

**Directorate of Economic Affairs and Finance of South Khorasan**

**Investment Services Center of South Khorasan**

**Pre-Feasibility Study for Producing PVC from Coke**

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**Abstract**:

Polyvinyl chloride is one of the most widely used polymers in the group of vinyl polymers. PVC uses include constructions, packaging, consumer goods, electronics, transportation and is also used for medical purposes. PVC is available in both soft (plasticized) and hard forms. Soft PVC is used in wire coating, thermal insulation (PVC foam), various car parts, adhesives, coatings and all kinds of wallpapers, and hard PVC is used in toys, doors and windows, pipes, sewers, downspouts and sealants.

The required land area is 150,000 square meters. The required electricity power is 7680 kWh annually, the water required is 46500 cubic meters annually and the fuel required is 3896341 cubic meters of gas annually. The project is expected to employ 666 people.

**1- Product Introduction:**

Polyvinyl chloride is formed by polymerization of vinyl chloride monomer. Most of the commercial production of PVC is done mainly through suspension polymerization, while bulk and emulsion polymerization is used less, and soluble polymerization is rarely used. PVC is a hard plastic that becomes soft and flexible by adding lubricants. The most commonly used is phthalate.

**1-1- product uses in home and foreign markets:**



The major uses of PVC are:

• Constructions

• Packaging industry

• Consumer goods

• Electronics

• Transportation

• Medical uses, etc.

Polyvinyl chloride is one of the most widely used polymers in the group of vinyl polymers. PVC is available in both soft (plasticized) and hard forms. We find soft PVC in tablecloths, bathroom curtains and in all kinds of wallpapers, and its hard form can be seen in toys, windows and doors, pipes, sewers, downspouts and sealants.

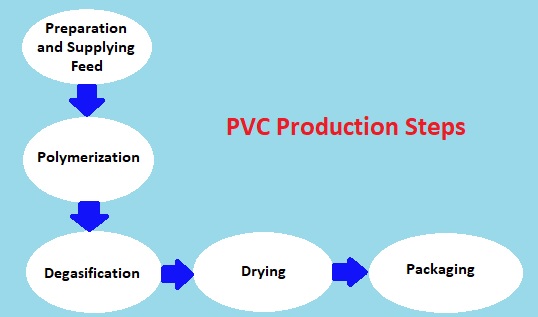
**The most important applications of hard PVC:**

Pipes and door and window frames. This type of PVC is often referred to as unplasticized (UPVC) and is less flammable due to having no additives.

**The most important applications of soft PVC: (plasticized)**

Because it is a good insulator, it is used in the wire coatings.

Other major uses include clothing, thermal insulation (PVC foam), car parts, adhesives and coatings.



**Producing PVC using coke**

**Introduction to coke**

coke is a carbon rich material with low impurities used as fuel. Petcoke is a carbonate solid derived from low-ash and low-sulfur bituminous coal. It is also hard and porous. Of course natural coke does exist, but the most used form is the one made from coal by man. Certain coal is used to produce metallurgical coke and the properties of coal determine the properties of coke produced. Inorganic coal material is sterile and remains in the coke as ash, affecting the performance of the blast furnace. The presence of ash in the coke increases the consumption of coke and limestone in the blast furnace and reduces the capacity of coke batteries.

Metallurgical coke is a porous material used in the blast furnace and is one of the major applications of coke in the metallurgical industry. coke inside the blast furnace plays different roles like energy provision and iron minerals revival, creating porosity to enable the passage of regenerative gases and carburizing the cast iron. It should be noted that coke is also used in the casting industry.

Coke contains a percentage of sulfur and phosphorus. Therefore, coke is the most contributing element for the presence of sulfur and phosphorus in the process of steel production. Sulfur and phosphorus are harmful elements in steels.

Introduction to coke production process:

To restore iron, you need an agent that separates oxygen from iron oxides. This agent is referred to as the regenerative agent. All blast furnace reactions happen at high temperatures resulting from burning petcoke. In the blast furnace, the coke obtained from coal is used for regenerating and melting. Natural gas and mazut are also used instead of coke. regenerative capability of the hydrogen in natural gas is much greater than the carbon in coke. therefore, natural gas is usually used in the blast furnace, so that hydrogen is released by burning this natural gas. Modern kilns, coal powder injection method is used, which greatly reduces the consumption of coke.

