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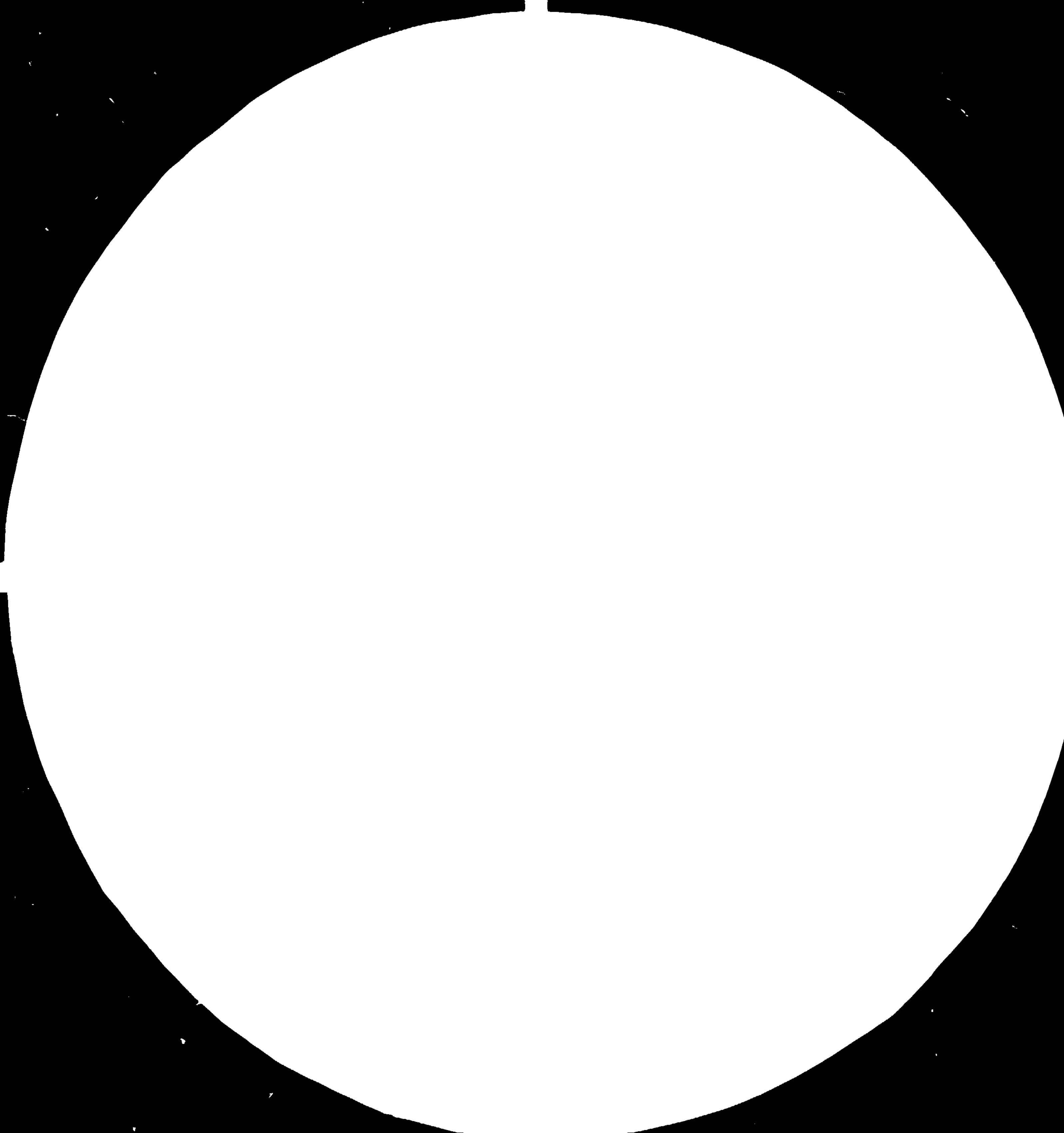

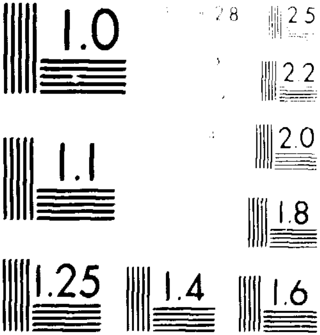
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THE MANUFACTURE OF LOW DENSITY POLYETHYLENE IN KENYA.

E.H. BATSCHA

JUNE 1982

Technical Assistance Expert
UNIDO

TABLE OF CONTENTS

1.0 INTRODUCTION

This report presents a prefeasibility study for the production of low density Polyethylene (LDPE) in Kenya. The technical process for the production of LDPE requires ethylene which in this special case will be produced from locally available alcohol (ethanol) or will, as an interim measure, be imported by ship from producers overseas.

Prefeasibility studies for the production of ethylene from locally available alcohol as well as for the import of ethylene are shown in the report. Also the various possible processes, their problems and alternatives are explained herein.

Full economic calculations are presented for a combined complex, starting from ethanol and upto the final LDPE product ready for sale. The last two chapters detail some thoughts on the possible future expansion and diversification of LDPE usage and of the ethanol consuming industry.

The writer wishes, at this point, to use the opportunity to thank to all people and institutions who have given their assistance and help and have supplied valuable information during the preparation of this report - Ministry of Industry - IPD Officers, UNIDO Advisers, plastic processors and consumers, local and foreign companies and agencies and foreign engineering contractors.

JOB DESCRIPTION
DP/KEN/80/001/11-62/31.2.A

Post Title: Expert in the preparation of a project in low density Polyethylene

Duration: Three Months

Duty Station: Nairobi, with travel within the country

Purpose of Project: To strengthen the functional role of the Ministry of Industry in planning and programming, co-ordinating and executing industrial development projects, and arriving at policy decisions.

Duties: The expert will work with officials of the Ministry of Industry and under the general direction of the team leader and will cooperate with other members of the international team to promote industrial development. The expert will be required to prepare a project for the production of LDPE in Kenya. This would include the following:

1. Prepare a prefeasibility study for a viable plant to produce low density Polyethylene from locally manufactured ethanol;

2. Prepare an alternate prefeasibility study for production of LDPE from imported ethylene as an interim measure pending availability of local ethanol;

3. Prepare guidelines for inviting project proposals from prospective enterpreneurs from within the country and abroad to set up production units;

4. Suggest a strategy for future expansion and/or diversification of the industry.

The expert will also be expected to prepare a final report, setting out the findings of his mission and his recommendations to the Government on further actions which might be taken.

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2.0 SUMMARY

This report presents a prefeasibility study for the production of low density Polyethylene (LDPE) in Kenya. The following are the main problems which have been analysed in the report:

2.1 Prefeasibility study for the production of ethylene from ethanol

2.2 Prefeasibility study for the import of ethylene from overseas

2.3 LDPE consumption forecast and manufacturing costs.

2.4 Economic study of the manufacture of LDPE

2.1 PREFEASIBILITY STUDY FOR PRODUCTION OF ETHYLENE FROM ETHANOL

The prefeasibility study is based on the know-how and information received from a well known US engineering contractor. It details investment, conversion costs and shows tables of maximum permitted cost of ethanol as a function of ethylene prices and at two production capacities, 40,000 MT/year and 30,000 MT/year. The study can be summarized in saying that, in order to achieve a realistic price for ethylene, the cost of ethanol (100% basis) must be maximum KShs.2.5/litre and preferably below that.

Furthermore it has to be stated that the quantity of ethanol required at the start of the project (1988) reaches about 48,500 MT/y (60.5 million litres) increasing to about 70,000 MT/y (87 million litres) in 1996. This quantity includes 10,000 MT/y ethylene for PVC production. Such quantities of ethanol are not available yet and the larger part is in the planning stage only.

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2.2 PREFEASIBILITY STUDY FOR THE IMPORT OF ETHYLENE

The technical complexity of the import of ethylene is described in full. The study is based on the investment figures for the storage system received from reputable West European and US engineering contractors.

Information on transportation, money and time involved, were received from West European shipping brokers.

It can be concluded that the import of ethylene does not seem to be a profitable venture. Even without duty on imported ethylene, the cost of it will reach $ 708/760 per ton ethylene, which is too high a price for a successful LDPE plant. As a matter of fact the price of ethylene will even be higher because depreciation should only be calculated over about 6 years (interim period) and this will raise the cost by $35/MT.

Other additional disadvantages are as follows:

a) the import of ethylene forces the siting of the whole complex in Mombasa area. This fact will require rail transport of alcohol from Western Kenya to the coast and adds about $ 45 to the ethanol moved, or $78 to the ton of ethylene produced from alcohol.

b) The imported ethylene, paid for in foreign currency, will leave practically no foreign currency savings at all.

c) The storage system is an expensive unit and adds about $12,000,000 to the investment, which would make the total project even less profitable.

2.3 LDPE CONSUMPTION FORECAST AND MANUFACTURING COSTS

The three different types of Polyethylene and their usages are described. Furthermore a somewhat conservative consumption forecast over the 12 year project period has been prepared. Know-how suppliers have been contacted but no definite answers received yet. The manufacturing costs and investment estimate are based on a project the writer carried out in Israel during the year 1974/1978 for a 60,000 MT/Y LDPE plant.

2.4 ECONOMIC STUDY OF THE MANUFACTURE OF LDPE

Two studies have been prepared:

2.4.1 One study based on conditions whereby a 40% duty is paid on imported equipment and the interest rate for loans is 15%.

2.4.2 A second study whereby no duty is taken on imported equipment and the interest rate is 8% only.

2.4.1 The first study proves the project to be not feasible.

2.4.2 The second study shows that the ethanol to LDPE project can live only if the Government is prepared to subsidize the alcohol producers. Even under these preferential conditions the project is a marginal one under the presently prevailing world conditions

As a matter of fact these results give a true picture of the bad state of business in which the world producers of ethylene and LDPE find themselves at the present moment. There is an excessive capacity of both materials in the world with resulting heavy competition and which forces the prices down to the minimum possible.

If one analyses the distribution of manufacturing costs of LDPE, one sees the following picture:

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Ethylene	-	49.6%
Variable	-	8.8%
Fixed	-	20.0%
Profit	-	21.6%
		100 %

Ethylene is the major cost component, which can be obtained at cheap prices in the world, especially at the presently "low" price of the barrel of crude oil. An upward trend in crude oil prices and a consequent rise in cost of Naphtha and and LPG might change the picture entirely and make the local production a successful venture.

Also the fixed costs (including depreciation) have a relatively high impact on the utlimate production costs. The reasons are twofold: the proposed LDPE plant is a relatively small unit and therefore fixed costs are relatively high per ton product and furthermore it is a new grassroot industry which require heavy investment for infrastructure such as utilities, storage,area and environmental preparations, buildings, laboratories, drainage, sewage, etc. Any further expansion will require less investment per ton product and will make the whole project more profitable.

The last item of importance is the profit of the enterprise. At the present depressed state of business it is doubtful whether anyone of the present producers can show as high a profit as this project (IRR = 14.7%). Most companies are happy if they can break even and od not slide into the red. During the last year several large chemical companies have decreased their output considerably and some have gone out of the LDPE business entirely, due to the heavy losses incurred to them by the weak market.

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It is recommended that this project should be re-evaluated periodically, as the feasibility is liable to change to the better with rising cost of crude oil and consequent higher cost of Naphtha ethylene and LDPE in the world market.

2.5 The last two chapters detail some thoughts on the possible future expansion and diversification of LDPE usage and of the ethanol consuming industry.

3.0 THE PRODUCTION OF ETHYLENE FROM ETHANOL - A PREFEASIBILITY STUDY

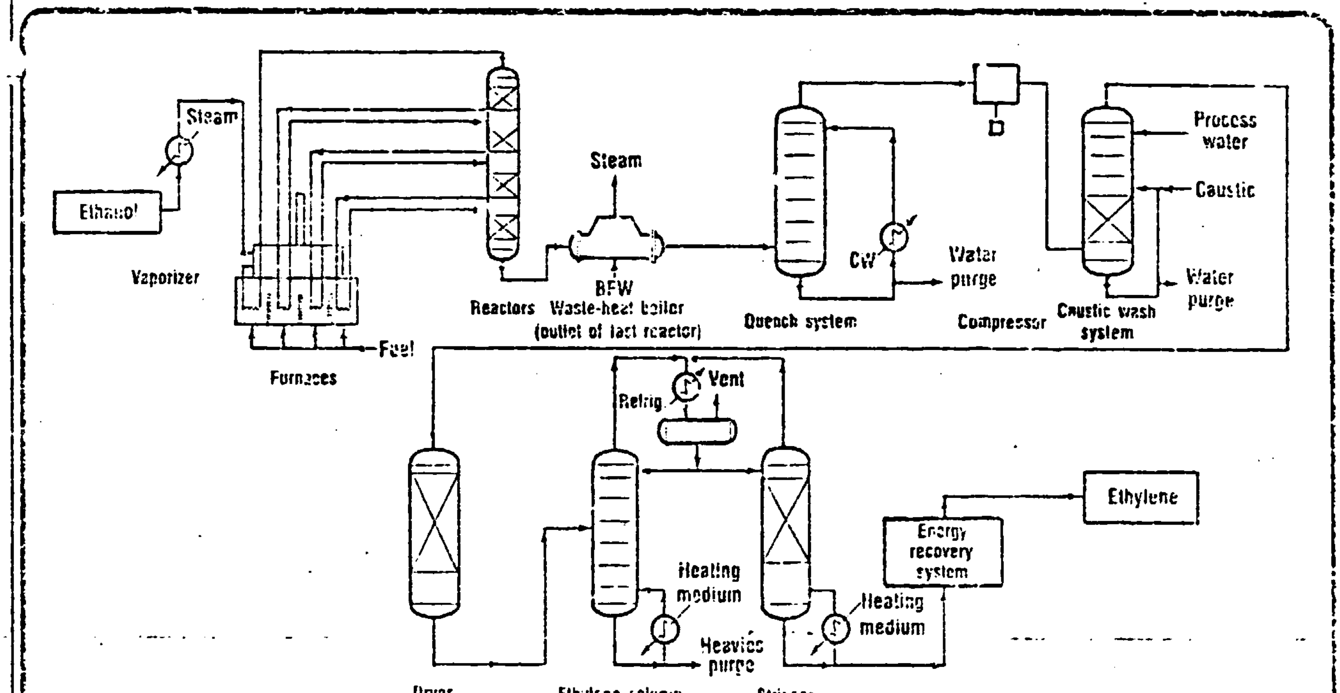
3.1 THE PROCESS

Until the mid 1940's, a significant portion of the ethylene produced industrially was derived from ethanol dehydration. Afterwards, thermal cracking of hydrocarbons, because of its superior economics, became the source of essentially all ethylene. Today, with the significantly increased cost of hydrocarbons and the large investments required for a modern ethylene plant, there is renewed interest in ethylene-from-ethanol plants derived from renewable natural resources. This is particularly so in Africa, Asia and South America. Also with the advance in chemical engineering research and technology new catalysts have been developed, having increased activity, higher selectivity and greater resistance to deactivation. This resulted in higher yields, increased reactor on stream time and less by products, meaning lower investment and lower conversion costs. The process itself is relatively simple, involving low pressures and somewhat elevated temperatures.
The basic reaction is the dehydration of ethanol:

$$C_2H_5OH \longrightarrow C_2H_4 + H_2O$$

Attached is a simplified flowsheet of a polymer grade ethylene plant.

