OCCASION

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

DISCLAIMER

This document has been produced without formal United Nations editing. The designations employed and the presentation of the material in this document do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations Industrial Development Organization (UNIDO) concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries, or its economic system or degree of development. Designations such as "developed", "industrialized" and "developing" are intended for statistical convenience and do not necessarily express a judgment about the stage reached by a particular country or area in the development process. Mention of firm names or commercial products does not constitute an endorsement by UNIDO.

FAIR USE POLICY

Any part of this publication may be quoted and referenced for educational and research purposes without additional permission from UNIDO. However, those who make use of quoting and referencing this publication are requested to follow the Fair Use Policy of giving due credit to UNIDO.

CONTACT

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

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

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

RESTRICTED

DP/ID/SER.B/102
16 February 1977
English

07721.

CHEMICAL INDUSTRY DEVELOPMENT

DP/SRL/69/012

SRI LANKA

TERMINAL REPORT

Prepared for the Government of Sri Lanka by the
United Nations Industrial Development Organization,
executing agency for the
United Nations Development Programme

United Nations Industrial Development Organization

id.77-944

United Nations Development Programme

CHEMICAL INDUSTRY DEVELOPMENT

DP/SRL/69/012

SRI LANKA

Project findings and recommendations

Prepared for the Government of Sri Lanka
by the United Nations Industrial Development Organization,
executing agency for the United Nations Development Programme

Based on the work of J. D. Adhia,
expert in the development of basic chemical industries

United Nations Industrial Development Organization
Vienna, 1977

Explanatory notes

References to dollars ($) are to United States dollars, unless otherwise stated.

References to "tons" are to metric tons.

References to "gallons" are to Imperial gallons (4.545 litres).

PCC refers to the Paranthan Chemicals Corporation.

ABSTRACT

The project "Chemical industry development" (DP/SRL/69/012) stems from the request, in 1969, of the Government of Sri Lanka to the United Nations Development Programme (UNDP) for assistance in the modernization and expansion of its basic chemicals industry, which consisted primarily of the electrolysis plant of the Paranthan Chemicals Corporation (PCC). This plant is based on solar salt, of which Sri Lanka produced about 80,000 tons yearly. It produced, yearly, about 1,100 tons of caustic soda, simultaneously generating about 950 tons of chlorine gas.

As executing agency for this project, the United Nations Industrial Development Organization (UNIDO) assigned an expert in the development of basic chemical industries to render assistance to PCC in improving its plant. In view of increasing demand, and since the production of PCC satisfied only about one third of the country's requirement of caustic soda, the expansion of the plant had been under active consideration. As the industry develops, it is considered that proper co-ordination between the related sectors of the chemical industry, such as the utilization of chlorine and the balancing of the production of soda ash will be of increasing importance. The present project was designed to pursue these aims.

The expert was to work in close collaboration with the industries oonoerned and to undertake the following duties:

Advise the Government on the improvement of co-ordination of the chemical industries

