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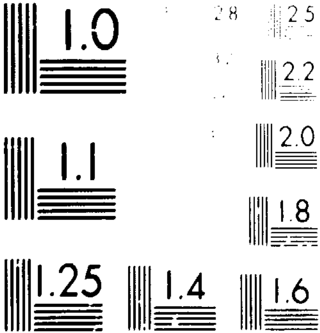
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THE DEVELOPMENT OF BASIC PETROCHEMICAL INDUSTRIES

IN

BANGLADESH.

ANALYSIS OF ROMANIAN PROPOSALS
FOR THE PRODUCTION OF PVC FROM METHANE .

SM/BGD/79/032

(UNIDO CONTRACT No. T81/69)

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38 Grosvenor Gardens
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November 1982

ROMANIAN PROPOSALS FOR PVC PRODUCTION IN BANGLADESH

SUMMARY

The Romanian proposals are far from being a full turnkey offer but have been examined in as great detail as the information provided allows.

All operators of acetylene from hydrocarbon plants have experienced operational problems in maintaining full output over long periods. We have found no evidence to suggest that a plant designed using Romanian technology would prove significantly better than others around the world but we have been unable to talk to the Romanians directly or to examine their operating records to confirm this.

A simple financial analysis indicates that the rate of return likely to be achieved is unacceptable even when taking into account the social benefits involved.

However, it may be still worthwhile to import vinyl chloride and polymerise within Bangladesh but we cannot comment on this possibility without some indication of the market demand.

ROMANIAN TECHNICAL OFFER

GENERAL COMMENTS

The Romanian Technical Offer was received in Dacca in mid November 1981. Despite having taken some two months to prepare, the documents contained only minor changes and additions to the previous issue. It had been intended that the review of the Romanian proposals should concentrate on those items contained in Table 1 rather than check the documents for errors and inconsistencies which will be rectified when the Romanians carry out the final design.

To comment effectively on the items in Table 1 would require very much more information than has so far been provided and in particular we would need P and I diagrams, layout for each unit, detailed equipment specifications, standards used etc. It seems clear that the Romanians have not done this work, at this stage, despite having promised a fixed price. We do not think that this information will be produced until after a contract has been signed.

However, from the information presented we have been able to establish that the processes proposed are standard ones and, with the exception of the Acetylene Plant similar plants are successfully operating in other parts of the World.

With regard to the Acetylene Plant the situation is somewhat different in that the only acetylene producer using the proposed process is in Romania and only an examination of the records of this plant can indicate the reliability of the system.

Table 1

ROMANIAN PROPOSAL

ACETYLENE, VCM AND PVC REVIEW

1 OPERABILITY

- a Control Systems
- b Buffer storage and number of vessels
- c Layout
- d Turn down ratios
- e Reprocessing or disposal of "off spec" material
- f Installed excess capacity

2 COST EFFECTIVENESS

- a Overall process design
- b Type and efficiency of equipment
- c Mechanical design and layout
- d Utility consumptions
- e Process efficiency

3 MAINTAINABILITY

- a Plant spacing
- b Installed spares
- c Material of construction

4 SAFETY

- a Toxic discharge
- b Fire protection
- c Explosion protection

5 MISCELLANEOUS

a Materials of construction

b Guarantees

c Product Quality

d Overall Heat & Mass Balance

e Standards and codes used

COMMENTS ON ROMANIAN EXPERTISE

We have no doubt that the basic technology developed by the Romanians is good, however, we should warn that some clients, in the past have been dissatisfied with the detailed engineering and equipment supplied from Romania. One example of this is a Soda Ash Plant built by the Romanians in Egypt which had severe commissioning problems and has only reached a reasonable output as a result of the efforts of an outside consultant over several months.

The following comments should also be made:

The Romanians have never built a complex of this type outside Romania.

The delay in receiving the Technical Proposal together with the even longer delay in receiving the Commercial Proposal may indicate a shortage of competent engineers available to work on the project. If this is so it may be that delays will be experienced throughout the design and construction of the project.