Ethyiene* from ethanol



*Polymer grade

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Ethanol is vaporised and passed through the catalyst filled reactor. The reaction is endothermic and stable temperature is important, therefore the gas is several times taken out of the reactor, re-heated and sent back. The hot gases leaving are quenched, thereby producing waste heat steam, then quenched with waste, caustic washed and dried. By Cryogenic means the rest of the impurities are removed to produce polymer grade ethylene.

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3.2 PLANT CAPACITY AND ETHANOL REQUIREMENTS

According to our forecast LDPE requirements will average 25,000 MT over the 12 year period 1988-1999. This quantity requires an average of 26250 MT polymer grade ethylene. In addition 10000 MT have been earmarked for the manufacture of PVC. Therefore a 40,000 MT/a ethylene plant is recommended and all calculations are based on this capacity.

Ethanol supplied can be either hydrated (95.6%) or anhydrous. Whatever material supplied, on a 100% basis 1.74 MT ethanol are required per 1.0 MT of polymer grade ethylene. According to our forecast, therefore, in 1988 about 48,500 MT (60.5 million litres) ethanol will be required raising to 70,000 MT (87 million litres) in 1996.

3.3 PROPOSED LOCATION

The best location for such plant is in West Kenya, near the ethanol producing facilities, probably adjacent to the main raw material supplier. Additional quantities will have to be transported from the other suppliers by rail, road or pipeline.

It should also be investigated if the existing utilities facilities available at the planned alcohol plants will have enough capacity for supply to the ethylene/ LDPE complex. This could reduce the initial investment by a considerable amount. Moreover it would be advantageous if also the projected PVC plant is located in the same area. This will facilitate supply of ethylene and is especially important in view that all technical personal experienced in plastic manufacture will be located in same area. Such arrangement can save on manpower, laboratory buildings and equipment, laboratory staff and ensure concentrated research and development. It can further save on administrative manpower, sales force, technical sales personnel and engineering management.

3.4 KNOW HOW

Know how is available from a limited number of engineering companies, such as:

Halcon-Scientific Design Group, Inc.
2 Park Avenue, N.Y.10016, USA.

C-E Lummus,
Bloomfield, New Jersey, USA.

Petrobras S.A.,
Rio de Janeiro, Brazil

We have contacted Halcon-SD and Petrobras, both of whom appear to be the most advanced in the field. Halcon-SD published extensively in the technical literature and they also send us full information for a 40,000 MT/a polymer grade ethylene plant.

Regarding Petrobras we met three representatives during their visit to the Ministry of Energy, in Nairobi in late March 1982. We also have summarised our technical requirements and sent those to Mr. L.R. Lindeman, Chief Process Engineer of Promon Engineering, Sao Paulo. Mr. Lindeman was one of the Petrobras representatives and he promised to forward all required data. Unfortunately these data have not yet been received but are promised to be forwarded shortly.

Exchange of letters with Halcon-SD and Promon Engineering is presented in section 3.10.

The following prefeasibility study is based on information supplied by Halcon-SD. As soon as the Brazilian offer arrives adjustments will be made, if so required.

3.5 INVESTMENT

The B.L. investment as detailed by Halcon-SD is as follows:

	in M$*	
Major Equipment	2,400	
Other materials	2,100	
Construction labour	1,600	
Construction Supervision	400	
Engineering and Procurement	1,600	
Total (April 82) M$*	8,100	- Gulf Coast Conditions

* Thousand Dollars.

Those figures will have to be translated to Kenyan conditions and therefore the following items will have to be added:

- 3.5.1 Utilities and storage
- 3.5.2 Shipping cost to site
- 3.5.3 Duty on imported equipment and materials
- 3.5.4 Adjustment of construction cost to local conditions
- 3.5.5 Interest during construction
- 3.5.6 Start up and training
- 3.5.7 Land
- 3.5.8 Contingency

3.5.1 UTILITIES AND STORAGE

Following required:

Steam Supply (Boiler)
B.F. Water Treatment and Tank
Air Compressors
Cooling Tower
Electrical Substation
Fuel Oil Tank
Inert Gas Supply
Ethanol Buffer Storage
Ethylene storage tank and liquifying unit
Trucks or rail or underground pipeline for ethanol
Process water supply, drainage, sewage
Fencing, guard building
Street lighting

It is estimated that the above will cost about 20% of B.L. plant, i.e. M$1500.

3.5.2 SHIPPING COSTS TO SITE

Estimated at 10% on all imported equipment and materials (M$4000 + M$1000) 10% = M$500.

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3.5.3 DUTY ON IMPORTED EQUIPMENT AND MATERIALS

Duty is 40% on c.i.f.

M$ 5,500 x 40% = M$ 2,200

3.5.4 ADJUSTMENT OF CONSTRUCTION COST TO LOCAL CONDITIONS

Add 25% to Construction Supervision = M$ 125

3.5.5 INTEREST DURING CONSTRUCTION

Based on 33% equity			= M$4,300 (without financial)
Balance loan at 15% interest			= M$8,700 (without financial)
Say outlay:	1st year	20%	= M$1,740
	2nd year	50%	= M$4,350
	3rd year	30%	= M$2,610

Then total interest over the three year construction period is about M$ 1,820

3.5.6 START UP AND TRAINING

Estimated at M$ 300

3.5.7 LAND

About 2 acres, Western Kenya, Kisumu area, estimated M$ 20.

TOTAL INVESTMENT

			M $
3.5.0	Battery limit, contractor's quote		8
3.5.1	Utilities and Storage		
3.5.2	Shipping to site		500
3.5.3	Duty		2,200
3.5.4	Adjustment to local construction		125
3.5.5	Interest during construction		1,820
3.5.6	Start up and training		300
3.5.7	Land		20
	Sub Total	M$	14,565
3.5.8	Contingency		435
	Total:	M$	15,000

3.6 OPERATING COSTS

3.6.1 VARIABLE COSTS

Operating requirements and costs are shown in Section 3.7

3.6.2 FIXED COSTS

a) Manpower: 4 men/shift
Lab. Testers
Process Engineer
Plant Manager

Altogether about $3/hr x 2000 x 20 + 100% overhead = M$ 240

b)	Maintenance $8.14/ton	= M$ 330
c)	Taxes and Insurance, 2% on investment	= M$ 300
d)	General Administration, 1.5% on investment	= M$ 225
e)	Depreciation, over 12 years	= M$1,250
f)	Interest on working capital	= M$ 45
	Total annual fixed cost	M$2,390

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3.7 CONVERSION COST PER MT ETHYLENE

(Without Ethanol Cost)

	Quantity per ton ethylene	Unit Cost $	Total Cost $/Ton	Total Cost M$/a
Variable Cost				
Catalyst & Chemicals			2.85	
Steam, ton	1.20	15.0	18.00	
Condensate return, m^3	(1.40)	0.75	(1.05)	
Cooling water, m^3	102	0.016	1.63	
Power, Kwh	340	0.048	16.30	
Fuel oil, 10^6 Kcal	0.32	15.25	4.96	
Process Water, m^3	0.34	0.13	0.05	
Inert Gas			2.00	
Total Variable Cost/MT Ethylene			44.74	
Fixed Cost				
Manpower				240
Maintenance				330
Taxes and Insurance				300
General Administration				225
Depreciation				1,250
Interest on W.C.				45
Total Fixed Cost/a				2,390

Total Conversion cost, without ethanol feed cost (at $/MT)
at 40,000 MT/a production: 44.75 + 59.75 = $ 104.50
at 30,000 MT/a production: 44.75 + 79.66 = $ 124.40

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3.8 REQUIRED PRICE OF ETHANOL

From the above figures one can calculate the maximum feasible price of ethanol at varying prices of ethylene. The calculated prices shown below are for 1.0 unit of anhydrous alcohol or 1.046 unit of hydrated alcohol, without any profit.

at 40,000 MT/a Production

Ethylene prices $/ton	Anhydrous Alcohol $/ton	Anhydrous Alcohol $/1ton	Anhydrous Alcohol KShs/1 ton
500	227.30	0.182	1.91
550	256.00	0.205	2.15
600	284.77	0.228	2.39
650	313.50	0.251	2.63
700	342.24	0.272	2.87
750	370.97	0.296	3.12
800	399.71	0.320	3.36
825	414.08	0.331	3.48
850	428.45	0.343	3.60
	at 30.000 MT/a Production		
500	215.86	0.173	1.81
550	244.60	0.196	2.05
600	273.33	0.218	2.30
650	302.06	0.241	2.54
700	330.80	0.265	2.78
750	359.54	0.288	3.02
800	388.27	0.311	3.26
825	402.64	0.322	3.38
850	417.00	0.334	3.47

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3.9 CONCLUSION

From the above tables it can be clearly seen that for a realistic price of ethylene the cost of ethanol must be well below KShs.3.0/1.

If we take the average price of ethylene at, say 700/MT, then the distribution of cost is as follows:

Ethanol	-	$ 595.50	-	85.1%
Variable cost	-	$ 44.75	-	6.4%
Fixed Cost	-	$ 59.75	-	8.5%
		$ 700/MT		100%

The most decisive factor in the total operating costs is the price of ethanol and it constitutes 85% of it. The variable expenses have nearly no impact at all and even extremely efficient production management will not be able to reduce much on those items.

Almost the same can be said about the fixed and financial costs. Each 1 million dollar added or saved will add or save about $150,000 per year, which amounts to $3.75 per ton ethylene at full production output.

On the other hand the cost and the good management of ethanol usage is extremely important. It will require a good and efficient technical management in order to keep the quantity of alcohol at 1.74 MT per MT ethylene. Each additonal 1% of ethanol (17.4 kg.) adds $6.0 to each ton of ethylene. This can result in a large amount of money (up to $240,000/year) and therefore this special item will have to be guarded very carefully.

3.10 EXCHANGE OF LETTERS AND INFORMATION

Attached are following documents:

(1) Telex to Halcon-SD Group, New York

(2) Reply from Halcon-SD

(3) Letters to Promon Engineering S.A., Brazil.

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UNITED NATIONS
DEVELOPMENT PROGRAMME

OFFICE OF THE RESIDENT
REPRESENTATIVE IN KENYA

Block D, 1st Floor
Kenya Railways Hqs.
P.O. Box 30218
NAIROBI

Telephone 28776/7/8/9
and 25848

Cable Address: UNDEVPRO NAIROBI
Telex: 22265

Reference:

UNIDO 30.3.82

TELEX No: 233044 NEWYORK USA (Name of Company HALCON-SD GROUP)

FROM BATSCHA

MISC 754 / MINISTRY INDUSTRY KENYA CONDUCTING A PREFEASIBILITY STUDY FOR A 40,000 MTPY PLANT CONVERTING ETHANOL TO POLYMER GRADE ETHYLENE. FIGURES FOR CAPITAL AND OPERATING COSTS USED FOR STUDY ARE THOSE PRESENTED IN YOUR ARTICLE APPEARING IN CEP JUNE 1981 FOR A SINGLE MULTISTAGE ADIABATIC REACTOR SYSTEM. FOLLOWING INFO REQUIRED: AAA ARE THOSE LATEST FIGURES OR IS THERE ANY UPDATING? BBB DIVISION OF CAPITAL COST INTO MAIN EQUIPMENT, MATERIALS, CONSTRUCTION, ENGINEERING AND KNOW-HOW FEE? CCC IS SUCH PLANT ALREADY IN OPERATION? REPLY TO [illegible] BATSCHA TELEX UNDEVPRO 22265 POSTAL ADDRESS UNDP, PO BOX 30218 NAIROBI, KENYA. EARLY REPLY BY TELEX APPRECIATED.

(METCALF UNDEVPRO NAIROBI)

KEN/80/001/A

Batscha
/crt 30.3.82

cc Mr Batscha

CB to clear

ORIGINAL SIGNED BY C.P.C. METCALF

.../20

APRIL 7, 1982

UNDEVPRO

NAIROBI, KENYA

RE: ETHANOL TO ETHYLENE, OUR MARCH 31 TELEX

FOR BATSCHA MINISTRY OF NDUSTRY'S PREFEASIBILITY STUDY OF A PLANT TOCONVERT ETHANOL INTO 40,000 MTA POLYMER-GRAE ETHYLENE, OUR ESTIMATED PRESENT-DAY CAPIAL COSTS FOR U.S. GULF COAST CONDITIONS AR RENDERED BELOW.

TABE I

BATTERY-LIMITS CAPITAL COSTS

IN MILLION U.S. DOLLARS

ELEMENT	COST
MAJOR EQUIPMENT	2.4
OTHER MATERIALS	2.1
CONSTRUCTION LABOR	1.6
CONSTRUCTION SUPERVISIO	0.4
COMPLETE ENGINEERING AND PROCUREMENT	1.6
TOTAL - PRESENT DAY	8.1
(TOTAL - WITH 21-MONTH PROJECT	

SCHEDULE

FOR COMPLETENESS, PLEASE FIND NEXT ELEMENTS OF PRODUCTION ON A U.S. GULF COAST BASIS.

TABLE II

OPERATINGREQUIREMENTS PER MT OF ETHYLENE

RAW MATERIALS

ETHANOL (100 PCT. BASIS)	1.74 MT

CATALYST AND CHEMICALS 2.85 DOLLARS

UTILITIES

STEAM (10.6 KG/SQ.CM. GAUGE)	1.20 M
CONDENSATE RETURN	(1.40) MT
OOLING WATER (DELTA T=10 DEGREES C)	102.0 ‡7.M
POWER	240.0 KWH
FUEL	0.32 MILLION KCAL
PROCESS WATER	0.34 CU.M.
INERT GAS	4.27 NCU.M.

MAINTENANCE

MATRIALS AND LABOR	DOLLARS 8.14

AS TO THE KNOWHOW FEE, WE WILL ADVISE ONCE YOUR PROJECT BECOMES SERIOUS.

.../22

HALCON SD'S EXPERIENCE WITH E-TO-E TECHOLOGY BEGAN IN THE EARLY SIXTIES, WHEN WE DESIGNED TWO PLANTS - WICH PERFORMED BETTER THAN THE DESIGN EXPECTATIONS. OUR NEWLY IMPROVED SYNDOL CATALYST, COMMERCIALIZED N 1981, IS IN OPERATION AT FIVE LOCATIONS, AND HAS BEEN SELECTEDFOR SERVICE AFTER DIRECT CONPARATIVE TESTS WITH COMPETING CAALYSTS. DURING COMMERCIAL EXPERIENCE OVER ONE YEAR, NO REGENERATION HAS BEEN REQUIRED FOR SYNDOL. THIS PERFORMANCE FAR EXCEEDS THE COMMERCIAL PEFORMANCE OF OTHER COMMERCIALLY-TRIED CATALYSTS.