Because coal has low strength and high impurity (approximately 35%) it cannot meet all the requirements as a blast furnace fuel, so it is converted to coke so it can have the required conditions (sufficient strength and low percentage of impurities and high thermal value) Changes that happen by converting coal to coke include:

1. An increase in the percentage of carbon resulting in an increase in the thermal value.

2. Increased resistance to mechanical factors such as impact, pressure, fall and wear.

3. Reduction of volatile impurities resulting from the release of gases and coal's volatile compounds

4. An increase in the effective surface area for further combustion, which is provided by making coke porous.

In addition to providing the required thermal energy in the blast furnace, coke also regenerates the iron oxides present in the iron ore. Regeneration can be carried out directly by carbon (???) or CO2, H2 gases.

The thermal value of the coke should be at maximum and the humidity should be minimal. (The amount of coke moisture depends on the stopping time in the extinguishing towers as well as the amount of water absorbed by the coke.) If the amount of moisture in coke is high, it has a negative effect on the operation of the blast furnace, because it prevents the creation of a suitable thermal state inside the blast furnace and the efficiency of the furnace decreases.

At Isfahan Steel Company, the wet method is currently being used to extinguish coke by spraying cold water on it, and the dry method (extinguishing by using nitrogen) is not used. By utilizing the dry method, we can reduce the amount of moisture in coke and increase its strength, and also use the energy of the gas blown into the coke.

Considering what's been stated, the required coke for being used in the blast furnace must meet the following conditions:

1. Its thermal value must not be less than 4000 kcal / kg.

2. The percentage of sulfur must not exceed 1%.

3. Coke must be of sufficient strength.

4. The percentage of ash must not be less than 14%.

5. The amount of moisture in coke must be less than 9% and the size of coke seeds must be 5 to 80mm. Normally, for a ton of raw iron to melt, 450 to 500 kg of coke is needed, and the price of this coke is about 30 to 50% of that of one ton of raw iron.

6. Volatile compounds must be less than 1%.

Iran's coal mines include:

1- Tabas Coal Mine

2- Kerman Coal Company

3- Central Alborz Coal Company (under water)

4- East Alborz Coal Company (Shahrood)

5- West Alborz Coal Company (Sangrood)

The Coke and Chemicals section consists of the following three main sections:

1. Coal section.

2. Coke section.

3. Chemicals Section: This section has five sub-sections:

4. Material recovery section.

5. Acid section.

6. Benzol refining.

7. Biochemical Energy Section.

8. Coal and Coke Research Unit.

**Analysis and determination of the minimum economic capacity including estimating the amount of fixed investment in Rial and foreign currency**

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

|  |  |  |
| --- | --- | --- |
| # | Description | Amount in Million Rials |
| 1 | Land | 82,500 |
| 2 | Landscaping and Buildings | 111,623 |
| 3 | Facilities | 44,615 |
| 4 | Vehicles | 29,985 |
| 5 | Equipment and machinery | 2989459 |
| 6 | Office and workshop equipment | 2,375 |
| 7 | Pre-operation costs | 26,000 |
| 8 | Miscellaneous costs (3% of the sum of the above not including the land) | 96121 |
| Total | | **3382678** |

## 1-1- Equipment and Machinery

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| # | Machinery | Quantity | Unit | Country of Manufacture | Unit Cost (Thousand Euros) | Unit Cost (Million Rails) | Total Costs (Million Rials) |
| 1 | PVC from coke production assembly including the production batch reactors in the following units:  1- Coke burning and feed unit  2- Catalyst and Solution Manufacturing Unit  3. Polymerization unit  4- Degassing unit  5. Cooling  6- Drying and packaging unit | 1 | suite | China | 20240 | 2404800 | 2404800 |
| 2 | Piping costs | 1 | suite | Iran |  | 34,417 | 34,417 |
| 3 | Insulation costs | 1 | suite | Iran |  | 8,163 | 8,163 |
| 4 | Control and command panels and measuring instruments | 1 | suite | China | 1002 | 120240 | 120240 |
| 5 | Profit storage tanks | 8 | Device | Iran |  | 800 | 6,400 |
| 6 | Laboratory equipment costs | 1 | Set |  |  | 3,100 | 3,100 |
| Machinery transportation, customs and installation costs (equivalent to 16%) | | | | |  |  | 412339 |
| **Total** | | | | |  |  | 2989459 |