Almost all companies operating the acetylene from hydrocarbon feedstock process have experienced operating and maintenance problems to a far greater degree than in most petrochemical process units.

In view of these comments it will be essential to obtain meaningful guarantees from the Romanians as to reliability (as measured by annual production) ease of maintenance etc. This is particularly true in the case of the Acetylene Plant.

BUFFER CAPACITIES

Smooth operation of a chemical complex is dependent upon having adequate buffer capacity between each plant or stage so that a fluctuation or a failure on one plant does not entail rapid load changes or a crash shut down on another unit. In general, this has been provided but there is no buffer capacity between the chlorine production plant and the consumer (Hydrogen Chloride Unit). Since the chlorine plant is likely to be the most reliable on the complex and since it cannot be shut down quickly or its load varied instantaneously, consideration should be given to providing chlorine liquefaction, liquid chlorine storage and vapourisation.

We are also concerned that if the hydrogen chloride unit has to shut down quickly there are no sodium hypochlorite facilities to absorb the surplus chlorine until the cells can be shut down. We believe that sodium hypochlorite could be a useful by-product.

The Romanian documents do not appear to include any substantial inert gas storage. If the whole complex has to be shut down quickly large quantities of inert gas will be required and it is unusual not to provide a reserve supply for this eventuality.

PLANT CAPACITIES

As indicated in Table 2 the proposed capacity of each plant gives a nominal 2 - 5% spare capacity over the next downstream user. When operating at full throughput this should help to increase flexibility of operation since the output of PVC will ultimately be determined by the unit with the smallest capacity.

In addition, a figure of 300 working days/year has been used for design purposes. Most contractors would use a design basis of 330 days/year giving hourly throughputs 10% less than the Romanians with a corresponding reduction in equipment size. It is not clear from the data whether 300 days/year is a conservative figure in use in Romania which it is expected will be exceeded or whether it is a realistic figure and the equipment itself is not as reliable as would be expected in North America or Western Europe.

PERSONNEL REQUIREMENTS

No detailed estimates of the total employment, which would be created by this complex, have been presented but the figures given for Acetylene (100), VCM (94) and PVC (92) indicate that, apart from the construction requirement, the complex would have a minimal impact on the employment problems in Bangladesh.

Table 2

CAPACITIES OF MAJOR PLANTS PROPCSED BY ROMANIA

PRODUCTION UNIT		CONSUMING UNIT	
PRODUCT	CAPACITY T/YR	CONSUMER	REQUIREMENT T/YR
Acetylene	15,000	VCM	14,240
HCl	22,000	VCM	21,504
VCM	32,000	PVC	31,800 *

*Includes about 1,600 t/yr recycled VCM giving net requirement of 30,200 t/yr.

(The quantity of recycle is not specified accurately in the proposal nor is it made clear that the PVC requirement does include recycle).

In addition to the spare capacity which is required for flexibility purposes, it is worth considering the provision of additional capacity for external sales. On average about an extra 8% capital spent on the initial plant will increase capacity by 10%. This is usually very much cheaper than building a small scale plant.

A 10% increase in capacity of the acetylene plant would make available 1400 tons/year for cutting and welding gas. The cost of this would be little more than the cost of the cylinder filling plant and the required number of cylinders. It would, however, be necessary to reach an agreement with Bangladesh Oxygen Company to allow them to distribute the product and perhaps own the cylinders.

SAFETY

Acetylene is a highly dangerous material with explosive limits in air ranging from 2.5 - 80 per cent. It can also decompose with resulting detonation in the absence of air if heated. Acetylene will also react with copper and silver to form acetylides which are highly sensitive explosives and can initiate an explosive reaction.

Regulations in the United Kingdom prohibit the storage or transmission of acetylene at pressures higher than 22 psig (except in solution). Similar regulations in the USA specify a maximum pressure of 15 psig while Germany uses 1.5 kg/sq. cm.