WE WILL BE PLEASED TO HEAR FROM YOU FURTHER, AS YOUR PROJECT DEVELOPS.

BEST REGARDS,

(9) MAURICE KUNSTENAAR

DIRECTOR - INTERNATIONAL SALES AND LICENSING

SCIENTIFIC DESIGN CO.

22255 UNDEVPRO

236408 SDC UR

ABOVE VIA RCA FROM 236408 SDC UR

UN.1/6/49 31 March 1982

Mr. L.R. Lindemann,
Engenheiro Senior
Divisao de Processos,
Area Industrial
Promon Engenharia SA
Avenida 9 de Julho 4939
01407 Sao Paulo SP
Brazil

Dear Mr. Lindeman,

It was a pleasure to have met you during your visit to Nairobi, together with Prof. R. de Moraes and Mr. I.R. Simas. This note comes just to summarise the main points of our meeting.

You will prepare for us an offer for a 40.000 MTPY polymerisation grade Ethylene plant from hydrated alcohol feedstock and based on the latest Petrobras know-how. The offer to include:

a) B.L. Capital cost, divided into:-
main equipment
materials, electrical, instruments
construction
engineering
know-how fee

It can be assumed that feedstock and all utilities will be supplied from outside to battery limit. Capital cost to include ethylene storage tank, at most convenient pressure from the process point of view, for a three day operating output and the inplant refrigeration unit if any required.

b) Feedstock and utilities requirements

Our hydrated alcohol is expected to have the following specifications:

Degree GL at 150°C	-	96° GL minimum
Dry matters	-	Nil
Acidity	-	1.8 g/100L max
Esthers	-	8 g/100L max
Aldehydes	-	1 g/100L max
Non alcohols	-	9 g/100L max
Higher alcohols	-	negative reaction
Furfural	-	" "
Methyl alcohol	-	" "

c) Manpower requirements

d) Throughput turndown ratio

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We would appreciate if you could attach a flowsheet and a typical plant layout. Let us please also know the price of hydrated alcohol paid by the Brazilian ethylene plant.

For easier communication you can write directly to me at the above address and telex number.

We are looking forward to receive your offer.

Sincerely yours,

E.H. Batscha
(Technical Assistant Expert-UNIDO)

EHB/bn

4.0 THE IMPORT OF ETHYLENE - A PREFEASIBILITY STUDY

The shipping of ethylene is in principal very similar to the shipping of LNG (liquified natural gas). Although moving LNG is presently done already on a very large scale, the transport by ship of ethylene in the world trade is relatively small. ICI has for many years shipped ethylene from the U.K. to their plants in the Netherlands, Israel has imported 16000 MT/year for about 6 years in the 1970's, Greece is planning to build a Polyethylene industry on imported ethylene, Egypt was investigating to base their plastics industry on ethylene imported from Italy, but this last project has apparently been shelved.

4.1 THE SHIPPING AND STORAGE OF ETHYLENE

The shipping is carried out in specially designed ships which can carry ethylene in liquified form at atmospheric pressure and at a temperature of minus 104°. For that purpose special storage tanks will have to be available in the supplier's port as well as in the receiver's port, in our case the port of Mombasa.

The ethylene storage consists usually of two tanks one inside the other. The inner tank must be capable of containing the cryogenic liquified ethylene and is therefore built of special 9% nickel alloy. The outer tank of carbon steel is built around the inner one at a distance of about one meter and the area between is all filled with "Perlite" insulating material. The tanks foundation is put on piles in order to maintain air circulation and to prevent the earth from freezing. Around the tank and up to a certain height (2-2½ meters max.) a wall of compacted earth will have to be built; the volume of the containment being at least 110% of the total tank capacity. This volume is necessary to contain the full amount of ethylene in

.../26

case of tank failure. In the more modern storage tanks and in order to reduce safety and security risks a a prestressed concrete wall is constructed around the outer tank at a distance of about 1.5 meters to serve as secondary cryogenic containment. In section 4.10 typical drawings of storage tanks are shown.

4.2 SAFETY

One has to bear in mind that ethylene is a dangerous material. A concentration of 3% to 29% ethylene in air is within the flammable limits and any such mixture, when coming in contact with a spark, will cause a heavy explosion and/or fire which may cause much damage. Therefore the tank must be located in an area where it can be assured that no spark can be generated within a distance of 45 meters, at least, from the outer tank wall. All equipment in that area must be explosion proof, no smoking and no work with open fire or with spark generating equipment will be permitted. Furthermore, the area must be surrounded with efficient fire fighting equipment and sensitive sensors who sound immediate alarm when fire breaks out or ethylene escapes uncontrolled from the storage tank. Also a flare or double relief valve system with snuffing steam will be installed on top of the tank to prevent any pressure built up inside the vessel.

4.3 STORAGE AND SUPPLY SYSTEM

The storage tank proper has been described in section 4.1. The usual way of construction is that the tank plates arrive on site already bent, formed and cut to measure. On site they are erected and welded. All the welds are 100% radiographed. Due to the nickel alloy construction, difficult weldings, radiographs and other special techniques involved in the erection of such tank, the storage system is an expensive investment and involves many specialists and experts.

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In addition to the tank proper, the storage system consists of two evaporators, two cryogenic pumps and one or two gas compressors and all the necessary process piping.

The way of ethylene supply starting from supplier up to the Polyethylene plant, is as follows:

The supplier has in his port of supply a storage system of sufficient capacity to fill the special ship which is berthed nearby. The liquid ethylene is pumped to the ship at very low pressure and is stored inside the cryogenic ship container at atmospheric pressure. Any gas created during the supply operation is directed back to the suppliers ethylene plant or liquification system. On arrival of ship in Mombasa it will berth near the storage tank and the liquid ethylene will be pumped from the ship into the onshore storage tank. It is mandatory that the distance between ship and storage be kept as short as possible, firstly because the cryogenic piping and insulation are very expensive and second to reduce the generation of ethylene vapour. Any generated vapour will be compressed by the ethylene compressor and sent directly to the polymerisation plant. Any excess ethylene gas generated during tank filling will have to be flared. During normal operation of supply from tank to PE plant, the pumps will pump the liquid ethylene through the evaporators to arrive as gaseous ethylene at the required pressure at the ethylene plant. Any ethylene evaporated in the storage tank due to the large temperature difference (up to 135^{o}C) will be taken up by the boil-off compressor and conveyed to ethylene plant at required pressure.

4.4 SUPPLIERS AND CONTRACTORS FOR STORAGE SYSTEMS

The following companies were contacted:

Chicago Bridge and Iron Company,
800 Jorie Blvd.,
Oak Brook, Ill.60251,
U.S.A.

Pittsburgh - Des Moines Corp.,
3400 Grand Avenue,
Neville Island,
Pittsburgh, PA 15225,
U.S.A.

Toyo Kanetsu K.K.,
Tokyo,
JAPAN.

Whessoe Ltd.
Darlington,
U.K.

Kloeckner Werke A.G.,
Georgs Marienwerke,
P.O. Box 2700, 4500 Osnabrueck,
WEST GERMANY.

A requisition was prepared detailing the required system and was sent to the above mentioned companies. A copy of this requisition is shown in section 4.10.

Answers with full quotations was received from: Chicago Bridge and Iron Co. via their french subsidiary,

Societe Nouvelle,
Constructions Metalliques de Provence (SnCMP)
Paris,
FRANCE.

and from:

Pittsburgh - Des Moines Corp. (PDM)

Toyo Kanetsu declined to send a quotation and answers are still awaited from Whessoe and Kloeckner Werke.

Copies of the letters and quotations are shown in section 4.10.

4.5 INVESTMENT

The investment is based on the offers received from PDM and SnCMP. It has not been finally decided whether the storage tank should be of 5000 MT capacity or smaller. The capacity will depend on the size of ships and this factor can only be determined at a more advanced stage of the project. A discussion on the possible sizes of ships is detailed in section 4.7. The following calculations will describe investment required for 5000 MT and 4000 MT capacities.

4.5.1 PDM's quotation for a 5000 MT tank, on a turnkey basis, is $ 12,600,000. To this figure the following expenses have to be added:

Off B.L. installations
duty on equipment
interest during construction
training, startup, contingency

therefore the total investments, according to PDM adds up to:

	M$
PDM quotation	12,600
Off B.L. installations	700
40% duty on equipment	1,600
interest during construction	1,460
start up,training, contingency	440
Total M$	16,800

4.5.2 SnCMP's quotation for a 5000 MT tank, on a turnkey basis, is FF 52,600,000 (M$8,680). By adding same items as above, total investment according to SnCMP will be:

	M$
SnCMP quotation	8,680
Off B.L. installations	700
40% duty on equipment	1,050
Interest during construction	1,000
Training, startup, contingency	370
Total M$	11,800

.../30

4.5.3 The PDM offer appears to be on the high side, whereas the SnCMP offer seems to be on the low side. For further calculations the investment was decided to be within the two quotations, i.e.

<u>M$ 14,300 for a 5000 MT tank</u>

and for a 4000 MT tank

$$14,300 \times \left(\frac{4}{5}\right)^{0.7} = \underline{M\$\ 12,230}$$

These investment figures do not include expenses for infrastructure in Mombasa Port. For discussion on this point, see section 4.6

4.6 <u>LOCATION</u>

As already stated before the storage system will have to be located in the Mombasa port area. A first meeting has taken place with the Port Authorities in order to find a suitable place with a requirement for minimum infrastructure investment. After looking at several possibilities the best presently available one, to our mind, is at the KIPEVU Oil Terminal at the southwest end of the port. At this point there is an already existing jetty where large ships can berth and the ethylene can be safely unloaded. Also a piping Trench is available, so that the infrastructure investment at this location can really be kept to a minimum. Any other place in the port area will require huge investment and will take a long time to develop. Should the project go ahead, the Ministry should insist that this particular area is earmarked for the ethylene storage system.

It must be understood that in case imported ethylene is used the polymerisation plant will also have to be sited in Mombasa area. The import of ethylene is only an interim measure and this means that at a later stage also the ethylene from ethanol plant will have to be sited nearby. This will require moving large quantities of ethanol (48,500 tons to 70,000 MT/ year) from Western Kenya to Mombasa. Such quantities

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can only be transported by rail and a meeting took place with the Railway Authorities (Mr. J.T. Kamande, Assistant Chief Traffic Manager/Commercial) to clarify the problems involved. A "turnaround" Kisumu/Mombasa journey takes 5 - 7 days with 13 to 15 cars, 30 tons per car. This means maximum possible transport of 450 tons/week or 23,000 tons per year, which is not sufficient. Therefore, two trains will be required per week in the beginning, with 15 cars each, increasing to three trains per week at a later stage. Special tanks will have to be built, about 30 units in the beginning, increasing to 45 units later on. This is by itself a large investment and has not been taken into account in the present investment calculations. Present transport costs of gasoline Kisumu/Mombasa are KShs.450/ton plus KShs.52/- per wagon for siding charges. The transport cost alone will add KShs.0.36/l ethanol. This is an additional expense which this industry can hardly afford.

4.7 SOURCES OF ETHYLENE

There are presently various sources of ethylene available as many of the huge ethylene plants are working only at part capacity and are eager to sell material at competitive prices. The nearest possible sources are - the Gulf area - Kuwait and Quatar, Yanbu at the Red Sea port of Saudi Arabia, Haifa Israel, and far away ports at the Mediterrenean like Italy, France, Spain and Lybia. We have contacted shipsbrokers in France and Netherlands to find out the size of available ships and the required time for a "turnaround" journey to the various ports. To give an idea about time and charges, an example is shown here:

Size of ship: 1778 MT ethylene (3200 M^3)

Port	Time of turnaround	\$/MT
Yanbu	18 days	115
Kuwait/Quatar	20.5/19.5 days	120
Haifa	24 days	143

Total annual load from those ports would be 35,000 MT, 31,000 MT and 27,500 MT respectively.

Again, those are only indicative figures, time not taking into account any possible holdup in the ports and costs do not include expenses for positioning of vessel at load port and any other port, handling charges in Mombasa port. Those charges are estimated to be 1 - 1.5% of freight value. The optimal solution will also be to have one particular ship of suitable capacity dedicated for that purpose on contract basis, instead of changing ships and suppliers as the cleaning of ships and repositioning is expensive and time consuming. The size of the ship will also determine the size of the storage tank. At the above quoted size of ships the storage tank must have a capacity of 4000 MT (7300 m^3) or somewhat larger. At the final stage one will have to look very carefully on all the factors involved in order to achieve the lowest cost of imported ethylene, material and shipping contained.

The exchange of letters with the ships brokers and the information received is shown in section 4.10.

4.8 COST OF IMPORTED ETHYLENE

Following is a calculation of the cost of the imported ethylene at the polymerisation plant, which is located within a short distance (upto 10 km) from Mombasa port, true to May 1, 1982.

At the present depressed market of ethylene it is expected that the f.o.b. prices is in the range of 500/550 per ton for long term contracts, although in the spot market one may sometimes pay as little as $450/480 per ton.

	$/ton ethylene
Price f.o.b.	500
Shipping	120
40% duty on c & f	248
Variable cost	5
Shipping insurance, port handling	14
Maintenance	10
Manpower	3
Taxes and insurance	6
Depreciation	34
Unforeseen	2
Total	942 /ton

There is an overall loss of ethylene resulting from boil-off during shipping and unloading and, general spillage, losses from leaks in piping and relief valves etc. of at least 2%. This adds another 19/ton ethylene, so the cost of ethylene at the polymerisation plant is $961/ton.

At an f.o.b. price of $550/ton the cost of ethylene at the polymerisation plant will be $1,033/ton.

As a matter of fact the cost of ethylene will be even somewhat higher because the import of ethylene is only an interim measure, say for up to 6 years, and this doubles the depreciation cost and may add $35 per ton of ethylene. Also the cost of ethylene does not include any profit factor.

4.9 CONCLUSIONS

From the above calculations it can clearly be seen that the cost of imported ethylene is much too high and is nearly as high as the cost of imported Polyethylene. This possibility might therefore have to be ruled out and stated to be not economically feasible.

Lets assume the Government foregoes the 40% duty on ethylene and then at an f.o.b. price of \$500/ton the cost of imported ethylene will still be

961 - 253 = 708 \$/ton

and at \$550/ton f.o.b. 1,033 - 273 = 760 \$/ton

These are more realistic prices although still on the high side. In section 6.0 it will be demonstrated that the polyethylene plant will not be able to afford ethylene prices higher than \$620/640 per ton. In order to achieve such costs the f.o.b. price of ethylene must drop to \$426/446 per ton which presently seems mission impossible.