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

|  |  |  |
| --- | --- | --- |
| # | Description | Costs in Million Rial |
| 1 | Raw materials | 388,500 |
| 2 | Salary | 224,554 |
| 3 | Fuel and energy | 15,463 |
| 4 | Repair and maintenance | 37,885 |
| 5 | Wear and tear | 86,811 |
| 6 | Advertising Cost (1% of Sales) | 16,750 |
| 7 | Unexpected expenses (2% of the sum of rows 1 to 4) | 13,328 |
|  | Total | 783,291 |

## 1-2- Raw materials

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| # | Main Raw Materials | Place of Supply | Annual Consumption | Unit | Unit Cost  (Rials) | Total Costs in Million Rials |
| 1 | Coke | Home, Abroad | 42,000 | Ton | 8,000,000 | 336,000 |
| 2 | Polypropylene bag for packaging | Home, Abroad | 1,500,000 | Unit | 35,000 | 52,500 |
|  | **Total** | | | | | 388,500 |

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 | Managing Director | 1 | 90,000,000 | 1,080 |
| 2 | Administrative and Financial Official | 1 | 50,000,000 | 600 |
| 3 | Administrative and financial employee | 10 | 24,000,000 | 2,880 |
| 4 | Procurement and sales employee | 10 | 24,000,000 | 2,880 |
| 5 | Warehouse keeper | 3 | 13,500,000 | 486 |
| 6 | Driver | 10 | 13,500,000 | 1,620 |
| 7 | Janitor | 3 | 12,500,000 | 450 |
| 8 | Guard | 3 | 12,500,000 | 450 |
|  | Total | 41 |  | 10,446 |
|  | Benefits, bonuses and premiums | | | 7,312 |
|  | Total | | | 17,758 |

## Production personnel

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| # | Description | Quantity | Monthly Salary (Rial) | Annual Salary (Million Rial) |
| 1 | Production Manager | 1 | 56,000,000 | 672 |
| 2 | Process Engineer | 15 | 36,000,000 | 6,480 |
| 3 | Electrical engineer | 9 | 36,000,000 | 3,888 |
| 4 | Site worker | 500 | 13,500,000 | 81,000 |
| 5 | Technical and repairs technician | 100 | 14,000,000 | 16,800 |
| 6 | Total | 625 |  | 108,840 |
|  | Benefits, bonuses and premiums | | | 97,956 |
|  | Total | | | 206,796 |

3-2- 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 | Diesel fuel | Cubic meter | 1,350 | 3,800,000 | 5,130 |
| 2 | Natural gas | Cubic meter | 3,896,341 | 700 | 2,727 |
| 3 | Gasoline | Liter | 4,500 | 10,000 | 45 |
| 4 | Electricity | KWh | 7,680,000 | 800 | 6,144 |
| 5 | Water | Cubic meter | 46,500 | 2,500 | 116 |
| 6 | Viscosine and oil | Liter | 15,000 | 50,000 | 750 |
| 7 | Communications | --- | --- | --- | 550 |
|  | Total | | |  | 15,463 |

\* The amount of gasoline consumed per car is considered to be 12 liters per working day in the unit.

\*\* The power consumption of this unit is calculated according to the following formula:

Power consumption = kWh \* hours of work \* number of working days \* number of shifts \* simultaneity factor

The simultaneity factor is calculated based on the number of shifts and the constants present in the power company's databases.

\*\*\* The water consumption of this unit is calculated according to the following formula:

Cubic meter of water consumed for green landscape = area of ​​green landscape \* 1.5

Cubic meter of sanitation water = (Total number of production and non-production personnel) \* 15

Cubic meter of water consumption for production line: Based on production line specifications.

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

|  |  |  |  |
| --- | --- | --- | --- |
| # | Description | Time (days) | Total Costs (Million Rials) |
| 1 | Raw material storing costs | 60 | 63,863 |
| 2 | Petty cash | 60 | 64,897 |
| Total | | | 128,760 |

**4- Investment Table**

|  |  |  |
| --- | --- | --- |
| # | Description | Total Costs (Million Rial) |
| 1 | Fixed investment | **3,382,678** |
| 2 | Circulating capital | 128,760 |
| Total | | 3,511,438 |

**5- Annual Production Costs**

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

|  |  |
| --- | --- |
| Description | Total cost |
| Raw material | 388,500 |
| Energy and fuel | 15,463 |
| Personnel expenses | 224,554 |
| Annual wear and tear, repair and maintenance costs | 124,696 |
| **Total** | **753,213** |

