OCCASION

This publication has been made available to the public on the occasion of the 50th anniversary of the United Nations Industrial Development Organisation.

DISCLAIMER

FAIR USE POLICY

CONTACT

Please contact publications@unido.org for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at www.unido.org

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

08013

Distr.
LIMITED

ID/WG.274/13
4 April 1978

ENGLISH

United Nations Industrial Development Organization

Expert Group Meeting on Fertilizer Plant Cost Reduction and Ways to Mobilize Sufficient Financing

Vienna, Austria, 11 - 14 April 1978

MEANS TO REDUCE COSTS OF FERTILIZER PLANTS - AN EGYPTIAN CASE HISTORY *

by

A. Raouf Shoukry**

---

* The views and opinions expressed in this paper are those of the author and do not necessarily reflect the views of the secretariat of UNIDO. This document has been reproduced without formal editing.

** Chairman, Abu Qir Company for Fertilizers and Chemical Industries, Alexandria, Egypt.

id.78-1745

In our developing countries, it is recognized that costs involved in establishing Fertilizer Plants are very high and are increasing from year to year, reaching - in some cases - to limits practically affecting developing countries objectives in expanding this industry.

In my paper " Nitrogen Fertilizer " Plants will be meant by the word " Fertilizer Plants ".

In 1970, we were establishing - In "HELWAN" (a city 30 Kms. south-east of Cairo) two lines, each to produce 170 Tons of NH_3/ day, according to the following data:-

a) Raw material is coke oven gas from the adjacent Cokerei Plant.
b) Process is partial oxidation under pressure.
c) CO_2 Removal by Shell sdip Process.
d) Traces of Co and CO_2 are removed by the old traditional Copper-liquor Process.
e) Ammonia to be reprocessed as Ammonium Nitrate - Calcium Carbonate calculated as 20.5 % N.
f) Capacity of each line is 200,000 Tons of $NH_4 No_3$ / $CaCo_3$ (20,5 % N.)

- This Production is equivalent to a Production of 237,680 tons of $NH_4NO_3.CaCo_3$ 34.5 % N.

The total cost of establishing such plant was about 27.5 - Million Egyptian Pounds, itemized as follows : -

- Value in thousands L.E. -

Serial No.	ITEM	Total Cost Investment
1	Site and site preparation	1,020,000
2	Civil Work and buildings	5,015,000
	<u>including</u> :	
	- Inside Roads	
	- Sewerage	
	- Inside Railways	
	- Utilities	
	- Antiacid and Fire Brick Works	
3	Machinery and equipment	18,570,000
	<u>including</u> :	
	- Transportation and Insurance	
	- Erection	
	- Local Manufactured vessels and steel-structure	
	- Erection Experts fees	
4	Furniture and Office Equipment	00,140,000
5	Transportation means (Busses - Cars and Lorries)	200,000

Serial No.	ITEM	Total cost Investment
6	Deffered revenue expenses including: - Wages and salaries during erection period. - Bank Fees. - Hermes Fees. - Start up Experts Wages and Salaries. - Contingencies.	00,800,000
7	Inventory (for 3 months Operation) (Chemicals, Plastic Bags,...)	00,600,000
8	Liquid cash for Operation	1,100,000
	Total Cost Investment:-	27,445,000 L.E.

Taking a rate of change of 0.65 US $ for each one L.E.

This means that, in 1970, Total Cost Investment of a Plant producing 237,000 tons NH_4No_3 / $CaCo_3$ 34.5 % N, was equivalent to:

= 42,300,000 US. $.

According to a study of the Establishment of Nitrogenous Fertilizer Production in Developing Countries by R.P. COOK and V. Raa Vangala, pages 18 & 29.