Another disadvantage of the polyethylene production viz imported ethylene is that there will be only a very small foreign currency saving.

4.10 DOCUMENTS

In the following section is a collection of all the letters sent and received as well as information regarding storage system and ethylene shipping.

UN.1/6/49 5 April, 1982

Chicago Bridge and Iron Company
800 Jorie Blvd.,
Oak Brook
Illinois 60521
U.S.A.

Dear Sirs,

The Ministry of Industry of Kenya is investigating the feasibility of importing 30,000 metric tons per year of ethylene for polymerization and other downstream plants. For that purpose it is considered to install a 5000 metric ton ethylene storage tank and ancillary equipment in the Mombasa port area.

Attached please find a full description of the required unit and would appreciate receiving an offer on a "budget price"basis.

Any further questions and your reply please send directly to the undersigned at the above address and telex number.

We are looking forward to receiving your offer,

Sincerely yours,

E. Batscha
(Technical Assistance Expert UNIDO)

EB/vd

Encl.

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ETHYLENE STORAGE UNIT

The Ministry of Industry, Kenya, is investigating the feasibility of importing 30,000 MTPY polymer grade ethylene in approximately 2500 ton lots per month at Mombasa port. The Ministry is interested to receive an offer for a storage tank and ancillary equipment according to following specifications.

A) Storage tank for liquified ethylene at atmospheric pressure of 5000 ton (approx. 9000 m^3) capacity. Inner closed tank made of 9% Nickel alloy and outer tank made of carbon steel. The outer tank to be enclosed by a prestressed concrete outer wall at a distance of approx. 1.5 m, to serve as secondary cryogenic containment. Supply to include:
All plates for the inner and outer tanks prefabricated for welding on site.
All insulation material
Supply of all electrical equipment and instruments within B.L.
All process piping within B.L.
Process design and full detail engineering

B) Ancillary equipment

B-1 Two evaporators, steam heated, to evaporate 6 ton/hr each.

B-2 Two cryogenic pumps, capable to deliver 6 ton/hr each of liquid ethylene from storage tank through the evaporator and to arrive at a pressure of 7 atmg at polymer plant B.L. (Disregard pressure drop through evaporator and pipe line)

B-3 One compressor to take boil off from storage tank directly to polymer plant B.L. (7 atmg)
Maximum outside temperature 28°C.

C) The offer to include "non-binding" budget cost and prices, divided as follows:

C-1 FOB supply of items detailed in section A

C-2 Construction cost for items detailed in section A at US Gulf or West European cost

C-3 Your preliminary estimate for the foundations and prestressed concrete wall

C-4 FOB price for the ancillary equipment detailed in section B

C-5 Construction cost for items detailed in section B US Gulf or West European cost.

D) This requisition can also be looked at as a turnkey job. In such case please let us have the investment cost, on a "non-binding" budget basis, divided as follows:

Main equipment
Materials, electricals, instruemnts
Construction
Engineering

Notes: a) Infrastructure requirements at Mombasa port are not part of this requisition

b) An alternative design for the storage tank can also be proposed by vendor

→ mr Batscha.

SN CMP

SOCIETE NOUVELLE
CONSTRUCTIONS METALLIQUES DE PROVENCE

SIEGE SOCIAL :
TOUR MANHATTAN
6, place de l'Iris, 92400 COURBEVOIE

Adresse postale :
Tour Manhattan cedex 21
92095 PARIS LA DEFENSE

Tél. : 773.12.34
Telex : 610.630 sncmp

UNITED NATIONS DEVELOPMENT
PROGRAMME
Office of the Resident Repre-
sentative in Kenya
Block D, 1st Floor
Kenya Railways Headquarters
P.O.Box 30218
NAIROBI
KENYA

10 MAY 1982
KEN 80/021
CEP 11/5
FILING REQUESTED BY:

N/Réf. P.82-188 Ethylene Storage Unit RM/KP 3rd May, 1982
V/Réf. UN.1/6/49

For the attention of Mr. E. BATSCHA
Technical Assistance Expert UNIDO

Dear Sir,

We refer to your letter dated 5th April, 1982 which we received through CBI CONSTRUCTORS LIMITED, and are pleased to submit our budget price for a 30,000 MTPY polymer grade ethylene plant to be erected at MOMBASA port.

Our "non-binding" budget price has been evaluated on a turnkey job basis.

- Main equipment including steel tanks, compressor, evaporators, pumps	FF 8,100,000
- Materials, electricals, instruments including piping	FF 7,800,000
- Construction including erection of the above items and the civil works	FF 31,100,000
- Engineering	FF 5,600,000
- Total Budget	FF 52,600,000

The job could be completed in 24 months.

We remain at your disposal for any further questions you may have.

Yours sincerely,

SN CMP
K GOEDHART

cc : CBI-CL (Mr. L A COOPER)

Societe anonyme au capital de 120 000 000 de Francs - Nº SIRET 320 889 421 00057 R.C.S. NANTERRE - CODE APE 2405

.../39

Pittsburgh-Des Moines Corporation
3400 Grand Avenue
Neville Island
Pittsburgh, PA 15225
412-331-3000

5th May, 1982

UNIDO
Office of the Resident Representative in Kenya
Block D, 1st Floor
Kenya Railways Headquarters
P. O. Box 30218
Nairobi, Kenya

ATTENTION: Mr. E. Batscha

Gentlemen:

We are pleased to respond to your request for a budgetary price for a 5000 metric ton ethylene tank and ancillary equipment. Our budget price is for a turnkey contract assuming an award sometime in 1982. The breakdown is as follows in USA dollars:

1)	One 5000 Ton Ethylene Tank With Firewater Deluge System	=	$ 3,700,000
2)	Tank Foundation (Ringwall) Plus Postressed Concrete Dike	=	$ 2,000,000
3)	Two 6 Ton/Hr. Vaporizers	=	$ 350,000
4)	Two Submerged Tank Pumps With Shop Testing	=	$ 340,000
5)	One Boiloff Compressor and Heat Exchanger	=	$ 280,000
6)	Instrumentation, Controls and Electrical Supply and Installation	=	$ 1,260,000
7)	Pipe Work, Insulation and Mechanical Installation	=	$ 1,790,000
8)	Control Room and Buildings	=	$ 300,000
9)	Site Preparation and Landscaping	=	$ 900,000
10)	Engineering Design and Management	=	$ 1,680,000
	TOTAL	=	$ 12,600,000

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Pittsburgh-Des Moines Corporation

Mr. E. Batscha
UNIDO
5th May, 1982
Page . . . 2

We appreciate this opportunity to help you in the early stages of planning. Please contact us if you should require additional information.

For more information as to our Company's capabilities enclosed is our Product Brochure.

Very truly yours,

PITTSBURGH-DES MOINES CORPORATION
SYSTEMS PRODUCT GROUP

Steven M. Jantsch

Steven M. Jantsch
Contracting Engineer

SMJ/bp
Enclosure

. . ./41

TOYO KANETSU K.K.
HIGASHI-SUNA 8-CHOME. KOTO-KU. TOKYO JAPAN
Cable: "TOYOKANETSU TOKYO" Telex: 262-2007 KANETU J

16th April, 1982
Ltr. Ref. 82-04-598

United Nations Development Programme
Office of the Resident Representative
in Kenya
Block D. 1st Floor
Kenya Railways Hqs.
P. O. Box 30218
Kenya

Attention: Mr. E. Batscha,
Technical Assistance Expert UNIDO

Subject: One (1) 5,000 metric ton ethylene storage tank and other ancilliary equipment
Your Ltr. Ref. No. UN/1/6/49 of 5th April, 1982

Dear Sir,

We acknowledge receipt of the enquiry in your letter No. UN/1/6/49 of 5th April, 1982 for the captioned subject.

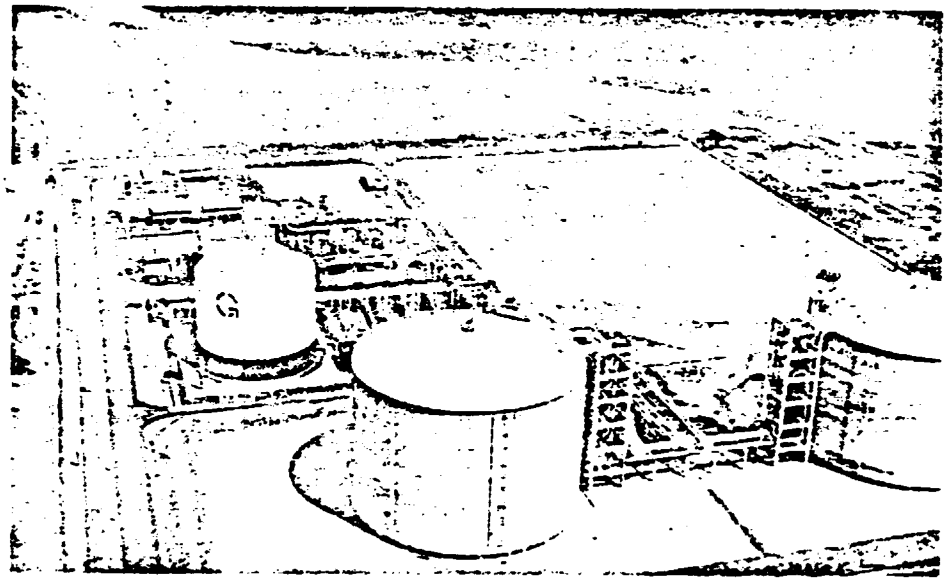
However, we regret to inform you that we are not in a position to quote a competitive price considering the tank capacity and site location of your project.

We are looking forward to an opportunity to serve you in the near future.

Sincerely yours,

Y. Kimura, Manager
Sales Section B
International Dept.

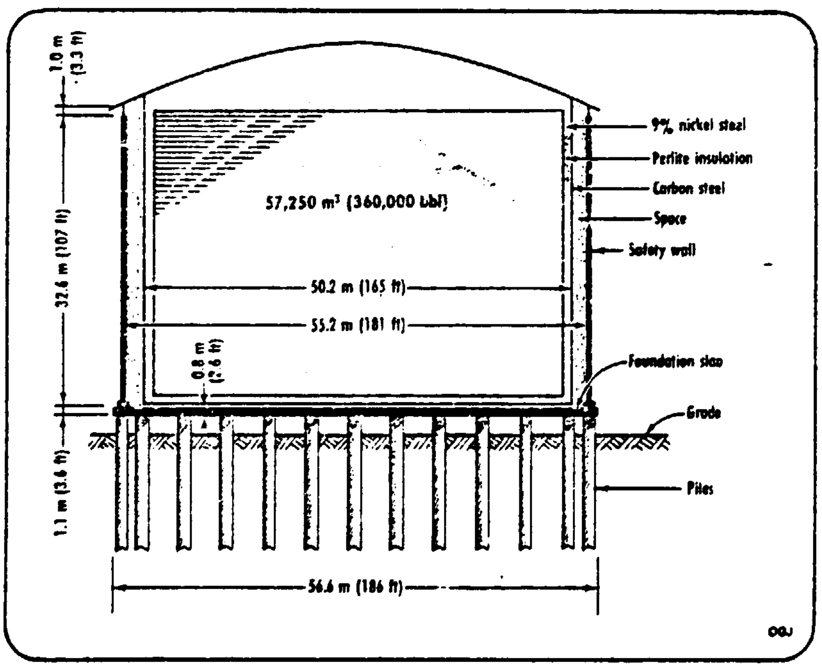
YK/TG/au



LNG storage tanks at Rotterdam Maasvlakte area LNG plant (Fig. 1).

Fig. 2

Section through LNG tank



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UNITED NATIONS DEVELOPMENT PROGRAMME

OFFICE OF THE RESIDENT REPRESENTATIVE IN KENYA

Block D. 1st Floor
Kenya Railways Hqs.
P.O. Box 30218
NAIROBI

Telephone 28776/7/8/9 and 25848

Cable Address: UNDEVPRO. NAIROBI
Telex: 22265

UNIDO 2.4.82

Reference:

Telex No. 290010 Paris France. (Name of Company: Petromar)

MISC 799 MR F. OLIVIER FROM E. BATSCHA. HOPEFULLY YOU REMEMBER ME FROM YOUR CONTACTS WITH IPE HAIFA. AM PRESENTLY UNIDO ADVISER TO MINISTRY OF INDUSTRY, KENYA. WE ARE INVESTIGATING FEASIBILITY IMPORTING 30,000 MTPY ETHYLENE IN APPROX. 2500 TON LOTS PER MONTH, MOMBASA PORT. APPRECIATE RECEIVING FOLLOWING INFORMATION:

aaa) YOUR ESTIMATE LENTH OF TIME FOR TURNAROUND JOURNEY FROM START LOADING BACK TO PORT OF LOADING FROM AHAIFA, ISRAEL, PERSIAN GULF OR YANBU SAUDI ARABIA.

bbb) ESTIMATED PRESENT SHIPPING COSTS PER TON ETHYLENE FROM ABOVE PORTS.

ccc) CAN YOU ADVISE WHOM TO CONTACT FOR SUPPLY OF ETHYLENE IN PERSIAN GULF.

YOUR EARLY REPLY TO E BATSCHA UNIDO, TELEX UNDEVPRO 22265 POSTAL ADDRESS POBOX 30218, NAIROBI, KENYA. (METCALF UNDEVPRO NAIROBI)

KEN/80/001/A

Batscha
/crt 2.4.82

CB to clear

ORIGINAL SIGNED BY C.F.C. METCALF

cc Mr E.Batscha

.../44

UNITED NATIONS
DEVELOPMENT PROGRAMME

OFFICE OF THE RESIDENT
REPRESENTATIVE IN KENYA

Block D, 1st Floor
Kenya Railways Hqs.
P.O. Box 30218
NAIROBI

Telephone 78776/7/8/9
and 25848

Cable Address: UNDEVPRC. NAIROBI
Telex: 22265

UNIDO

2.4.82

Reference:

TELEX No: 11030 AMSTERDAM, HOLLAND (Name of company: Philip Brothers (Holland) BV)

[illegible]

MISC 798 MRS R SANDELOWSKY FROM BATSCHA. MINISTRY OF INDUSTRY KENYA IS INVESTIGATING FEASIBILITY IMPORTING 30,000 MTPY ETHYLENE APPROX. 2500 TON LOTS MONTHLY MOMBASA PORT. PLEASE SUPPLY FOLLOWING INFORMATION:

aaa) ESTIMATED LENGTH TIME TURNAROUND JOURNEY FROM START LOADING BACK TO PORT OF LOADING FROM HAIFA ISRAEL, PERSIAN GULF OR YANBU SAUDI ARABIA.

bbb) ESTIMATED PRESENT SHIPPING COSTS PER TON ETHYLENE FROM ABOVE PORTS.

ccc) PREVAILING ETHYLENE PRICES FOR EXPORT.

ddd) PLEASE ADVISE WHOM TO CONTACT FOR SUPPLY ETHYLENE FROM PERSIAN GULF.