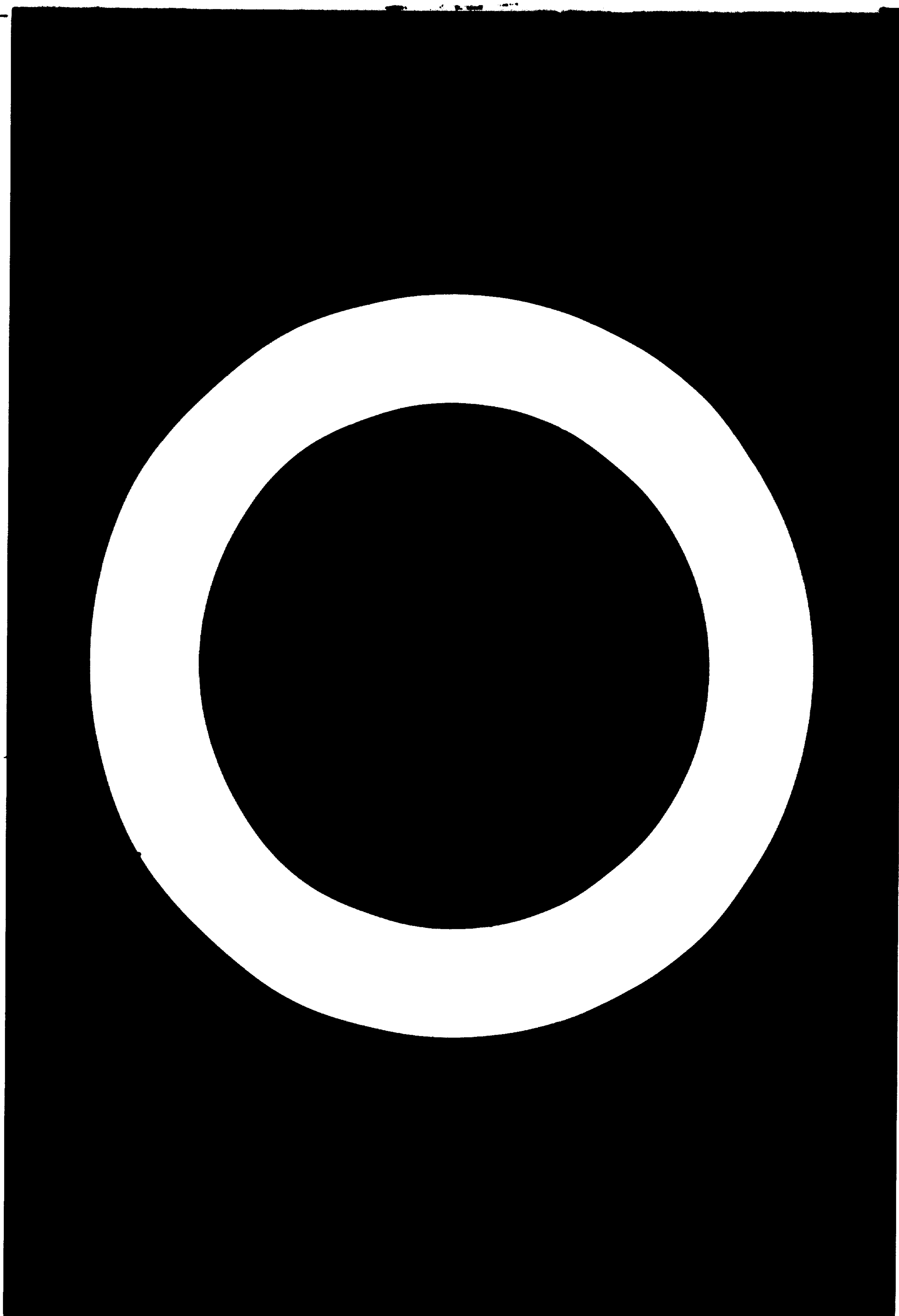
Assist the Government in making feasibility studies, from both the technical and economic standpoints of the proposed new complex for the manufacture of caustic soda, chlorine gas, pesticides (BHC, DDT), sulphuric acid, soda ash, ammonium chloride and the like

Make process evaluations of such manufactures

Recommend improvements of the existing chemical plants

Train, or recommend, training programmes for local personnel.

All of the objectives were achieved. This project was financed by total appropriations of $84,409 by UNDP.



CONTENTS

INTRODUCTION

In 1969 the Government of Sri Lanka requested the United Nations Development Programme (UNDP) for assistance in the modernization and expansion of its basic chemicals industry, which consisted basically of the electrolysis plant of the Paranthen Chemicals Corporation (PCC). This plant is based on solar salt, of which Sri Lanka produced about 80,000 tons/year. From this raw material, PCC produced, yearly, about 1,100 tons of caustic soda, simultaneously generating about 950 tons of chlorine gas.

UNDP set up the project "Chemical industry development" (DP/SRL/69/012), with the United Nations Industrial Development Organization (UNIDO) as executing agency. An expert in the development of basic chemicals industries was assigned to the project to assist PCC in improving its plant. This work was completed successfully. In view of the increasing demand for caustic soda and since the production of PCC satisfied only about one third of the requirements of Sri Lanka for caustic soda, it was considered that proper co-ordination between related sectors of the chemical industry, such as the utilization of chlorine and the balancing production of soda ash would be of increasing importance. The original project was therefore modified to suit this purpose. Over the duration of the project, it was supported by appropriations of $84,409 by UNDP.