**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 (Kg) | Unit Value  (Rial) | Total costs (Million Rial) |
| 1 | PVC Granules | 30,000 | 40,000,000 | 1,200,000 |
| 2 | Sodium hydroxide | 19,000 | 25,000,000 | 475,000 |

**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 |
| 720,773 | 0.44 | 2.25 | 2,247 | 2,440 |

**8- Profit and Loss Calculation Table**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Profit and Loss Forecast Table | | | | | |
| Description | 1st year | 2nd year | 3rd year | 4th year | 5th year |
| Production Amount | 21,000 | 24,000 | 27,000 | 30,000 | 30,000 |
| net sales | 1,172,500 | 1,340,000 | 1,507,500 | 1,675,000 | 1,675,000 |
| Production Costs | | | | | |
| Raw material | 271,950 | 310,800 | 349,650 | 388,500 | 388,500 |
| Production staff salaries | 144,757 | 165,437 | 186,116 | 206,796 | 206,796 |
| Energy Consumption | 10,824 | 12,370 | 13,916 | 15,463 | 15,463 |
| Maintenance | 26,519 | 30,308 | 34,096 | 37,885 | 37,885 |
| Unexpected | 9,330 | 10,662 | 11,995 | 13,328 | 13,328 |
| Wear and Tear | 60,768 | 69,449 | 78,130 | 86,811 | 86,811 |
| Total production costs | 524,148 | 599,026 | 673,904 | 748,783 | 748,783 |
| Stock Adjustment | 20 | 20 | 20 | 20 | 20 |
| The finished price of the sold product | 524,128 | 599,006 | 673,884 | 748,763 | 748,763 |
| Gross profit | 648,372 | 740,994 | 833,616 | 926,237 | 926,237 |
| Operation Costs | | | | | |
| Office staff salaries | 17,758 | 17,758 | 17,758 | 17,758 | 17,758 |
| Administrative and sales costs | 23,450 | 26,800 | 30,150 | 33,500 | 33,500 |
| Total operating costs | 41,208 | 44,558 | 47,908 | 51,258 | 51,258 |
| Operating Profit | 607,164 | 696,436 | 785,707 | 874,979 | 874,979 |
| Non-operation Costs | | | | | |
| Pre-operation depreciation | 5,200 | 5,200 | 5,200 | 5,200 | 5,200 |
| Fixed asset insurance | 2,993 | 2,993 | 2,993 | 2,993 | 2,993 |
| Total non-operating costs | 154,206 | 154,206 | 154,206 | 154,206 | 154,206 |
| Pre-tax net profit and net loss | 452,958 | 542,230 | 631,501 | 720,773 | 720,773 |
| Net profit | 452,958 | 542,230 | 631,501 | 720,773 | 720,773 |
| Annual profit | 0 | 452,958 | 995,187 | 1,626,689 | 2,347,462 |
| Gross profit on sale | 0.39 | 0.55 | 0.55 | 0.55 | 0.55 |
| Net profit on sale | 0.27 | 0.40 | 0.42 | 0.43 | 0.43 |

**Pre-Feasibility Summary**

|  |
| --- |
| **General Specification** |
| Project Name: PVC Production from Coke |
| Location: Tabas – South Khorasan |
| Project Capacity: 3000 tons of PVC granules, 19000 tons of Sodium hydroxide |
| Number of Personnel: 666 |
| Working Days: 300 |
| Product Usage: construction, packaging, consumer goods, electronics, transportation, medical, etc. |
| Technical Study |
| Land Area: 150,000 square meters |
| Building Area: 12,600 square meters |
| Main Raw Materials: Coke |
| Supplying Method of Raw Materials: Internal (home) mines |
| Power Requirement: 7,680,000 kwh annually |
| Water Requirement: 46,000 cubic meters annually |
| Fuel Requirement: 3,896,341 cubic meters of gas annually |
| Economical & Financial Study |
| Fixed Investment Cost (Rial & other Currencies): **3382678** million rials |
| Working Capital: 128,760 million rials |
| Total Investment:  **3511438** million rials |
| Annual Sale: 1,675,000 million rials |
| Net Present Value(NPV): 948,961 million rials |
| Break Even Point(BEP): 36% |
| Internal Rate of Return(IRR): 44% |
| Investment Return Period: 2.25 years |