PLEASE REPLY SOONEST TO E. BATSCHA, UNIDO, TELEX UNDEVPRO 22265 POSTAL ADDRESS UNDP P.O.BOX 30218, NAIROBI. (METCALF UNDEVPRO NAIROBI)

KEN/80/001/A

Batscha
/crt 2.4.82
GB to clear

cc Mr E. Batscha

ORIGINAL SIGNED BY C.P.C. METCALF

.../45

[illegible]

PLS REPLY [illegible]

[illegible]

TO [illegible] NAIROBI KENYA
FM PETR[illegible] PARIS

Copies Sent to
Mr Batsha
UNIDO
13/4/82

ATT. [illegible] BATSHA

REF. ETHYLENE SHIPMENTS INTO MOMBASSA

WE HAVE BEEN STUDYING THE LOGISTICS OF YOUR REQUIREMENT

BUT FIRST TO ANSWER YOUR FIRST 2 QUESTIONS :

(1). LENGTH OF TIME FOR ROUND VOYAGE
HAIFA/MOMBASSA/HAIFA 24.[illegible] DAYS
KUWAIT/MOMBASSA/KUWAIT 20,5 DAYS
YANBU/MOMBASSA/YANBU 1[illegible] DAYS
SKIKDA/MOMBASSA/SKIKDA 31 DAYS
QATAR/MOMBASSA/QATAR [illegible],5 DAYS

ABOVE TIMES INCLUDE LOADING AND DISCHARGING - NOW SINCE YOUR ARE CONSIDERING ONLY 25[illegible] MT PER MONTH/3[illegible],000 MT PER YEAR, WE MUST CONSIDER THAT ONE VESSEL ONLY WILL BE USED IN CONTINUOUS EMPLOYMENT. THIS WILL AVOID THE COSTLY RE-POSITIONING CLEANING [illegible] THE VESSEL EVERY VOYAGE.

TAKING THE ABOVE ROTATION TIMES, [illegible] BASIS LOADING

1) HAIFA, WE WOULD PERFORM 15 VOYS PER YEAR
2) KUWAIT, WE WOULD PERFORM 17/1[illegible] VOYS PER YEAR
3) YANBU, WE WOULD PERFORM [illegible] VOYS PER YEAR
4) SKIKDA, WE WOULD PERFORM 11/12 VOYS PER YEAR

THIS CORRESPONDS TO A VESSEL OF CARGO DEADWEIGHT FOR :

1) HAIFA [illegible] MT ([illegible] CBM)
2) KUWAIT [illegible]/17[illegible] MT (3[illegible] CBM)
3) YANBU [illegible] MT ([illegible] CBM)
4) SKIKDA [illegible] MT ([illegible] CBM)

[illegible]

QATAR YOU WOULD RECEIVE 2000 MT EVERY 24 DAYS
KUWAIT " " " 1500/1700 MT EVERY 20/21 DAY
YANBU " " " 1000 MT EVERY 15 DAYS
SKIKDA " " " 2500/2700 MT EVERY 31 DAYS.

UNFORTUNATELY, SIZES OF SHIPS ARE NOT BUILT TO FIT IN WITH OUR CALCULATIONS.
SIZES OF VESSELS WE DO HAVE TO WORK WITH ARE 2420 CBM, 3200 CBM [illegible] AND 5[illegible] CBM. WHICH IN CARGO DEADWEIGHTS EQUALE AS FOS 1344 MT, 1778, 2[illegible] MT AND 2780 MT.

[illegible] 2420 CBM (1344 MT) AND LOADING

QATAR [illegible] A FREIGHT OF USD 203 MT
KUWAIT " " " " OF USD 1[illegible] MT
YANBU " " " " OF USD 145 MT
SKIKDA " " " " OF USD 203 MT
QATAR " " " " OF USD 100 MT

[illegible] COST [illegible] COST OF [illegible] POSITIONING VESSEL [illegible] LOADPORT.

IT IS OBVIOUS WITH ABOVE THAT YANBU IS THE MOST ATTRACTIVE LOADPORT FREIGHT WISE, BUT ONLY ABOUT 24000 MT COULD BE TRANSPORTED FROM THIS SOURCE IN ONE YEAR.

LOADING A 3200 CBM (1778 MT) FROM

QATAR WE HAVE FOS FREIGHT USD 143 MT
YANBU " " " " USD 115 MT
KUWAIT " " " " USD 120 MT

WITH TOTAL RESPECTIVE QUANTITIES OF 27000 MT, 33000 MT AND 30.000 MT.

.../47

ABOVE FREIGHTS ARE THEORETICALLY BASED ON WHAT WE THINK WOULD APPLY TODAY.
THERE ARE MANY IMPONDERABLES FOR THE FUTURE, BUT ONE MAY CONSIDER THAT IN FIVE YEARS, RATES MAY INCREASE BY 30 PCT, BUT THERE ARE ALSO BUNKER PRICES, PORT AND SUEZ CANAL DUES TO CONSIDER.
THE OBJECT OF THE ABOVE CALCULATIONS WAS TO DEMONSTRATE THE COMPARISON OF FREIGHTS BETWEEN DIFFERENT PORTS. WE HAVE NOT MENTIONED YET, OTHER ALTERNATIVE LOADING PORTS, LAVERA IN FRANCE AND PRIOLO IN ITALY.

- IT SHOULD BE BORNE IN MIND ALSO, THAT THERE ARE (INCLUDING VESSELS UNDER CONSTRUCTION OR ON ORDER) LESS THAN 20 ETHYLENE CARRIERS OF THE SIZE WE ARE DISCUSSING, AND VESSELS OBTAINABLE TO-DAY, ARE HALF A DOZEN. (WITH MORE RESTRICTIONS IS LOADING HAIFA).

- WE WOULD INDEED BE PLEASED TO PUT YOU IN TOUCH WITH POTENTIAL ETHYLENE SUPPLIERS, EITHER IN ALGERIA, FRANCE, ITALY, KUWAIT OR QATAR.

- WE APPRECIATE THAT THIS INITIAL TELEX WILL NOT PROBABLY FULFILL ALL YOUR DEMANDS, AND WE LOOK FORWARD TO GOING FURTHER IN DEPTH WITH YOU IN THE FUTURE.

PLEASE DON'T HESTITATE TO KEEP IN TOUCH FOR FURTHER INFORMATION.

TO CONCLUDE, THE FREIGHTS GIVEN ARE BASED ON OUR INTERPRETATION OF THE MARKET AND WHILST NOT NECESSARILY INCORRECT SHOULD NOT BE CONSTRUED AS REFLECTION OF OWNERS IDEAS.

- WE WILL BE PLEASED TO APPROACH OWNERS ON YOUR BEHALF, WHEN YOU GIVE US THE NECESSARY AUTHORITY.

REGARDS.

MOLL / OLIVIER

[illegible]
[illegible]

BRSSP C 210967F

PLSE REPLY TO 290010 PETROMARGAZ

13-04-82/0084///34//

received 19/4/82
answered 19/4

TO METCALF UNDEVPRO NAIROBI

FM PETROMAR PARIS

ATT MR E. BATSHA - UNIDO

RE = ETHYLENE SHIPMENTS INTO MOMBASSA

PLEASE LET US HAVE AT YOUR EARLIEST CONVENIENCE YOUR COMMENTS TO OUR TELEX 09.04.82/0061.

PLEASE CLARIFY WHETHER SIZE OF RECEIVING STORAGE WILL BE DETERMINED ACCORDING TO SELECTED SIZE OF VESSEL OR WHETHER OTHER PARAMETERS WILL BE TAKEN INTO ACCOUNT.

WE WISHED TO REVERT TO THE PARAGRAPH WHERE IN LINES 31 AND 32 WE STATED THE SIZE OF VESSELS THAT ARE OR WILL BE AVAILABLE 86/87 AS OF TODAY.

WE SHOULD ADD VESSELS UNDER CONSTRUCTION OR ON ORDER. THEIR SIZES ARE 4000, 4340 AND 5500 M3 AND DELIVERIES ARE SCHEDULED BEFORE 1984.

UNITED NATIONS
DEVELOPMENT PROGRAMME

OFFICE OF THE RESIDENT
REPRESENTATIVE IN KENYA

Block D, 1st Floor
Kenya Railways Hqs.
P.O. Box 30218
NAIROBI UNIDO

Telephone 28776/7/8/9
and 25848

Cable Address: UNDEVPRO. NAIROBI
Telex: 22265 20.4.82

Reference:

Telex No: 290010 PARIS (FRANCE) (Name of Company: PETROMARGAZ)

MISC 906 MR F. OLIVIER FROM E BATSCHA. THANKS YOUR TELEXES. HAVE BEEN LAST WEEK MOMBASA PORT FOR SUITABLE LOCATION OF STORAGE. PRESENTLY THINKING ~~4/500~~ 4000/5000 MT STORAGE CAPACITY. ASSUME LARGER SHIPS REDUCE SHIPPING COST AND IN LATER STAGE WILL HAVE TO FIND LOWEST TOTAL COST OF MATERIAL AND SHIPPING COMBINED. HAVE PRESENTLY SUFFICIENT MT MATERIAL FOR FEASIBILITY STUDY. ~~ACT~~ CHECKING SUITABILITY OF EXISTING JETTY PLEASE GIVE LENGTH OF SHIPS AND REQUIRED WATER DEPTHS FOR 2500/2700 CBM SHIPS.
(ZAGORIN UNDEVPRO NAIROBI)

KEN/80/001/A

ORIGINAL SIGNED BY C.P.C. METCALF

Batscha
/crt 20.4.82
GB to clear

cc Mr E. Batscha

.../50

22265 UNDEVPRO290010+

08 042+

22265 UNDEVPRO290010+

22265 UNDEVPRO

~~110300 PDAN NL~~

COPY

DATE: - 8 APR 1982	
FILE:	
ACTION REQUESTED	ACTION TAKEN
FILING REQUESTED BY:	

8.3.82 RSD:KP :LH

received 19/4/82
answered 19/4/82

RE.: ETHYLENE

THANK YOU FOR YTLX OF APRIL 5TH.

WE ARE INTERESTED IN YOUR ENQUIRY FOR 30,000 MT A/M PRODUCT PER ANNUM.

1) PLS LET US KNOW WHETHER OTHER SOURCES OF SUPPLY BESIDES ISRAEL, PERSIAN GULF, SAUDI ARABIA WOULD BE OF INTEREST.
2) WHEN WOULD IMPORT EFFECTIVELY START?
3) WHAT DISCHARGE FACILITIES ARE AVAILABLE AT MOMBASA?

IS THERE ANY WAY TO CONTACT YOU BY PHONE?

THANKS IN ADVANCE,
PHILIPP BROTHERS/AMSTERDAM
MRS. R. SANDELOWSKY

++++

.../51

UNITED NATIONS DEVELOPMENT PROGRAMME

OFFICE OF THE RESIDENT REPRESENTATIVE IN KENYA

Block D, 1st Floor
Kenya Railways Hqs.
P.O. Box 30218
NAIROBI

Telephone 28776/7/8/9
and 25848

Cable Address: UNDEVPRO. NAIROBI
Telex: 22265

UNIDO 19.4.82

Reference:

Telex No: 11030 AMSTERDAM (NETHERLANDS) (Name of Company: Philips Brothers)

MISC 907 MRS R SANDZLOWSKY FROM E. BATSCHA. THANKS YOUR TELEX 8/4. AAA)LOOKING FOR LOWEST SHIPPING COST SO ANY SUPPLIER OF LOW COST MATERIAL AND SHIPPING COSTS COMBINED IS ACCEPTABLE, BBB) PRESENTLY CONDUCTING FEASIBILITY STUDY TO BUILD 4/500 MT STORAGE TANK IN MOMBASA PORT. IF PROJECT APPROVED READY FOR IMPORT DURING 1987, CCC) PHONE CONTACT DURING WORKING HOURS NAIROBI 332811 BUT PREFERABLE AT KIMANI COURT HOTEL FROM 1900 HOURS ONWARDS NAIROBI 333916. (ZAGORIN UNDEVPR NAIROBI)

KEN/80/001/A

Batscha
/crt 19.4.82
GB to clear

cc Mr Batscha

.../52

Postal Address
P.O. Box 30172
Nairobi Kenya
Telephones:-
Head Office: 555533/4 555550/1 27787
Factory: 555190/555591/555777/555920
Pharmaceutical Warehouse: 555777 Ex. 35
Cable: Chemicals
Telex: 22155 Chemicals

TWIGA Chemical Industries Limited

Mr Mungai
16.4.82

IND/PEM/EN

7th April,1982

Ministry of Industry
Industrial Survey & Promotion Centre
P.O. Box 30418
NAIROBI

2512

Dear Sirs,

LDPE FEASIBILITY STUDY

This refers to the recent visit (to our offices) of your Messrs Muraya/Batscha and the discussions held.

The information required by you with regard to ethylene has already been passed to Mr. Batscha in a telephone conversation with the writer on the 6th April,1982. However, for the sake of future reference we would let you have the details as follows.

1. The European ethylene price in the 1st quarter of 1982 is USD600 pmt. ICI Petrochemicals/Plastics Division estimate the freight to Mombasa to be at least USD 100 pmt extra.

2. It is estimated that European prices in the next 2-3 years are likely to be USD 800 depending of course on the oil prices.

3. ICI Petrochemicals/Plastics Division would have ethylene available in 3500t shipment lots and would be pleased to discuss future requirements into Kenya.

4. ICI Petrochemicals/Plastics are expanding their manufacturing facilities in the middle east (Saudi Arabia, Qatar etc) with the prospect that LDPE will become available for the east coast of Africa at low price. It is therefore important, as you will appreciate, to bear this in mind in your study.

We trust the above information will be valuable to you but should you require any further assistance please do not hesitate to get in touch with us.

Yours faithfully
TWIGA CHEMICAL INDUSTRIES LIMITED

P.E. MWANGI
INDUSTRIAL CHEMICALS DEPARTMENT

c.c. ICI Pet/Plastics

DIRECTORS:
T.S. Jenkinson* (Chairman), Dr. N. Greenhalgh* (Managing),
J.K. Kalinga, P. Muthipani, D. Sabharwal (Indian)
(*British)

An associate of Imperial Chemical Industries

.../53

5.0 THE MANUFACTURE OF POLYETHYLENE

5.1 THE VARIOUS TYPES OF POLYETHYLENE

Today three different types of PE are known and they differ one from the other mainly in their manufacturing process, density, molecular structure and usage. The one common thing to all the types is that they are all a polymer of ethylene and ethylene constitutes their major composition (up to 99.5%). The three types are:

Low density Polyethylene (LDPE)
High density Polyethylene (HDPE)
Linear low density Polyethylene (LLDPE)

5.1.1 Low density Polyethylene

Density range is between 0.912 and 0.930 gr/ cm^3. The material is produced by the high pressure process, pressures ranging between 1200 atm and upto 2500 atm and even higher, depending on the know-how and grade produced. The polymerisation process is of the free radical initiation type using peroxides as catalysts. Due to the heavy branching of the molecular chain the material is low in crystallinity and has therefore flexible properties. This makes it especially suitable for films, sheets, nets, tubes, flexible pipes, flexible containers, wire and cable coating, extrusion coating, rotational moulding, etc. LDPE was discovered by ICI in 1939 and represents therefore the oldest one of the types and also the most widely used in the world.