In carrying out reactions with acetylene, higher pressures may be allowed but the whole arrangement of production, storage and transmission should be examined very carefully.

The Romanian process purifies the acetylene by absorption in ammonia at 11 atm and we have no evidence to suggest that this is in any way unsafe. Nevertheless it would be desirable to examine the operating records of the Romanian plant over several years to confirm their safety record.

Details of the proposed installation such as the distance apart of flame arresters are not given and we are, therefore, unable to comment.

REFRIGERATION

The lowest temperature refrigeration levels are provided by standard compression type refrigeration sets but the higher temperature levels of refrigeration are obtained by absorption refrigerators. These work on a different principle and have the disadvantage of using some 5 - 6 times more energy than a comparable compression cycle. For this reason they are not normally used in Western Europe except for small domestic units.

The energy for the absorption cycle can be provided directly by burning natural gas compared to the electric motor drives of the compression system (except in the largest systems which can use steam or gas turbines to drive the compressors). While this offsets to some extent, the increase in energy consumption it is likely that this particular design has been chosen because it can be supplied from Romania rather than from a third country.

STANDARDS

The only standards given in the proposal are references to environmental standards with respect to atmospheric concentration of toxic chemicals. In this case both Romanian and German practice is quoted. No engineering standards or safety standards are mentioned.

AMMONIUM CHLORIDE PLANT

The process is straightforward consisting of mixing, crystallisation, centrifuging, drying and bagging and should present no undue operating problems.

Those areas of the plant coming into contact with hydrochloric acid are rubber lined or made of graphite and provided care is taken during construction to prevent damage to the linings the equipment should give good service.

Insofar as we have been able to check the equipment sizes they appear to be adequate for the duties but there are a number of areas which we are unable to comment due to lack of information in the bid documents. These are listed below:

1	Plant layout -	no plan of the unit is given and hence we cannot comment on operating or maintenance problems, safety and manpower requirements
2	Instrumentation -	the flowsheet is inadequately instrumentated eg no level indicators are shown on the feed vessels D1 and V1. We assume that this is an oversight on the part of the bidder and that sufficient instruments will be supplied to enable the plant to be operated efficiently and safely. We have been unable to verify this.

ROMANIAN COMMERCIAL OFFER

CAPITAL COSTS

The KHD offer is not fixed and is subject to escalation based on various UK indices and the time period between the date of order and the despatch of the equipment.

We have, therefore, had to add our own estimates of the cost of escalation, spares, licence fees, insurance, transportation of KHD equipment etc and have concluded that the minimum foreign exchange costs up to acceptance of the plant will be the equivalent of $360,378,000. This assumes no escalation in the price of Romanian equipment and excludes civil and erection costs on the assumption that the skills and materials are available locally.

Even with the adjustments made, the price used for the financial evaluation is far from being an accurate fixed price and in sounding this warning we can quote KHD who in their offer commented as follows.

"Please note in connection with our prices that the specifications which we have received with your letters No. 115451 dated 24.06.1981 and No. 120487 dated 17.08.1981 for numerous items are technically not clear regarding scope, layout, specification etc. They most probably require further clarification. Therefore, for the time being, we have made numerous assumptions when determining the scope, layout and technical characteristics of the equipment laid down in the technical part of scope of supply submitted herewith. Our prices have not taken into consideration such clarifications witn resulting changes of scope, layout and technical characteristics of the equipment. Should such clarifications result in adjustments, our prices will have to be adjusted too".

The most recent figures submitted by the Romanians are given in Table 3.

PRICE OF PVC

Due to a large excess in capacity, prices of PVC around the world are at an uneconomical low level. Table 3 gives the prices of pipe grade PVC in the USA and compares the changes in price of PVC and Vinyl Chloride with crude oil costs. It can be seen that margins have been significantly reduced since the beginning of 1980 although there is some evidence that prices of PVC are beginning to increase once more. the pattern in Europe has been similar to that in the USA and bulk plastics producers in Western Europe were estimated to be losing a total of $200,000,000 a month during 1981 and early 1982. This loss has recently been estimated to have increased to $300,000,000 a month (Financial Times, 24th August 1982).

