Including but not limited to, the following

Abstract

Product Name	PVC integrated complex				
Year Plant capacity	1 st Year: 50%, 2 nd year: 90%, 3 rd year to 20 th year: 100% of nominal capacity				
Raw material	Salt (NaCl) and Natural Gas (Methane)				
Raw material source	Natural Gas: National Natural Gas grid pipeline Salt: Local at project site adjacency				
Land area	50 Hectares				
Plant location	Jask, Hormozgan Province, Iran				
Estimated total investment	2610 million Euro (Fixed Capital Investment) 124.5 million Euro (Working Capital)				
The main products and prices	PVC: 790 US\$/ton, Propylene: 715 US\$/ton, Liquid Caustic: 110 US\$/ton				
IRR	19.45 %				
IRRE	29.81 %				

1, Introduction

The PVC integrated complex project includes the process unit to supply main raw materials and intermediates. The complex involves:

<u>1.1- Methanol plant</u> to produce methanol from Natural gas with capacity of about 2700 KTPA (8000 ton/day). This plant will supply feed for MTO plant.

<u>1.2- MTO plant</u> to convert methanol to olefins (ethylene and propylene) with capacity of 460 KTPA ethylene and 450 KTPA propylene. This plant will supply feed (ethylene) for VCM plant and the propylene would be sold.

<u>1.3- Chloralkali plant</u> to produce Chlorine- the feed of VCM plant. The capacity is 603 KTPA chlorine and about 679 KTPA caustic soda (based on 100%) is produced as well and would be sold.

<u>1.4- VCM plant with capacity of 1010 KTPA vinyl chloride monomer from ethylene</u> and chlorine through balanced process. This plant will supply feed for PVC plant.

<u>1.5- PVC plant with capacity of 1000 KTPA polyvinyl chloride suspension-grade from VCM. The PVC is the final and main product of the complex.</u>

The scheme of the project is shown below:



Fig. 1: Scheme of the PVC integrated complex

Main raw materials:

As it can be seen from the above diagram, the main two raw materials are NaCl Salt and Natural gas (methane) which are planned to be supplied from outside of battery limit. NaCl Salt would be provided from salt ponds in adjacency of the project site with estimated unit price of 25 US\$/ton.

Also Natural gas is available through national grid with the price of 0.056 US\$/Nm3 as per recent approval of oil ministry in Dec. 2015 on the price. Proved natural gas reserves of Iran are about 1,046 trillion cubic feet (29.6 trillion cubic meters) or about 15.8% of world's total reserves. It has the world's second largest reserves after Russia.

2、Products and specification

PVC suspension-grade is the main product of the complex project. The specifications of the products is shown below:

S-PVC PLANT	t	K-Value	Viscosity Number	Bulk Density(₉ /1)	Sieve Analysis	<250 pm (%)	Retained on 0.4 mm sieve (%)	Porosity (%) (Plasticiser absorption)	Volatile matter (%)	Flowability (s/150g) (10mm nozzle)	Residual VCM (ppm)	Dark resin particles	Fish eyes	Sulfate ash (wt-%)
	DIN			60							53743	VinnolitF5	VinnolitH1	
Test method	ISO	1628-2	1628-2	60	4610	4610	4610	4608	1269	6186	6401	Inpowder	Felttest per 25 cm ²	3451-1
S 5831 S 6031 S 6532 S 6732		58 <u>+</u> 1	82	540-600	95-100	0-1	<1	14-20	< 0.3	<u><</u> 25	<u><</u> 1	<u><</u> 20	<u><</u> 5	<u><</u> 0.1
		60±1	87	520-580	95-100	0-1	<1	16-22	< 0.3	<u><</u> 25	<u><</u> 1	<u><</u> 20	<u><</u> 5	<u><</u> 0.1
		65 <u>+</u> 1	105	550-610	95-100	0-5	<1	19-25	< 0.3	<u><</u> 25	<u><</u> 1	<u><</u> 20	<u><</u> 20	<u><</u> 0.1
		67 <u>1</u> 1	113	550-610	95-100	0-5	<1	18-24	< 0.3	<u><</u> 25	<u><</u> 1	<u><</u> 20	<u><</u> 20	<u><</u> 0.1

Table 1: Specification of PVC (Typical suspension-grade)

Polymer-grade propylene is another product which the product of the MTO plant of the complex. Also C4+ and C5+ are by products of the MTO plant. The specifications of polymer-grade propylene is shown by the following table:

Table 2: Specification of Propylene (Typical polymer-grade)

COMPONENT	VALUE AT B.L.		
Propylene [% vol. min.]	99.5		
Propane [ppm vol. max.]	5000		
Ethane [ppm vol. max.]	200		
C4, C5, sat. [ppm vol. max.]	200		
Ethylene [ppm vol. max.]	100		
Butene [ppm vol. max.]	100		
Acetylene [ppm vol. max.]	5		
Methylacetylene [ppm vol. max.]	3		
Propadiene [ppm vol. max.]	5		
Butadiene [ppm vol. max.]	50		
Green Oil (C6-C12) [ppm vol. max.]	20		
Oxygen [ppm vol. max.]	2		
CO [ppm vol. max.]	0.03		
CO2[ppm vol. max.]	5		
Total Sulphur [ppm vol. max.]	1		
Methanol [ppm vol. max.]	5		
Water [ppm wt. max.]	2		
Total Carbonyls (as Methyl Ethyl Keton) [ppm vol. max.]	1		
Chlorides [ppm vol. max.]	1		