5.1.2 High Density Polyethylene

Density range is between 0.940 and 0.960 gr./cm^3. The polymer is produced by a low pressure process, pressure not exceeding 50 atm. The catalyst is either of the Ziegler type which is a complex between an aluminium alkyl and a transition metal halide such as $TiCl_4$ or a catalyst of silica or silica alumina impregnated with a small amount of a metal oxide, usually chromium or molybdenum oxide. The polymerisation can take place in solution, slurry or fluidised bed. The polymer has a straight chain with only little branching and this makes it a highly crystalline polymer. It is therefore a stiffer product, with higher impact resistance and those properties makes it especially suitable for injection moulding, blow moulding, larger diameter pipes and fittings, fibre-weaving, etc. The polymer was discovered by Ziegler in Germany in the 1950's and its world usage is somewhat smaller than LDPE.

5.1.3 Linear Low Density Polyethylene

This is the youngest member of the PE family and has been developed in the late 1970's. The first announcement was made by Union Carbide Co. (USA) in 1977, but today there are several other manufacturers who can produce LLDPE, although by different processes.

The density range is similar to LDPE, i.e.0.912 - 0.930 but the product is more crystalline, with less chain branching and consequently stiffer, tougher and more impact resistance than LDPE. The main outlet is also for film and sheets but due to above mentioned properties makes it a tougher film which requires less thickness than film produced from LDPE.

Presently there are four companies who already market LLDPE - Union Carbide Co. (USA) Dow Chemicals (USA), Dupont & Canada and CdF Chimie, (France). Union Carbide, Dow, Dupont have based their process on the low pressure type and claim that, by slight variations of catalysts and comonomers they are able to produce HDPE and LLDPE in nearly same system. CdF and Dow have now developed, each one, a process whereby LLDPE can also be produced in the existing high pressure units, by changing the catalyst to the Ziegler type and introducing comonomers of the alpha Olefines family.

.../55

Upto now most of the LLDPE is marketed in the USA. There is little material available in Europe and as yet no material has been brought to Kenya. From the literature and talks with suppliers and consumers it is known that the usage of 100% LLDPE presents some problems in the conversion equipment, and might require design and screw changes. However, for the time being, it is recommended to use blends of conventional LLDPE and LLDPE. (10-30% LLDPE). The additional LLDPE adds additional strength to the film, higher impact resistance, and by reducing the required film thickness it can save on material per unit area. Due to its present scarcity it is more expensive even upto 40%, in comparison to LDPE, but the forecast is that, with sufficient material on the market within 5/6 years, the price of LDPE and LLDPE will be only slightly different. The forecast also says that within the coming years LLDPE will catch an ever increasing share of the market with equivalent decrease of consumption of conventional LDPE. It is therefore imperative that anyone considering building a new LDPE facility must also have the possibility to produce LLDPE.

5.2 THE LOCAL CONSUMPTION AND USAGE OF LDPE

A market survey for LDPE has been conducted and published in April 1979 for ISPC by Mr. V. Subramanian. This report describes in detail the various uses and applications of this material and there is no need to repeat same in this report. It will deal only with matters concerning consumption and will stress some points, mainly on the agricultural uses of LDPE. The 1979 report states a 1978 consumption of 7080 ton LDPE and forecasts consumption to 1985 as follows:

Year:	1978	1980	1982	1985
MT/a:	7080	9230	13160	20325
ann. growth:	14%	19.4%	15.6%	

Our team conducted a market survey to check the 1981/82 consumption and to compare it with the 1979 forecast. According to our survey the consumption in 1981/82 was about 10,000 MT. This was also confirmed by suppliers (ici agency and Dow Chemicals office). Following is a list of the larger convertors and their 1981/82 (admitted) consumption.

	1981/82 Consumption MT
Cosmoplastics	2,400
Uniplast	1,800
Metaplastic	1,600
R. H. Devani	1,600
Ghordan Das Dharamshi	700
Cosmic Crayon	600
Premium Drums	120
Panplastic	100
Eslon	40
	8,960

In addition there are a number of smaller producers, who were not visited, but altogether it will sum up to about 10,000 MT. We also found some of the convertors having stopped or reduced their output pending receipt of import licence or delay in shipping due to one reason or another. The 10,000 MT consumption is somewhat smaller than the forecast (13,160 MT) but still gives an impressive annual growth of 12.2%. It is difficult to forecast future local consumption, especially as so many forecasts have been proven wrong over the recent years and double so for one who has only recently arrived in Kenya. Growth in LDPE will certainly continue in view of the high growth of the population and their parallel raise in standard of living. More and more people will buy packaged goods and also the usage of LDPE in agriculture will grow although probably not at the high rate anticipated. It appears as if a major market exists for black pipes and tubes upto 2" with nozzles for spray and drip irrigation. This market has not been tapped yet and all such material is presently imported.

It is also obvious that in case LDPE is produced locally and readily available by phone call and without import licence and all the difficulties tied to the import proceedings, this material will be used on a larger scale and will be more competitive in its usage in comparison to alternative material such as paper, HDPE, PP and others. In following section we present a forecast which covers the 1982-1999 period: 1 year to decision, 4 years of plant construction and 12 year operation of plant and it was preferred to present a rather conservative outlook for LDPE consumption.

5.3 LOCAL MARKET FORECAST

Basis for forecast:

Consumption growth		Population Growth	
1982	10.000 MT.	1982	16.7 million
3 years	10% p.a.	2 years	3.2% p.a.
2 years	9% p.a.	5 years	3.0% p.a.
5 years	8% p.a.	5 years	2.5% p.a.
Onwards	7% p.a.	onwards	2% p.a.

Year	Consumption MT	Population (000')	Kg/ Capita
1982	10,000	16,700	0.600
1983	11,000	17,200	0.640
1984	12,100	17,800	0.680
1985	13,310	18,300	0.730
1986	14,500	18,800	0.770
1987	15,810	19,400	0.815
1988	17,100	20,000	0.855
1989	18,400	20,600	0.890
1990	19,900	21,100	0.940
1991	21,500	21,700	0.990
1992	23,200	22,200	1.045
1993	24,800	22,700	1.090
1994	26,600	23,300	1.140
1995	28,400	23,800	1.190
1996	30,400	24,300	1.250
1997	32,600	24,800	1.315
1998	34,800	25,200	1.380
1999	37,800	25,700	1.470

5.4 KNOW-HOW

As explained in section 5.1.3 - anyone considering building a new LDPE facility must also have the possibility to produce LLDPE. Therefore it is our recommendation to approach first of all those companies who have the know how for both processes. Presently, there are only two companies who have both processes for licensing. Dow Chemicals (USA) and CdF Chimie (France).

Dow Chemicals was contacted through their local offices and meeting with their local Managing Director:

Mr. Peter E. Petersen,
Dow Chemical Kenya Ltd.,
P.O. Box 49470,
Nairobi.

CdF Chimie was contacted by letter to:

Mr. Bernard Fleureau
Manager Licensing Department,
CdF Chimie,
Tour Aurore - Cedex No.5,
92080 Paris La Defense,
France.

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One of the main questions to both potential know how suppliers was in as far as the two materials can be produced in one reaction unit, although with different catalyst systems. The answer to this question is of main importance regarding investment and manufacturing costs.

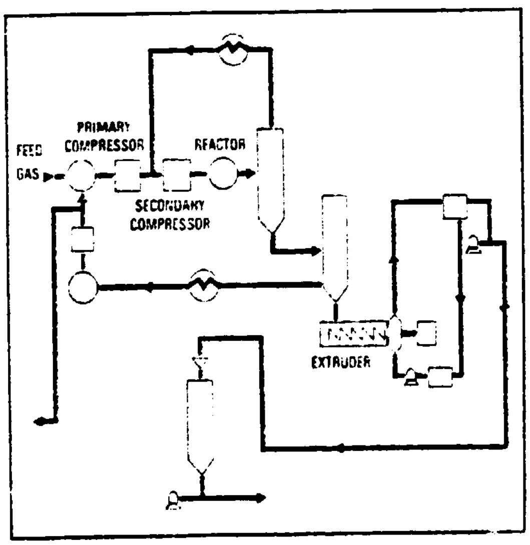
Copies of letters to Dow and CdF are shown in section 5.9. No answer has as yet been received from the two companies.

5.5 THE PROCESS

In principal all know how holders of LDPE operate a similar process which differs mainly in small, although important, design details and operating conditions. A general flowsheet and process description is given below:

CdF Chimie

LD and LLD POLYETHYLENE



Process
Process for branched and linear polyethylene manufacture by means of polymerization of ethylene and co-monomers under high pressure.

End products
Wide range of resins.

Description of the process
Monomers are compressed at a well fixed pressure level depending on grades to be obtained. By means of proper catalysts the reaction is initiated and continuously operated in a reactor of peculiar design. Its accurate control is obtained by controlling the catalyst injection.
The reaction heat is carried away by the effluents.
Melted resins receive several additives if necessary and are pelletized and cooled in a water stream.

Yields
Specific consumptions:

LDPE	LLDPE
• ethylene: 1.015 t/t PE;	• monomers: 1.015 t/t PE;
• electricity: 800 kWh/t PE.	• electricity: 600 kWh/t PE.

Advantages
The process is simple but very elaborated. It enables the building of large size units, which leads to substantial investment savings, even with adequate safety system.

References
LDPE in operation: 1,400,000 t/y
LLDPE in operation: 55,000 t/y - under study: 110,000 t/y
FRANCE, ITALY, VENEZUELA, JAPAN, CZECHOSLOVAKIA, QATAR, PORTUGAL.

.../60

The manufacture of LDPE is, in essence, a process whereby ethylene is polymerised, by means of catalysts, at extremely high pressure (1200 - 2000 atm and above) and elevated temperature. Polymer grade ethylene is compressed to the required reaction pressure in specially designed hypercompressors and fed into a stirred autoclave reactor. Some companies use tubular reactors instead. Catalysts are added and also co-monomers and chain transfer agents, if so required. Part of the gas is polymerised and upon leaving the reactor the ethylene/polyethylene mixture is expanded to 300 atm. in one seperator and down to 0.5 atg. in a second one. The polyethylene melt is fed into an extruder where it is pelletized, cooled, dried and conveyed to a silo. Additives are added at the extrusion stage according to the recipe. Unpolymerised ethylene gas is recycled to the hypercompressors, compressed and refed into the reactor.

The production of LLDPE is basically conducted in the same way, the main difference being a different catalyst system and the introduction of a comonomer of the alpha olefin family (butene-1 or higher).

A typical analysis of polymer grade ethylene is as follows:

not less than 99.85% ethylene

maximum allowed impurities: H_2:	10 ppm by volume
C_2H_2:	50 ppm " "
C_3 and higher:	1000 ppm by volume
sulphur comp. as "S":	5 ppm by weight
O_2 :	5 ppm by volume
Co :	20 ppm by volume
Oxygenated Compounds other than Co, Co_2 i.e. CH_3OH, acetone, etc:	10 ppm by volume

5.6 THE PRICE OF IMPORTED POLYETHYLENE

The prices given to us from suppliers and consumers vary between \$820/ton to \$900/ton c & f

Lets take an average price of \$800/ton and built the cost of LDPE paid by consumer, in his plant, Nairobi area.

		$/ton	
c.i.f. Mombasa		860	
Duty 40%		344	
Insurance 1.25% on c.i.f.		11	
From ship to plant, 10% on c & f		85	
Total:	$	1,300/ton	= KShs.13,650/ton

As stated in Section 5.1.3 the price of imported LLDPE may be higher today, even up to 40%, but decreasing gradually as more material comes to the market. Within 5 years the price difference between LDPE and LLDPE will be 10 - 15% in the more competitive markets and upto 20% in the far away ones.

5.7 INVESTMENT

No answer has yet been received from any one of the two potential know-how suppliers. The following investment estimate is based on the writers own experience. The writer was managing the construction of a 60,000 MT/year LDPE plant in Haifa Israel, during the years 1974-1978 and the investment estimate as well as the conversion costs are based on this particular unit. The plant went on stream in September 1978 and has been working satisfactorily ever since.

The polymerisation unit, battery limit, investment is estimated to be: M\$ 25,500

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To this figure the following items will have to be added:

5.7.1 Utilities and storage

5.7.2 Shipping cost to site

5.7.3 Duty on imported equipment and materials

5.7.4 Adjustment of construction to local conditions

5.7.5 Interest during construction

5.7.6 Training and start up

5.7.7 Land

5.7.8 Contingency

5.7.1 <u>Utilities and Storage</u>

Following required:

Utilities as detailed in 3.5.7
Warehouse for finished PE
Warehouse for chemicals, spare parts
Refrigerated storage for catalysts
Pressure storage for butene-1
Workshop, mechanical, electrical, instruments
Laboratory
Administrative building
General infrastructure

All above is estimated at M$ 4000

5.7.2 <u>Shipping Cost to Site</u>

10% on all imported equipment and materials

M$ 12,000 x 10% = M$ 1,200

5.7.3 <u>Duty on Imported Equipment</u>

M$ 12,000 x 40% = M$ 4,800

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5.7.4 Adjustment of Construction to Local Conditions

Estimated M$ 400

5.7.5 Interest During Construction

Based on 33% equity = M$ 12,000 (without financial)

Balance loan at 15% interest = M$ 24,000 (without financial)

Outlay:	1st year	10%	= M$ 2,400
	2nd year	25%	= M$ 6,000
	3rd year	40%	= M$ 9,600
	4th year	25%	= M$ 6,000

The total interest over the four years construction period is about M$ 6,120

5.7.6 Training and Startup

Estimated at M$ 500

5.7.7 Land

Estimated at M$ 80

TOTAL INVESTMENT

		M$
5.7.0	Battery limit	25,500
5.7.1	Utilities and storage	4,000
5.7.2	Shipping Cost to site	1,200
5.7.3	Duty on import	4,800
5.7.4	Adjustment to local construction	400
5.7.5	Interest during construction	6,120
5.7.6	Training and Start up	500
5.7.7	Land	80
	Sub total	42,600
5.7.8	Contingency	400
	Total M$	43,000

5.8 CONVERSION COST

5.8.1 Variable Cost

The variable cost (without ethylene) is estimated @ $115/ton. This does not include 40% duty

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on imported chemicals and catalysts. If duty added, the variable cost will raise by $ 10/ton.