Table 3

30,000 MTA PVC Plant from Methane via Acetylene

Capital Costs

	$ US
ROMANIAN SUPPLY	
Engineering Services & Know-How	63,587,000
Equipment and Materials	163,600,000
Transport	13,851,000 **
	241,038,000
OTHER SUPPLY	
Licenses, Design and Technical Assistance	880,000
Equipment and Materials	67,000,000
Transport	1,382,000 **
	69,262,000
CIVIL AND ERECTION	120,700,000
Total	$ 431,000,000

Note these figures appear to exclude the following items

1. Insurance
2. Spares
3. Chemicals and Catalysts
4. Cost of Land
5. Financing Charges
6. Escalation
7. Land fill, roads, jetty, admin buildings, boundary fence and gatehouse
8. Technical assistance after completion of a test run
9. Duties, taxes etc in Bangladesh

** Transport costs for Romanian equipment are estimated by the Romanians at 8.47% of the equipment and material cost but for third country supply transport is given at only 2.06% of the equipment and material cost.

TABLE 4

U.S. MARKET PRICES
U.S. cents/lb

YEAR	1979				1980				1981				1982	
BUSINESS QUARTER	1	2	3	4	1	2	3	4	1	2	3	4	1	2
PVC Pipe Grade	24.5	27.0	29.0	30.5	32.0	32.5	25.0	26.0	24.5	27.5	27.5	24.5	17.5	20.0
VCM	14.25	15.2	17.2	18.5	20.2	18.0	17.0	17.0	17.0	20.0	20.0	16.0	13.0	16.0
CRUDE OIL	4.7	5.0	6.0	8.0	8.6	8.6	9.3	9.3	10.7	10.7	10.7	11.3	11.3	11.3

Notes

1. These are believed to represent preva[illegible]lling prices including discounts etc. Prices do, however, vary depending on the type of co[illegible]ct, quantity, grade of resin etc.

2. The crude oil prices are based on contract prices for Saudi market crude and are included for comparison.

Clearly, this state of affairs cannot continue indefinately and prices must ultimately increase to make the manufacture of bulk plastics more attractive. The timing and degree of any upward movement in prices is uncertain but for the purposes of this assessment we have assumed prices of 33.3 cents/lb, 40 cents/lb and 60 cents/lb. The lowest of these corresponds approximately to the margin being obtained in the USA in 1979.

Other factors such as freight charges, size of order, type of contract (long term contract or single purchase), specification of material etc also affect the price at which it can be sold and prices being paid in Bangladesh reflect these.

Until the market survey currently being undertaken has been completed it is not possible to be precise as to whether the whole of the projected output of the plant will be consumed within Bangladesh or whether there ma be a possibility of small exports. In view of the current and future World overcapacity it is likely that any exports would have to be at a very low fob price. The viability of the project is, therefore, likely to be determined by the import saving.

CASH FLOW

In calculating the cash flow we have taken three cases with different PVC prices and different rates of production build-up. These are tabulated below:

Years from Contract Signature	5	6	7	8	9
Years from Start up	1	2	3	4	5
Price of PVC	Output as percentage of design capacity				
Case 1 33.3 cents/lb	60	75	90	100	100
Case 2 40 cents/lb	80	95	100	100	100
Case 3 60 cents/lb	80	100	100	100	100

The build-up to full capacity may be determined by either market demand or technical difficulties in production and for this reason we believe that the third case is over optimistic but it is included since it does indicate the effect of prices and conditions which produce a positive cash flow in the first year of operation.

Our calculations indicate that in case 1 it will be 22 years before all the foreign exchange expended has been recovered. The periods corresponding to cases 2 and 3 are $19^1/_2$ years and 14 years respectively.

These figures assume that the down payment itself is not financed and that the operating costs do not involve any foreign currency expenditure.