Under the terms of the amendment to the project, the expert was to work in close collaboration with the Industrial Board or other relevant high-level governmental organ and was required to undertake the following tasks:

Advise the Government on the improvement of co-ordination of the chemical industries

Assist the Government in performing feasibility studies from both the technical and economic standpoints, on the proposed new chemical complex for the manufacture of caustic soda, chlorine, pesticides (DDT and BHC), sulphuric acid, soda ash, ammonium chloride etc.

Make process evaluations of all these manufactures

Recommend improvements of the existing chemical plants

Train local personnel or recommend measures for such training.

I. PRESENT SITUATION OF THE CHEMICAL INDUSTRY OF SRI LANKA

Most of the advice rendered by the expert to the Government of Sri Lanka (Ministry of Industries and Scientific Affairs) and also to PCC has been submitted through formal notes and reports. In order to avoid repetitive documentation, therefore, this terminal report does not summarize the numerous reports made during the past six years. A list of published works, major reports, special reports and committee reports is attached to this report as annex I. One set of the published work (annex I, A) has been submitted to the Chairman of PCC. One copy of each of the five major reports (annex I, B) is available both in the Colombo office and the Factory Library of PCC. Copies of special reports (annex I, C) are also with PCC.

In addition to the documentation listed in annex I, nearly 1,800 pages of short notes have been submitted to the Chairman of PCC. (A master copy of these notes had been collected for the expert's personal file.) At the suggestion of one of the Directors of the present Board of PCC, it was decided to leave with the corporation the six volumes of the box file containing these notes. In order to facilitate quick reference to these notes, a master index has been prepared and attached to this report as annex II. The present positions of various projects with which the expert was associated are given below.

PCC: first expansion

A 10-ton chlorine compressor, a chlorine washing column and the new chlorine liquefaction plants have been commissioned successfully. The caustic evaporator and the new switchgear are being erected and are expected to be commissioned during latter part of July 1977. The erection of the evaporator, although awarded to a well-known firm of engineers, and despite the inolusion in the contract of a penalty clause to ensure completion by March 15, was considerably delayed, and could not be commissioned before the departure of the expert. A special note (annex III) has been prepared on the commissioning of this plant. It is only here that the Stage I expansion project may give rise to unforeseen problems during the normal running of the existing plant.

PCC: second expansion

Technical discussions were held with the staff officers of PCC on the specifications for a rectifier for the third cell room, and decisions were taken. These specifications were checked by Ceylon Electricity Board engineers, and the purchase procedure has been begun. The rest of the work has been outlined in the notes of the expert (Vol.V, pp.361 and 364; Vol.VI, pp. 5, 7, and 92).1/ The salt-dissolving and brine-purification plant capacities will require closer examination.

Ultramarine blue: Pirisudu

These projects have been completed and are now in commercial production at the Negombo plant of the Ceramics Corporation.

Carbon black from coir waste

The project construction has been partially completed. After preliminary trials, the Sri Lanka Industrial Development Board will undertake the installation of auxilliary equipment.

Zinc oxide from waste metallic zinc

The pilot plant work has been successfully completed and is awaiting commercial exploitation. Details must be worked out for reclaiming metallic zinc from used dry cells.

The second caustic soda/PVC complex

A recent re-examination of the earlier studies made on this project has shown that the establishment of a second caustic soda project would not be economically viable without profitable utilization of chlorine.

A detailed study on the PVC project made in February 1972 had shown that the Kureha-Chiyoda process for manufacturing PVC through naphtha was the most economic; the calcium carbide route was found to be unfavourable. Since this study, the prices of naphtha in the international markets have undergone drastic changes. As a result, a re-examination of the project report by the expert has proved the calcium carbide route to be the more economical in the present context. The Credit Institute for Economic Development (KFW) of the Federal Republic of Germany is being commissioned to prepare a feasibility study of the project. The lime and limestone required for the production of calcium carbide must meet rigid specifications

1/ See annex II.

for both chemical content and physical properties, including the poorly defined term, burnability. The factory site will be determined, to some extent, by the location of a suitable bed of limestone.

The Nylon 6 project

It has been decided to finance this project with convertible foreign exchange. The project is being executed.