5.8.2 Fixed Costs

a) Manpower: 4 operators + 1 foreman/shift
4 packaging op./shift
3 laboratory letters/shift
2 graduate engineers
1 chemist
Plant Manager

65 x $ 3 x 2000 + 100% overhead = M$ 800

b) Maintenance: 3% on plant investment M$ 37,000 x 3% =	M$1,100
c) Taxes and Insurance: 2% on total investment	M$ 800
d) Sales and Administration	M$ 400
e) Know how and R & D	M$ 400
f) Depreciation over 12 years	M$3,580
g) Interest on W.C.	M$ 200
Total annual fixed cost	M$7,280

At an annual average production of 25,000 MT over the 12 plant projection - fixed cost (without interest) is = $ 290/ton.

Total conversion cost, without ethylene is
$ 115 +_ $290 = $ 405/MT

.../65

5.9 Note

A complete offer for a LDPE/LLDPE plant has been received from CdF Chimie, France, after finalising the writing and typing of this report.

The offer was reviewed and it can be stated with confidence that the investment figures and operating costs are very similar to those quoted in this Chapter. Therefore all the technical information and economic calculations appearing in this final report are now backed by up to date information from engineering contractors and know how suppliers.

5.10 DOCUMENTS

In this section are letters to Dow Chemical Co. and CdF, France.

3500

April 6, 82

Mr. Peter E. Petersen,
Managing Director,
Dow Chemical Kenya Ltd.,
P.O. Box 49470,
NAIROBI.

Dear Mr. Petersen,

It was a pleasure to have had the opportunity of meeting with you and to discuss some points of interest to the Ministry of Industry, Kenya. Attached please find a summary of the main points and we would appreciate if you could bring those to the attention of your management and inform us back in due course. For any further questions and your reply please contact us at the above address.

Sincerely yours,

E.H. Batscha
Technical Assistance Expert
UNIDO.

Muraya Nyamu
Ministry of Industry

EHB/bn

The Ministry of Industry, Kenya is investigating the feasibility of producing low density Polyethylene in the country, for a capacity of about 30,000 MTPY.

1.0 Ethylene

Ethylene for the polymerisation unit will ultimately be manufactured from locally available ethanol. As an alternative, and for the first period of operation, it is considered to import ethylene from the nearest available sources.

We understand that your company will have shortly in operation an Ethylene facility in the Persian Gulf area and will be interested to supply liquified ethylene to Mombasa port. In order to enable us to prepare a realistic feasibility calculation, please let us know the following:

a) Prevailing f.o.b. prices of ethylene for export deals.

b) Shipping cost per ton ethylene, in approximately 2,500 to 3,000 metric tons lots, ex Persian Gulf.

c) Estimated length of time for "turn around" journey from start loading back to port of loading.

d) Would you consider supplying ethylene also from others of your sources, like Mediterranean ports, and can this be competitive.

e) Size of storage tank of Mombasa port is presently considered to have a capacity of 5000 metric tons and will be complete with 2 evaporators, 2 pumps and boil-off compressor. Boil-off ethylene will be sent directly to the polymer unit, at a short distance from the storage area.

Your company certainly has experience with such facilities and we would appreciate if you could give us a "rough" estimate for the investment required for such unit, within battery limits.

2.0 Supply of Know How for LDPE

Would you consider supplying know how for a 30,000 MTPY LD Polyethylene plant, or even more to, consider a joint venture with the Government of Kenya.

Again, in order to enable the Ministry to prepare a feasibility study we would require data such as:

- Investment Estimate
- Average requirements of feedstock, Chemicals and utilities,
- Manpower requirements

The Ministry will sign a secrecy agreement, if so requested.

We are aware that your company has recently developed a process for production of linear LDPE by high pressure operation. Can the production of liner LDPE be undertaken in the same sector and with same equipment like the production of conventional LDPE, or has a complete separate system to be considered. Can the two LDPE's be manufactured in same Reactor under "blocked" operating conditions?

6th April [illegible]

EKB/kn

UN/1/6/49

April 26, 82

CdF Chimie S.A.,
Tour AURORE - CEDEX No.5,
92080 Paris Defense 20
FRANCE.

Attention: MR. B. FLEUREAU
Manager Licensing Department

Dear Mr. Fleureau,

The Ministry of Industry, Kenya, is investigating the feasibility of building a 30,000 MTPY LD Polyethylene plant based on ethylene produced from locally available ethanol. Your process seems to be suitable to the particular needs of Kenya, especially due to the fact that you are producing also linear low density Polyethylane.

We are therefore interested to know if the production of linear LDPE can be undertaken in the same reactor and with same equipment like the production of conventional LDPE, although with separate catalyst systems, or have two completely different units to be considered? Can the two LDPE's be manufactured under "blocked" operating conditions? Will you consider supplying know how for a 30,000 MTPY unit of combined LDPE/LLDPE production?

In order to enable the Ministry to prepare a feasibility study we would appreciate receiving your answers to the above questions and further of all data for:

Investment estimate

Average requirements of feedstock, Chemicals and utilities

Manpower requirements

The Ministry will sign a secrecy agreement if so requested.

Your early reply will be very much appreciated.

Sincerely yours,

E.H. BATSCHA
Technical Assistance
Expert - UNIDO.

[illegible]
for PERMANENT SECRETARY

.../70

EHB/bn

- 70 Orw 35/31

(S9)

CdF Chimie S.A.

SOCIETE CHIMIQUE DES CHARBONNAGES

ADRESSE POSTALE
TOUR AURORE
PLACE DES REFLETS
CEDEX 5
92080 PARIS DEFENSE 2
TEL 778 51 51
TELEX CDFCH D 610826 F

N° D APPEL DU CORRESPONDANT 778.52.80.

Ministry of Industry
Industrial Promotion Department
Kenya House
Koinange/Monrovia Street
P.O. Box 30418
NAIROBI
(KENYA)

Yours réf.

UN 1/6/49.April 26

Ours réf.

DTv1/CO/087.

May 14, 1982

24 MAY 1982
2635

Dear Sir,

We thank you for your letter of April 26, 1982 and of the interest you have mentioned for our high pressure polyéthylene technology.

The production of conventional LDPE and linear LDPE is possible with the same reactor and with the ~~the~~ some equipment. However if a plant is designed to produce both LDPE, it cannot be optimized for the production of each LDPE.

Moreover for changing from one type of polyéthylene to the other, the line must be stopped for several days and completely cleaned, due to the incompatibility of the two types of catalyst. Consequently for industrial coun- tries, we dont recommend to undertake the production of linear and conventional polyéthylene in the same line. However such a possibility exists and can be studied for particular cases for example in developing countries.

Not with standing, taking in consideration the actual and the foreseen share of the market for linear LDPE, 30 % of the total market of LDPE, our recommandation would be to build a plant for the production of conventional LDPE only, keeping the possibility to retrofit this plant in the future for the production of linear LDPE, if the development of the market is faster than it is expected for the moment.

We are ready to discuss these points with you, if you have the opportunity to come in Europe in a next future.

To allow you to prepare a preliminary feasibility study, we send you attached hereto information on our low density polyéthylene processes that we ask you to consider as confidential.

Mr Githinga
For your action please
27/5/82

(2) Mr. E.M. Balscha
I think this was your correspondence. Githinge

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As far as the investment is concerned, our estimation for a 30 000 MT/y plant built in France of January 82 would be for the battery limit :

- For LLDPE only .... 14 millions US $
- For LDPE only .... 16 millions US $

- for a versatile unit LDPE/LLDPE 18 millions US $

To take in account engineering services, and off sites batterie limit for a grass-root plant, these values shall be increased of 50 %.

We look forward to hearing from you soon.

Sincerely yours,

B. FLEUREAU
Manager Licensing Dpt
CdF-CHIMIE SA

Enc.- 2

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6.0 ECONOMIC STUDY OF THE PRODUCTION OF LDPE

6.1 COST AND FEASIBILITY OF LDPE PRODUCTION VIA ETHANOL

As shown in Section 5.8 the total conversion cost (without ethylene and interest on loans) is:

Variable cost:	$ 115/ton
Fixed cost	$ 290/ton
	$ 405/ton

Total investment is estimated:	M $
ethanol to ethylene plant	15,000
polymerisation plant	43,000
Total:	58,000

Average profit to be 15% on investment (25.000 MT/Q average production) is:

M$ 8,700/year or $ 348/ton

Therefore the maximum allowed cost for 1 ton ethylene is: $\frac{1300 - (405 + 348)}{1.05} = \$ 521$

In order to produce ethylene at $521/ton one would have to obtain ethanol at KShs.2.02 per litre which under the present circumstances is not feasible. If, on the other hand, ethanol is supplied at KShs.4/- per litre, the cost of ethylene will rise to $ 933/ton and in such case the total production cost (without profit) will be on the average $ 1,384/ton which is already much higher than the target price of $1300/ton.

From the above one can see that the project under the above stated conditions is not feasible. It is a well known fact that heavy chemical industry, like the above described, is given incentives in most countries of the world. This industry is very heavily money intensive and usually does not come into full

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production in the first years of operation and therefore only preferential financial conditions, duty exemptions and tax concessions can make such projects feesible.

On the writer's project for a 60,000 MT/year LDPE plant mentioned in section 5.7, the following incentives were given:

a) Investment grant of 12% of total investment

b) Duty exemption on all imported equipment and materials

c) Interest rate on loan (58% of investment) was 9-12% instead of 20% interest of commercial banks

d) Double depreciation for income tax purposes

e) Income tax holiday for five years of the first year of taxable income.

Such incentives are not extremely excessive and the writer has known larger incentives to assist the petrochemical industry in Western Europe.

6.2 COST AND FEASIBILITY OF LDPE PRODUCTION VIA IMPORTED ETHYLENE

It has been shown in sections 4.8 and 4.9 that under the described circumstances the production of LDPE based on imported ethylene is not a feasible project.

Even if the Government agrees to forgo the 40% duty on imported ethylene, the ethylene cost will still be much higher than the target price and will be (including profit) in the $1500/ton range. No more calculations have been prepared for this type of project.

6.3 ECONOMIC STUDY - A DIFFERENT APPROACH

As stated in section 6.1 it is common that heavy chemical industry receives financial incentives to help it overcome the first difficult years and such

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incentives are concentrated, among others, in duty exemptions and preferential interest rates on loans.

In the following sections we will present calculations based just on such incentives and from those calculations the viability of the industry can better be judged. Following incentives have been taken into account:

a) full exemptions from duty on imported equipment and materials
b) loans at 8% average interest rate

6.4 COST OF ETHYLENE FROM ETHANOL - BASED ON NEW APPROACH

6.4.1 INVESTMENT

	M$
Battery limits, contractors quote	8,100
Utilities and Storage	1,500
Shipping to site	500
Adjustment to local conditions	125
Interest during construction	825
Start up, training	300
Land	20
Sub total	11,370
Contingency	330
Total: M$	11,700

6.4.2 FIXED COST

Consequently fixed cost will be decreased accordingly:

	M$/a
Manpower	240
Maintenance	330
Taxes and insurance	235
General Administration	175
Depreciation (12 years)	975
Interest on working capital	45
Total:	2,000

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6.4.3 TOTAL CONVERSION COST WITHOUT ETHANOL FEED COST

At 40,000 MT/year production

44.75 + 50 = $ 94.75/ton

At 30,000 MT/year production

44.75 + 66.67 $111.42/ton

6.4.4 REQUIRED PRICE OF ETHANOL

At 40,000 MT/a production

Ethylene prices	Anhydrous Alcohol		
$/ton	$/ton	$/l	KShs./l
500	232.90	0.186	1.95
550	261.65	0.209	2.20
600	290.40	0.232	2.44
650	319.10	0.255	2.68
700	347.85	0.278	2.92
750	376.60	0.301	3.16
800	405.30	0.324	3.40
825	419.70	0.335	3.52
850	434.00	0.347	3.65

At 30,000 MT/e production

500	223.30	0.178	1.87
550	252.00	0.202	2.12
600	280.80	0.225	2.36
650	309.50	0.248	2.60
700	338.25	0.270	2.84
750	367.00	0.294	3.08
800	395.75	0.316	3.32
825	410.10	0.328	3.44
850	424.50	0.340	3.57

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6.5 COST AND FEASIBILITY OF LDPE PRODUCTION VIA ETHANOL - BASED ON NEW APPROACH

6.5.1 INVESTMENT

	M$
Battery limit	25,500
Utilities and storage	4,000
Shipping cost to site	1,200
Adjustment to local construction	400
Interest during construction	2,990
Training and start up	500
Land	80
Subtotal	34,670
Contingency	330
Total M$	35,000

6.5.2 FIXED COSTS

	M$
Manpower	800
Maintenance	1,100
Taxes and Insurance	700
Sales and Administration	400
Know how and R & D	400
Depreciation (12 years)	2,915
Interest on W & C	200
Total M$	6,515/year

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6.5.3 MAXIMUM FEASIBLE COST OF ETHYLENE AND ETHANOL

The total average conversion cost, according to new approach, and without ethylene and interest on loan, is:

Variable cost:	$ 115/ton
fixed cost:	$ 260/ton
	$ 375/ton

Total investment is estimated

	M$
Ethanol to ethylene plant	11,700
Polymerisation plant	35,000
Total	46,700

Average profit to be 15% on investment (25,000 MT average production):

M$ 7000/year or 280/ton

Therefore the maximum permitted cost for 1 ton ethylene is

$$\frac{1,300 - (375 + 280)}{1.05} = \$\ 614$$

In order to produce ethylene at $ 614 one would have to obtain ethanol at an average price of $298.40/ton or KShs.2.50/litre. This is still a very low price and well below the cost of presently locally produced alcohol. From talks with people versed in the Indian and Brazilian chemical industry we were given to understand that this is about the price paid in those countries for industrial alcohol. India can achieve such prices due to their old depreciated plants and in Brazil the alcohol for industry is subsidised by the Government.