Such a Plant Costet by 1975:-

= 90 Million US $.

i.e. more than double its cost in 1970.
It is evident that such drastic increase in the Cost Investment

of Fertiliser Plants, is mainly due to the sharp increase of Petrolium Prices in January 1974, where the cost of one barrel of Crude Oil increased from 3 US $ to 11.5 US $, and successive increase in prices of Land, Civil Works, Machinery, Wages and Salaries etc ..,

An Interesting Comparison Between Two Plants:-

One in Helwan Constructed in 1970
Other in Aswan Constructed in 1960

Comparison is as follows:-

Serial No.	Item of Comparison	HELWAN Plant	KIMA Plant at Aswan.
1	Location	30 Km South Cairo	850 Km South Cairo
2	Capacity	240 Tons NH_3 per day	400 Tons NH_3 per day
3	Raw Material	Coke oven gas	Water Electrolysis
4	No. of Streams	Two	Four
5	Date of Finishing Construction	1970	1960
6	Total Cost Investment	27.5 Million L.E. = 42.5 M.US $	22 Million L.E. = 33.8 M. US $

Comment:-

The long distance between Cairo and Aswan where KIMA Plant is located, means increasing cost of :-

- Transportation of Equipment
- Especially conditioned Houses for all working Staff (from the Chairman till the unskilled).

- Increasing salaries and wages (50% more than Helwan).
- Every tool and bolt must be purchased from Cairo and transported to Asswan.
- Water electrolysis is a more costly process in its equipment and machinery than Coke oven gas.
- 4 Streams in Asswan i.e. double the No. of streams in Helwan, which means more capital cost.
- KIMA Plant is - 20% more in capacity than Helwan.

Inspite of all these factors, which are in the favour of Helwan, yet the total cost investment of Asswan Plant is still less than that of Helwan.

However, this difference in cost investment is not comparable with the drastic increase of cost during the period 1970 - 1975.

COMMENT

As long as prices of machinery, equipment, cost of civil works, etc..., are - in most cases - beyond our control as Developing Countries, thus, it is very important to discuss other relevant aspects that have impact on plant investment costs, aiming to reduce the total cost of a Fertilizer Plant to limits enabling us to expand Fertilizer Industry and thus, reaching our goal of increasing production rapidly enough to approach self-sufficiency before the begining of the year 2000.

Fixed and Working Capital Costs of Fertilizer Plants

In considering the fixed and working capital costs of a Fertilizer Plant, I prefer to think of it, as made up of seven (7) components, according to the following classification:-

1. Cost of Site and Site Preparation:-

   This includes cost of:-

   a. Site.
   b. Leveling of site by filling or excavation.

2. Cost of Civil work and Buildings:-

   This includes the cost of:-

   a. Piling if any.
   b. Reinforced concrete. (R.C.)
   c. Plain Concrete.
   d. Building and massonary.
   e. Sewerage (Industrial - Rain - Fecals,...)
   f. Inside Paving and Roads.
   g. Inside Railways.
   h. Water supply (canals or others...)
   i. Antiacid Work.
   j. Fire Brick Lining.
   k. Fee of Civil Consulting and Design Office.

3. Cost of machinery and Equipment:-

   This includes the following items:-

   a. Price of machinery and equipment.
   b. Cost of Transportation and Customs.
   c. Insurance Premium.
   d. Engineering and Design.

e. Cost of local Manufactured Vessels and Machinery.

f. Cost of Erection Tools and Consumable Materials (Welding gas...).

g. Cost of Erection. (Erectors and Supervisors).

4. Furniture and Office Equipment.

5. Transportation Means:-

(cars - Busses - Lorries,...).

6. Deffered - Revenue Expenses:-

a. Wages and salaries during construction period and untill start-up, including start-up Experts wages and allowances.

b. Travelling expenses.

c. Bank Charges till start up.

d. Consultations Fees.

e. Contingencies.

7. Working Capital:-

a. Inventory for 3 months operation:-

Including Chemicals, Raw materials, Plastic bags,...).

b. Liquid cash for operation :-

The total sum of these 7 Components is the fixed and working capital cost of the Plant.

After analysing components of fixed and working cost of a Fertilizer Plant, I will state hereafter my point of view concerning major components of capital costs which can be reduced.

A. Site Factor:-

One of the most important Items which can play an effective roll in reducing capital costs of a Fertilizer Plant is Site.

Locations and sites of fertilizer plants must be established on the basis of detailed comparisons and studies; correct selection of plant site has virtually become a science based on experience and fundamental basis.

The old theory of chosing a site just near the source of raw material or on top of well mouth must be readjusted, as this theory may result in a very costly site, delaying project and in the end, increasing cost of overall project. Misinformation about site conditions as Bearing strenght, Ground water level, Environmental conditions etc... may lead to a wrong site location, with its consequential losses.