Cost of Production (figures rounded to nearest 1,000)

1	CAPITAL CHARGES		$/year
	Depreciation		
	Civil 2 1/2% (40 years) straight line		3,017,000
	Equipment & Materials (15 years)		20,687,000
			23,604,000
	Interest		
	Romanian supply	6%	14,462,000
	Other foreign supply	10%	6,926,000
2	OPERATING CHARGES (100% capacity utilisation)		
	Natural gas ($1/MCF)		
	160210×10^3 NM^3		5,657,000
	Electric power ($0.05/KWH)		
	241.38×10^6 KWH		12,069,000
	Operating labour		1,640,000
	Maintenance 4.5% of $206 mm material		9,270,000
	Insurance		500,000
	Total Annual Cost		$74,428,000
	Less credit for caustic soda		
	24 tons @ $500/ton		12,000,000
			$62,428,000

This is equivalent to 94c/lb for PVC ex works. 94c/lb is a highly optimistic figure since the production cost does not include a number of significant items such as catalysts and chemicals, the cost of land and post start up technical assistance which may be required. Moreover, it is based on operators at 100% capacity utilisation.

It also ignores the income from ammonium chloride but since the value of this is based on the nitrogen content its value is no greater than the ammonia from which it is made. This plant should, therefore, be viewed as a cheap way of neutralising hydrochloric acid.

At 80% plant utilisation the minimum ex works cost rises to $1.11 per lb.

Return on Capital

Our most optimistic estimate of the total erected cost of the project including local costs but excluding interest charges is $475,700,000. The following rates of return are therefore achieved at full capacity but ignoring the value of by-product ammonium chloride. (It has been assumed that the value of ammonium chloride is approximately the same as the cost of the ammonia from which it is produced).

Case	Price of PVC	Income $	RoI
1	33.3 cents/lb	-7,316,400	
2	40 cents/lb	-2,688,0005	
3	60 cents/lb	10,536,000	2.2%

Even making allowances for social benefits this project does not appear to be viable.

Recommendations and Future Work

It is clear from the figures that the Romanian offer should not be accepted since it likely that it would be cheaper to import PVC. However, this does not answer the question "How should the demand for PVC in Bangladesh be met?". The choices are as follows:-

a) Import PVC chips or compound as at present

b) Import Vinyl Chloride and polymerise in Bangladesh

c) Import Ethylene Dichloride and convert to Vinyl Chloride and hence PVC

d) Import ethylene or naphtha as starting materials.

The production of ethylene from naphtha is likely to be uneconomic at a scale of less than about 300,000 tons/year and since Bangladesh is unlikely to be able to absorb more than a small proportion of this quantity this route does not appear attractive.

The importation of either ethylene dichloride (EDC) or vinyl chloride could be an attractive possibility since the economics of scale are such that a

PVC plant much closer to the output required in Bangladesh could be installed. It would also give experience in downstream petrochemicals and PVC compounding and would, at the same time, give some savings in foreign currency costs. The Romanian proposal does not give a breakdown of costs so that we are unable to compare the cost of the full project with a partial one on the same basis.

However, other sources indicate that a 30,000 ton/year PVC plant should cost of the order of $50 million, but would depend on storage facilities required. Such a plant would be based on imported vinyl chloride (or perhaps ethylene dichloride which can be cracked to vinyl chloride and is more easily transportable).

While this approach would suffer the disadvantage of not being based on indigenous raw materials it does have the following significant advantages.

1. There should be a foreign currency saving compared with the importation of PVC.

2. With the present overcapacity in the World it should be possible reach to a long term agreement for the supply of VCM or EDC at low rates.

3. Since the technology is widely available, and to many people more acceptable than the acetylene route, it should be possible to get bids and finance from several sources and hence to obtain a lower price.

4. Economic size plants are smaller (and hence better suited to Bangladesh) than basic petrochemicals.

5. The construction of a PVC plant does not preclude the subsequent building of upstream plants for vinyl chloride and/or ethylene should this become desirable in the future.