6.6 SUBSIDY FOR INDUSTRIAL ALCOHOL

In the long run it can be expected that locally produced alcohol will be produced at a maximum cost of KShs.4.0/litre. For demonstration purposes it is assumed that alcohol is available at this price, whereby the industry is paying KShs.2.50/l and the Government is subsidising the alcohol by another KShs.1.5/l. In the next sections an economic study is presented based on subsidised alcohol and following tables are shown:

Table 1 : 12 year financial projection of combined project, starting from ethanol to polymer for sale

Table 2 : IRR of the project

Table 3 : Foreign currency component in ethylene production

Table 4 : Foreign currency component in PE production

Table 5 : Foreign currency earnings and cost of saved $

TABLE 1: TWELVE YEARS FINANCIAL PROJECTION

Investment: M$ 46,700 Equity: M$ 15,410

No.	Details	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	Average
A.	Production MT													
1.	Ethylene (including 10000 MT for PVC	27850	29320	30895	32575	34360	36040	37930	39820	40000	40000	40000	40000	35730
2.	Polyethylene	17000	18400	19900	21500	23200	24800	26600	28400	30000	30000	30000	30000	24930
B.	Prices in $/MT													
1.	Ethylene for PVC only	625	625	625	625	625	625	625	625	625	625	625	625	625
2.	Polyethylene	1300	1300	1300	1300	1300	1300	1300	1300	1300	1300	1300	1300	1300
C.	Revenue in M$													
1.	From Ethylene for PVC	6250	6250	6250	6250	6250	6250	6250	6250	5312	5312	5312	5312	5937
2.	From Polyethylene	22100	23920	25870	27950	30160	32240	34580	36920	39000	39000	39000	39000	32478
	Total M$	28300	30170	32120	34200	36410	38490	40830	43170	44312	44312	44312	44312	38415
D.	Costs in M$													
1.	Variable Cost	17641	18631	19690	20820	22021	23152	24423	25694	25980	25980	25980	25980	23000
2.	Fixed Operating	4380	4380	4380	4380	4380	4380	4380	4380	4380	4380	4380	4380	4380
3.	Depreciation	3890	3890	3890	3890	3890	3890	3890	3890	3890	3890	3890	3890	3890
4.	Interest on Invest. loan	2490	2241	1992	1743	1434	1245	996	747	498	249	-	-	1180
5.	Interest on Work Capital	245	245	245	245	245	245	245	245	245	245	245	245	245
	Total M$	28646	29387	30197	31078	32030	32912	33934	34956	34993	34744	34495	34495	32695
E.	1. Profit before tax	(346)	783	1923	3122	4380	5578	6896	8214	9319	9568	9817	9817	5720
	2. % Return on Equity	-	5	12.5	20	28.5	36	44.7	53.3	60.5	62	63.7	63.7	37.1
F.	Cash Flow in M$													
	Profit before tax	(346)	783	1923	3122	4380	5578	6896	8214	9319	9568	9817	9817	5720
	Depreciation	3890	3890	3890	3390	3890	3890	3890	3890	3890	3890	3890	3890	3890
	Interest on Invest. loan	2490	2241	2017	1815	1633	1470	996	747	498	249	-		1180
	Total M$	6034	6914	7830	8827	9903	10938	11782	12851	13707	13707	13707	13707	10730

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TABLE 2: NPV and IRR

Year	Net Cash Outflow	Net Cash Inflow	P.W. Factor 10%	NPV 10%	NPV Cumulative 10%	PW Factor 20%	NPV 20%	NPC Cumulative 20%
- 3	3,500		1.331	(4,658)	(4,658)	1.728	(6,048)	(6,048)
- 2	11,090		1.210	(13,419)	(18,077)	1.440	(15,970)	(22,018)
- 1	19,850		1.100	(21,835)	(39,912)	1.200	(23,820)	(45,838)
0	12,505		1.000	(12,505)	(52,417)	1.000	(12,505)	(58,343)
1		6,034	0.909	5,484	(46,933)	0.833	5,026	(53,317)
2		6,914	0.826	5,710	(41,223)	0.694	4,798	(48,519)
3		7,830	0.751	5,880	(35,343)	0.578	4,525	(43,994)
4		8,827	0.683	6,028	(29,315)	0.482	4,255	(39,739)
5		9,903	0.621	6,150	(23,165)	0.402	3,981	(35,758)
6		10,938	0.564	6,169	(16,996)	0.335	3,664	(32,094)
7		11,782	0.513	6,044	(10,952)	0.279	3,287	(28,807)
8		12,851	0.467	6,000	(4,952)	0.232	2,981	(25,826)
9		13,707	0.424	5,811	859	0.194	2,659	(23,167)
10		13,707	0.385	5,277	6,136	0.162	2,220	(20,947)
11		13,707	0.350	4,797	10,933	0.135	1,850	(19,097)
12		13,707	0.319	4,372	15,305	0.113	1,548	(17,549)

$$IRR = 10 + 10 \frac{15,305}{32,854} = \underline{14.66\%}$$

TABLE 3: F.C. COMPONENT IN ETHYLENE PRODUCTION

The foreign currency component calculation is based on alcohol at KShs.40/l, whereby KShs.1.5/l is Government subsidy:

Details	Total Cost in local cur.	Total Cost M$	% f.c. Comp.
Variable Cost			
Raw Material		20,740	38%
Catalysts		114	100%
Utilities		1,676	40%
Total	KShs.236,565	22,530	38.5%
Fixed Costs			
Manpower		240	40%
Maintenance		330	50%
Taxes, Insurance		235	30%
Gen. Admin.		175	15%
Depreciation		975	85%
Interest on loan		300	85%
Interest on W.C.		45	15%
Total	24,150	2,300	63%
Grand Total	260,715	24,830	40.7%

The foreign currency component in the production ethylene is

40.7%

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TABLE 4: FOREIGN CURRENCY COMPONENT IN LDPE

At 25,000 ton/y average production

Detail	total costs in MKShs.	total cost % in M$	% f.c. Component	Costs in foreign currency in MKSh.	Costs in foreign currency in M$	Costs in local currency
Ethylene		16,295	40.7%			
Variable costs		2,875	50 %			
Total	201,285	19,170	42.1%	84,740	8,070	116,545
Fixed Costs						
Manpower		800	40 %			
Maintenance		1,100	50 %			
Taxes, Insurance		700	30 %			
Sales, Admin.		400	20 %			
Know-how, R & D		400	85 %			
Depreciation		2,915	85 %			
Interest on loan		925	85 %			
Interest on W.C.		200	30 %			
Total	78,120	7,440	64 %	50,620	4,820	27,500
Grand Total	279,405	26,610	48.44%	135,360	12,890	144,045

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TABLE 5: FORFIGN CURRENCY CALCULATIONS

	$/Ton	M$/y
Foreign currency saving from import replacement:	870	21,750
Foreign currency expenses	515	12,890
Foreign currency saving	355	8,860
% Saved value	40.8%	

Cost of $ 1.0 saved in KShs. = $\frac{144,045}{8,860} = \underline{\underline{16.25}}$

If we add to this figure the KSh.1.5/1 which the Government is paying as subsidy to the alcohol producer, all this in order to save M$8,860/year (average), the cost of the $ will reach:

$$\frac{229,680}{8,860} = \underline{\underline{26 \text{ KShs.}}}$$

6.7 SENSITIVITY

6.7.1 CHANGE IN INTERNATIONAL PRICE OF LDPE

Increase of 5% in the International market will bring the average f.o.b. price to $ 798/ton and the cost at the consumers plant to $1,365/ton. This will allow an ethylene cost of:

$$\frac{1365 - (375 + 280)}{1.05} = 675 \text{ \$/ton}$$

and an alcohol price of KShs.2.8/l. In such case the subsidy can be reduced by KShs.0.3/litre and the foreign currency saving will be $398/ton PE (an increase of $43/ton) and the annual foreign currency saving will rise to M$9,962 (instead of M$8,860). Therefore the saved $ (including subsidy) will drop by KShs.3/$ to KShs.23/$.

6.7.2 CHANGE IN INVESTMENT COST

Increase in 10% investment, by M$4.670 will increase fixed cost expenses by M$740 which is $30/ton LDPE. This should decrease the profit by this amount or by about 10% on the average.

6.7.3 CHANGE IN PRODUCTION AND SALES

Every 1000 MT of increased production and sales reduces the fixed cost by $12/ton and increase profit accordingly. Instead of increased profit the subsidy can be reduced by KShs.70/ton alcohol.

6.8 CONCLUSIONS

From the above presented results it can be deducted that the ethanol to LDPE project is a very marginal one, at the best. Under preferential financial conditions and Government subsidy to the alcohol producers the project itself enjoys an IRR of about 14.7% but from the Government point of view the saved dollar is produced at very high cost.

As a matter of fact these results give a true picture of the bad state of business in which the world producers of ethylene and LDPE find themselves at the present moment. There is an excessive capacity of both materials in the world with resulting heavy competition and which forces the prices down to the minimum possible.

Lets analyse the distribution of costs:

	$/ton LDPE	%
Ethylene	645	49.6
Variable	115	8.8
Fixed	260	20.0
Profit	280	21.6
	$ 1,300	100.0%

Ethylene is the major cost component, which can be obtained at cheap prices in the world, especially at the presently "low" price of the barrel of crude oil. An upward trend in crude oil prices and a consequent rise in cost of Naphtha and LPG might change the picture entirely and make the local production a successful venture.

Also the fixed cost (including depreciation) have a relatively high impact on the ultimate production costs. The reasons are twofold: the proposed LDPE plant is a relatively small unit and therefore fixed costs are relatively high per ton product and furthermore, it is a new grassroot industry which require heavy investment for infrastructure such as utilities, storage area and environmental preparations, buildings, laboratories, drainage, sewage, etc. Any further expansion will r require less investment per ton product and will make the whole project more profitable.

The last item of importance is the profit of the enterprise. At the present depressed state of business it is doubtful whether anyone of the present producers can show as high a profit as this project. Most companies are happy if they can break even and keep their heads above water and do not slide into the red. During the last year several large chemical companies have decreased their output considerably and some have gone out of LDPE production entirely, due to heavy losses incurred to them by the weak market.

It is recommended that this project should be re-evaluated periodically, as the feasibility is liable to change to the better with rising cost of crude oil and consequent higher cost of Naphtha, ethylene and LDPE in the world market.

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7.0 FUTURE EXPANSION AND DIVERSIFICATION OF THE LDPE CONVERTING INDUSTRY

The LDPE industry in Kenya is only in its infancy. The reasons are obvious, but with proper effort and government help the usage of LDPE can be increased considerably, mainly for products of everyday use and as a vehicle for identifying agriculture and for a general raise in the standard of living of the population.

Mr. Subramanian in his report, issued April 1979, gives a very good account of the expansion possibilities of the industry; so here only a few items are added which probably were not sufficiently emphasised before:

7.1 One very important point is the price of the material. It is recommended not to raise the price by adding higher import duty, under no circumstances. The materials cost is already very high and it must remain competitive to other alternative materials, like paper, LDPE, PP, etc. As long as there is no plant in the country all effort should be concentrated to obtain the cheapest material from overseas and by these means spread the usage of LDPE. The LDPE is known as "poor man's plastic" and it should remain as such for the good of the country.

7.2 Other possible usages of LDPE which are not yet introduced in the country at all or at a small scale only, are the following:

7.2.1 Small diameter black pipes and tubes up to 2".

This product is mainly used for drip and spray irrigation purposes. It is an important tool in the intensification of agriculture and in the conservation of water. The writer has discussed this matter with managers of agricultural farms and they saw possibility for wide spread use in the country. At the present this product is imported. It was strange to see that the only producer in the country has sold his equipment about a year ago (due to his own reasons not connected to the market) and no new producer has entered the market yet. In the writer's country, Israel, the manufacturer of irrigation piping is the second largest consumer of LDPE after films and sheets, about 12% of total consumption.

7.2.2 Tubes for electric conducts

Those tubes are put in the wall during construction of the buildings to enable the laying of electric cables at a later stage of construction. It is understood that under the present building code such tubes are made of UPVC. PVC is usually not used for such purpose in many other countries due to the fact that PVC evolves toxic hydrochloric acid gases in case of fire. It is recommended to have a second look at the subject.

7.2.3 Rotational Moulding

This method is used mainly for very large containers, water cisterns, small boats, large garbage bins and other large objects. The products can be larger than those produced by any other method such as injection moulding. The main advantage of the process lies in the relative cheapness of the machinery and in the cheapness of the mould. For the production of rotational moulded products one may use LDPE, LLDPE or blends of same.

7.2.4 Garbage Containers:

In many countries the large garbage containers used in apartment houses, public buildings, shops and private houses are made of LDPE, injection or rotationally moulded. In Nairobi the garbage is collected in containers made of galvanized carbon steel. LDPE containers are cheaper, more durable, make less noice and are easier to clean. It might be worthwhile to discuss this matter with the City Council and probably with other townships in the country. In general also black LDPE bags are very much in use for garbage collection. In many large cities; notably London, the shopkeepers put the full garbage bags in the evening in front of their shops for collection during the night.

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8.0 SOME THOUGHTS ON THE EXPANSION AND DIVERSIFICATION OF THE ETHANOL CONSUMING INDUSTRY

As a last chapter in this report it was thought to be useful to mention some other uses of ethanol for the production of chemicals. Each product will, of course have to be investigated and evaluated on its own merit, but it seems there might be some products of interest for local manufacture. The advantage is that the ethanol conversion industry can be based on relatively small units, compared to some products produced in the large plants of the petrochemical industry.

Acetaldehyde: produced by the oxydation/dehydrogenation of ethanol. Acetaldehyde is an important intermediate in the manufacture of acetic acid, acetic anhydride, pentaerythritol, butanol, chloral, 2-ethylhexanol.

Potential know-how suppliers:
Humphreys and Glasgow, UK
Bofors Nobel Chematur, Sweden
Veba Chemie - West Germany

Acetic Acid: manufac ured by the oxidation of acetaldehyde. It is used in the production of esters such as vinyl acetate, ethyl acetate, butyl acetate, amylacetate, cellulose acetate, acrylates, peracetic acid and acetic anhydride.

Potential know how suppliers:
Humphreys and Glasgow, UK
Bofors Nobel Chematur, Sweden
Hoechst, West Germany
Scientific Design, USA
Petroquisa, Brazil and others

Acetic Anhydride: can be produced by cracking of acetic acid or by oxidation of acetaldehyde. This material is especially important in cases where acetylations by acetic acid are difficult such as in the production of cellulose acetate and aspirin.

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Potential know-how suppliers:

Humphreys and Glasgow, UK
Bofors Nobel Chematur, Sweden
Bechtel Corp. USA and others

Cellulose Acetate: produced by reaction of acetic anhydride on cellulose. The cellulose can be obtained from digestion and purification of the short fibres removed from cotton seeds after ginning operation or from wood pulps.

The product can be spun into fibres (triacetate fibres) from an acetone solution. Other possible uses are in the plastics industry as moulding powder and in the cigarette filter field. It may be an interesting material for local manufacture and it is recommended to investigate this possibility further. Present manufacturers who might also licence know-how are:

FMC - USA
Celanese - USA
Dupont - USA
Tenessee Eastman - USA

Vinyl Acetate: can be produced by reaction between acetaldehyde and acetic anhydride. By product acetic acid is recirculated for conversion into acetic anhydride required in the reaction.

Present manufacture: Celanese Corp., USA

There are a number of other products although it is doubtful that they will be of any interest for local production, such as:

n - butanol as solvent
2 - ethylhexanol as plasticisers

Even butadiene can be produced by the reaction of ethanol and acetaldehyde.

As stated in the beginning the production of the above mentioned chemicals are interesting as they can be produced in small units. The Brazilian chemical industry is putting much effort in the production of such chemicals out of ethanol and it is recommended to come into closer contact with their manufacturers and know-how suppliers.

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