Example :-

A site for a fertilizer plant was choosen on basis of short distance (6 Km) from natural gas well,

- Soil strenght was 0.3 Kg / cm^2.
- Water table was 60 cm deep only,

of course it was impossible to execute civil foundations without rigging about 7000 piles, each pile having a depth ranging between 18-26 m.

- Execution of such number of piles delayed project by 18 months and costed 3,000,000 US $.

The second alternative for that site, was a site 40 Km far from chosen site, but with a bearing strenght of 1.5 kg/cm^2, no piles were needed, Water table was at 3.5 m deep,

- Cost of 40 km of piping and its erection was estimated as 6,000,000 US $.

Choosing of second site was the correct choice and should have saved 18 months of production, equivalent to 90 million US $.

Comment :-

Site factor is considered as one of the most difficult items to decide in estimating investment costs for fertiliser plants. Recent publications on this subject recommend a certain factor to be considered in estimating site costs when compared with developed countries.

For example :-

	Factor
In developed countries	1.10
In developing countries	1.25
In developin countries (remote locations)	1.35

Point of view :-

a) These percentages are somewhat low and I suggest factors to be :-

In developed	1.00
In developing	1.35
In developing (remote)	1.50

b) I prefer not to depend on solid ratios and to elaborate an economic comparison between different site locations. Taking into consideration loss of production as a result of project delay.

B. CIVIL WORK

Civil works in modern fertilizer plants (1000 t NH_3/ day, 1600 t urea/day) represents approx. 15 - 20 % of the total cost investment of the plant; accordingly, reduction of cost in such item will influence to a greater extend the total cost investment of the Project.

Type and reduction of cost may be influenced by two major factors :-

a) Type and design of different plant sections:-
Due to lack of cement and reinforcing steel bars in developing countries,

the design of:-

- Compressorhouse
- Urea storage
- Store house and magasines,

must be done using the minimum amount of reinforced concrete. For the Compressorhouse, only the foundations to be R.C. and rest of building to be a simple skelton of steel structure and eternite covers.

For urea storage, Asbestos or wooden sheets could be used; R.C. to be used only in Columns.

- There is no need to install pipes on R.C. piperacks. A cost comparison must be done between piperack system and underground culverts.

I, personally, prefer to substitute piperacks by less height sleepers of concrete (1 m height), thus sparing ⅓ cost of pipe racks.

b) Using modern techniques in execution of high level buildings

as prilling tower, stacks and urea storage,

by classical methods , a prilling tower of 60 m height,
20 m diameter

will be executed in 18 months.
When using the sliding form system, this tower was built in 21 days, in Abu Qir Project.

- Primary-Reformer stack with 40 m height was built in 15 days.

- Urea storage of 150 m lenght
60 m breadth

is executed in 18 months by the sliping form system, while by classical methods, it needs 36 months.
You can imagine reduction in cost investment which could be obtained by using such modern technique.

c) Scientific Planning and Execution Programmes :-

To have the best scheduling execution of Civil Work, I prefer to use,

(critical path analysis)

and "Programme Evaluation and Review technique" (P E R T) which is a very modern planning tool for execution of Fertilizer Projects, enabling us to minimize execution time and thus, reducing total cost investment of the Project.

d) Machinery & Equipment :-

Cost of machinery and equipment, including its erection, represent the major component of the total cost investment of a Fertilizer Plant.

Example :-

From the 126 Million Dollars which are the total cost investment of a 1000 ton/day NH_3 and 1600 ton/day Urea, the cost of Machinery and equipment, including erection, is 78 Million Dollars, i.e. 62% of the total cost investment of the Plant.
Reduction of Costs can be successfully attained by:-

1. Establishing a system for manufacturing some of the vessels, tanks and steel-structure locally.

   The total weight of such items may reach 8-10% of the total tonnage of the Plant.
   Pressureless tanks and vessels from normal alloy steel, water tanks, chemnies, sand and gravel filters,.....
   all cross sections of steel structure.
   These Items could be locally manufactured and erected.