Caustic Soda and Chlorine are the two products of the Chloralkali plant of the complex. As Chlorine will be consumed in production of VCM and then PVC, so the product – Caustic Soda- could be sold to be used by different demand markets. The specification of polymer-grade propylene is shown by the following table:

PVC integrated complex included: Methanol, MTO, Chloralkali, VCM & PVC Plant

#	Property	Units	Test Method	Value
1	Purity	wt%	ASTM D-3875	48.5 min
2	Na ₂ CO ₃	wt%	ASTM D-3875	0.4 max
3	Na CL	wt.ppm	Spectrophotomerty (Denora)	15 max
4	Na ₂ SO ₄	wt.ppm	ASTM D-516/D-4130	15 max
5	AL ₂ O ₃	wt.ppm	Standard Method	10 max
6	Total Fe (As Fe ₂ O ₃)	wt.ppm	ASTM D-2790	6 max
7	SiO ₂	wt.ppm	ASTM D-859-88	5 max
8	Total Ca(As Cao)	wt.ppm	ASTM D-511	10 max
9	Hg	wt.ppm	Mercury Analysis	0.5 max
10	Sp.Gr.@(15.60C)		ASTM D-3875	1.515 min
11	Appearance		Visual	Clear
12	Na CLO3	wt.ppm	Vogel Analysis	120 max

Table 3: Specification of Caustic Soda (Liquid)

The complex sale able products and the sales unit prices are as followings:

Description	Plant Capacity (ton/year)	Unit price (US\$/ton)
PVC (suspension-grade)	1,000,000	790
Propylene (polymer-grade)	450,000	715
Caustic Soda (50% liquid)	1,349,756	110
C4⁺ fractionate	126,945	400
C5⁺ fractionate	45,963	350

Table 4: Products Sales

C4+ and C5+ fractionates are the by-products of MTO plant in the PVC integrated complex.

3. Infrastructure requirements

All utilities would be supplied though Central utility of the complex and only raw water and Fuel natural gas to be supplied from outside. In other word the utilities to be supplied from outside of the complex are:

Raw water: 30,318,363 m3 /year by unit price of 1.5 US\$/m3

Fuel Natural gas for complex process units: 328,638,778 NM3 by unit price of 0.05 US\$/NM3

Fuel Natural gas for complex power plant: 765,799,397 NM3 by unit price of 0.05 US\$/NM3

Also export jetty and export infrastructures are available in Jask port.

And Raw materials for the plant is as follows:

Description	Feed Requirements (ton/year)	Unit price	Annual price (US \$)
NaCl	1,327,403	25 \$/ton	33,185,075
Natural Gas (Nm3)	2,500,783,192	0.056 \$/Nm3	140,043,859
HCL 100%	14,924	82.5 \$/ton	1,231,230
Chemicals for PVC plant			46,140,000
VCM catalyst			2,623,764
MTO Catalyst			26,740,937
Methanol Catalysts			6,113,616
Memrane and Electrods for Chloralkali plant			*5,000,000
Chemicals for Chloralkali plant			16,824,677

Not:

- > Costs related to chemicals and catalyst is calculated annually.
- * It should be noted that the costs of "Memrane and Electrods for Chloralkali plant" have been calculated from the fourth year. Because For the first 3 years do not actually charge.

4. Market Overview, Evaluation of operational capacity in Iran, A review

of the import and export

According to the market study for PVC, the regions of India, Africa and Middle East with total net trade of -4 million tons/year PVC in 2018, are and will be the main target markets. North America and North East Asia are the PVC net exporters. For the balancing of supply and demand, supply of min. 2 million tons PVC in 2018 is required.

Iran PVC capacity is 745 KTPA and would reach to 800 KTPA in 2017. Next export of PVC from Iran in 2014 was 91 KT. PVC Demand in Iran in 2014 is 425 KTPA and is supplied though the local supply. In other world all PVC of the new plants should have export plan and exporting to target markets.

In this project, PVC is planned to be exported to target markets mainly India.

5、PVC production technology

PVC technology is suspension technology and it is preferred to get from the licensor of VCM as integrated plants (VCM/PVC).

6. Economic analysis. Scheduling of project investment

Due to low IRR and IRRE of the project in comparison with min. discount rate of 18% in Iran and thus the negative NPV, the project is not feasible in this scenario of implementing the MTO plant to supply ethylene and sales the propylene monomer without converting to downstream.

In fact, the investment of the MTO plant is very high and it is not feasible in fact. Project time schedule is 4 years for construction starting 2016 until end of 2019.

7、Estimation of total investment cost of the project、Estimation of

economic indicators

Fixed Capital Investment: 2610 Million Euros including:

- 360 Million Euros for Methanol plant
- 850 Million Euros for MTO plant
- 210 Million Euros for Chloralkali plant
- 230 Million Euros for VCM plant
- 370 Million Euros for PVC plant
- 73 Million Euros for equipment Transportation, Insurance and Custom Tariff
- 380 Million Euros for Central Utility plant

- 138 Million Euros for Land, Building, Pre-production expenditures, Owner and MC Cost, Contingencies.

Working Capital Investment: 125 Million Euro Economic Indicators:

- IRR: 19.45 %
- IRRE: 29.81 %
- NPV: 7.4 Million Euro (based on 18% discount rate)
- Payback period: 4 years (Normal Payback period) after start of operation
- Break-Even-Point: 30.6% (4th year of operation)

8、Return on investment and internal rate of return

- IRR: 19.45 %
- Payback period: 4 years after start of operation

9、Iran's Oil Ministry Project License

Feedstock and Implementation license would be taken from the Oil Ministry after preparation of financial planning for the project like the letter of intent of financers.