2. Cost of Transportation :-

   Transportation of heavy equipment for example Urea Reactor weighing 250-300 tons, needs Imported Special cranes and special railway wagons to transport it from ex-works till site and then special devices to erect on its foundation.
   After finishing Transportation and Erection of such Units, all Cranes and Wagons used are of minor value to Plant.
   I prefer to have 2 Units each 120-150 tons, where our local capabilities can help in transportation and erection.

Example :-

The standard Urea reactor of capacity 1600 tons/day has a weight of 250 - 300 tons.

The total cost of its transportation from local harbour till site is as follows :-

Serial No.	I T E M	C o s t
1	a. Special railway wagon	100,000 US $
2	b. 2 Cranes, each 250 tons to shift from barge to wagon then from wagon on foundation.	8,000,000 US $
3	Daily Rates and allowances for 4 experts staying 15 days.	60,000 US $
	T O T A L :	8,160,000 US $

Comment:-

If this reactor is designed as two reactors each 150 tons, then local cranes and experts can successfully do the job. The site is equipped with cranes of capacity 90-100 tons.- These cranes are able of lifting such reactors.
Also, a reactor of 150 tons can be easely transported by using standard railway wagons.

3. Exemption from Import Duties on imported Plant Equipment , raw materials, chemicals and spare-parts:-

As an average, those import duties may reach 15% of the total equipment prices.
Most of the developing countries are now encouraging establishement of fertilizer industry by giving complete exemtion from import duties. In Abu Qir Plant, a Presidential Decree was issued, exempting us from all import taxes and from Profit taxes for a period of 8 years after Production.

4. How to reduce cost of Erection:-

a) Cost of : erection tools, equipment and consumable materials can only be reduced if detailed lists of such items are elaborated, classified to local and imported items within a reasonable period before starting of erection.
A detailed and Planned shedule for procurement of such items should be executed, thus decreasing loss of time and stoppages during erection period, as a result of deficiency of such items.

b) Foreign erectors and supervisors:-

The compensation for erectors in the form of daily rates and living allowances is one of the most costly items.
It reached = 15 million dollars in one of the 1000 tons NH_3/ day.

i.e. 20% of the total cost equipment.
To avoid such figures, Plant Management must make use of the max. number of local erectors.
Training of local personnel to carry on erection must be emphasized within the period from Contract signature till starting of erection. Foreign erectors can be allocated for sensitive jobs as alignment of centrifugal compressors, turbines, High grade stainless-steel welding, Electronic syste s and so on.

P A Y M E N T:-

Especially for welding of H.P.-Pipes and Noble metals, payment must be effected according to a certain system (meter, lenght or inch diameter).

After x-raying, if welding seams showed faulty welding, then payment must be reduced by the percentage of defaut, and the cost of repairs to be deducted from the payment of the welder himself.

How to reduce Deferred Revenue Expenses during Construction Period of a Fertilizer Project:

a) For Wages and Salaries:-

A good experience had been gained during execution of some fertilizer projects by scheduling expenditures every 3 months and excess liquid funds were blocked in a separate account for 3 or 6 months. Interest gained from blocking of such accounts was used to compensate wages and salaries of local staff, during construction period.

b) Loan - Insurance Fees and Bank Charges:-

NonPetrolium developing countries usually finance their projects through loans from developed countries, delivering machinery and Know-How.
The Insurance fees of the total loan are usually born by the developing country.

Example:-

Hermes fees in some countries was about 2.5 % of the total price machinery. This must be a point of negociation with developed countries to share such fees with developing countries.
The same can be said regarding bank charges which may sum-up to 1.5 % of total cost of machinery.

Before coming to an end I find it necessary to mention 3 main general factors which could be commented by your esteemed group of experts. Those factors can play a reasonable roll in reducing cost investment of Fertilizer Plants:-

1) It is preferable for developing countries to extend their already existing plants rather than to build new plants. Reasons are well known to you all.

2) No-Turn Key Job Contracts:-

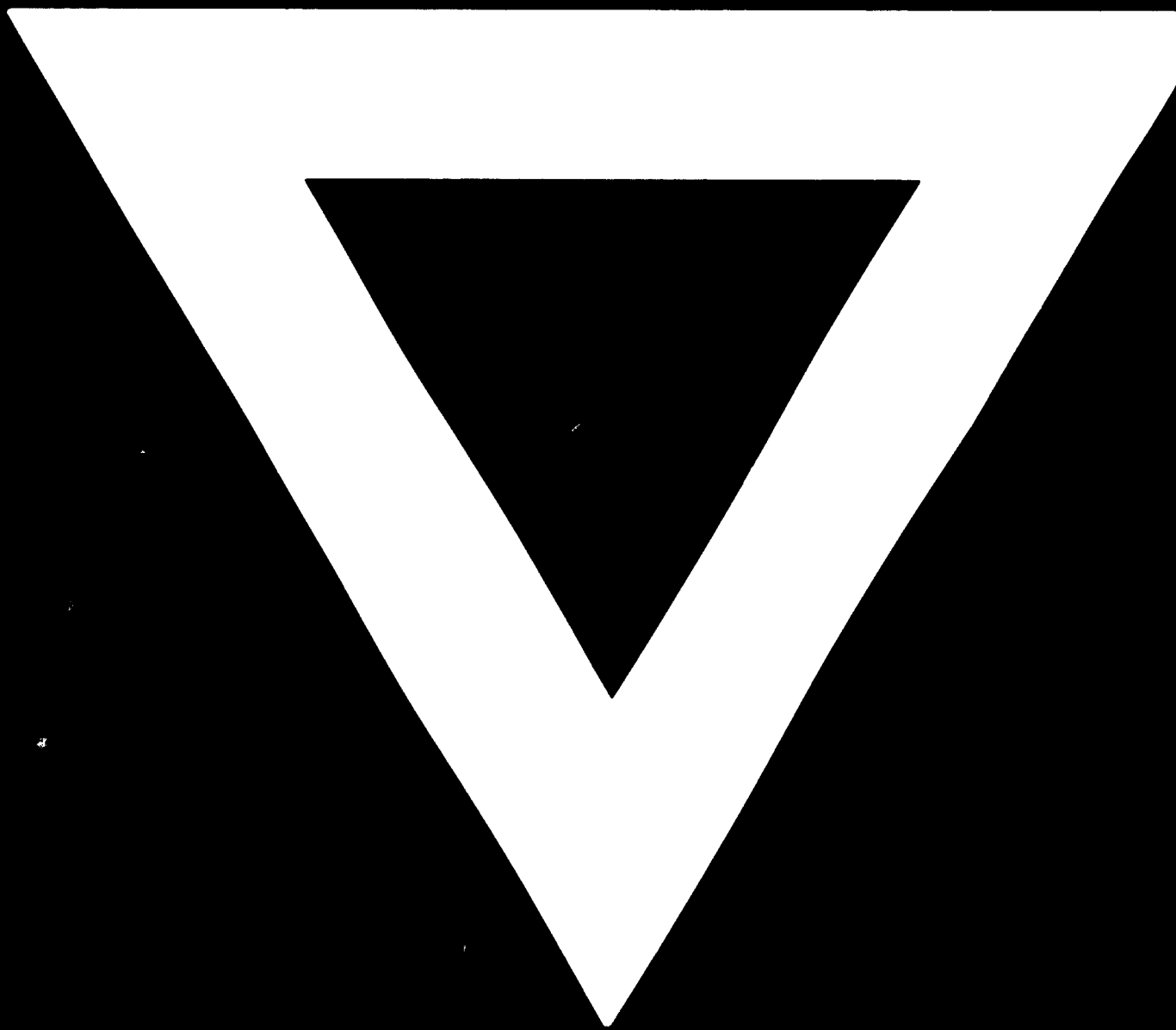
I prefer Engineering contracts with delivery of machinery and contractor will only supervise civil and erection works: He will supervise also start-up and guarantees.

3) Wider use of Low-Technology and Small-Scale Plants:-

Although I am not personally convinced of this fact, but we all recognise that large-scale complexes and modern plants are not always the best answer to the problem of fertilizer supplies in developing countries. A classic example of successful use of low-technology fertilizer production is in China. Hundreds of small ammonia Plants are in operation, using local coal as feed stock. There are also several hundred small phosphate plants.

I suggest that UNIDO adopt a policy of carrying out investigations about usage of such low-technology which is of less capital investment costs. The adoption of such low-technology, low-capital type plants, should be a way of assisting some developing countries in achieving a certain degree of self-sufficiency in Fertilizers and thus, in Food Production.

C-664



78.11.06