Alginates

Preliminary project work has been completed. The National Textile Corporation has undertaken the commercial manufacture of the product.

Recovery of Epsom salts from solar salt bitterns

The project has been re-examined for technical and economic viability by the National Salt Corporation, and a decision has been taken for its implementation. The first recovery plant will be put up at Hambantota salterns in the south.

The ilmenite slag process

The large-scale trials in the Union of Socialist Soviet Republics with Sri Lankan ilmenite and weera wood charcoal proved to be successful and their power consumption, yields and furnace capacity were found to be more favourable than had been expected from earlier laboratory-scale trials. Representatives of the Hungarian Metallurgical Trust have proposed using Government-level aid cum supplier's credits for a four-furnace project (45 to 50 thousand tons/year slag production), including a marketing arrangement both for the slag and the cast iron produced. The proposal is under examination by the Government of Sri Lanka, and a decision is expected by the end of 1977. The views of the expert and his suggestions for further action were sent in a recent note to the Secretary of the Ministry of Industries and Scientific Affairs. The up-grading of ilmenite increases its value eightfold by volume and about fifteenfold by weight, so the project is basically very sound. Capital investment must be kept at the lowest possible levels as regards the turnover investment ratio and other considerations.

The Soda ash project

With the establishment of a sheet-glass factory at Dankotuwa and additional sodium silicate factories, the demand for soda ash may reach a level at which the establishment of a dual-process plant may become feasible. The main raw materials are salt, ammonia and carbon dioxide gas. The site for the dual-process plant must be adjacent to the fertilizer plant at Sapugaskande. KFW has been requested to prepare a feasibility study on this project. A background note on this industry is included as annex IV to the present report.

Iron oxide pigments from waste pickle liquor

This project is now in commercial production at the Ceylon Steel Corporation.

II. RECOMMENDATIONS

For the short term

In order to make this terminal report a useful reference document, the suggestions for plant modifications which have yet to be carried out are summarized below. When carried out, these suggestions will lead to further improvement in the capacity or efficiency of the plant.

1. General

Import or have locally fabricated, spare parts for the machinery required for the first and second expansion

To import the spare coils or winding wire for the AEG Rectifier-transformer

To organize an apprentice-training scheme

2. Brine purification

Replace all brine-transfer pumps with ones of larger capacity (110 gallons per minute (gpm))

Import a Sedipur settling aid

Resaturation of brine, preferably after pre-heating

Order a compressed-air sparger for the neutralization tank

Order a backwash arrangement for the sand filter

Order an additional salt-dissolver for the second expansion

3. The cell house

Replace the asbestos paper by a deposited diaphragm. Deposition to be effected by application of vacuum

Brine pre-heating to 60°C

Control feed brine pH more effectively

Dope new diaphragm cells with calcium chloride regularly

Lag the cells with polystyrene foam (Rigifoam)

4. Caustic evaporators (old evaporator for second expansion)

Improve caustic cooler operation (better salt removal arrangment, re-circulation for better cooling etc.)

Divert caustic cooler cooling water to hot well

Build a steam-jet ejector

Make arrangements for the collection of all caustic spillages

Replace steel pipes by Monel metal ones (strong liquor system)

5. <u>Chlorine gas: drying, compression etc.</u>

Set up a chlorine cooler (glass tube/PVC) installation

Use refrigerated brine in the titanium coil

Install graphite pipes for the acid cooler for drying tower No. 2

Obtain an additional chlorine compressor or convect the present 5-ton machine to 10-ton capacity

6. <u>Liquid chlorine</u>

Obtain liquid level gauges for storage tanks

7. <u>Table salt</u>

Develop a salt dryer

8. <u>Boiler house, power plant etc.</u>

Develop a hydrogen burner for the boilers

Research and development

All of the following matters should be investigated:

1. Construction of a prototype miniature electrolytic cells for the study of:

Optimum current density

Optimum brine-feed pH

Effect of sulphate ion (SO_4^{-2}) on anode consumption

Optimum concentration (grams per litre - gpl) of caustic soda (NaOH) in the cell effluent

Investigations on chlorate content

Improvement in electrical current efficiency

Development of an optimal diaphragm material

Optimization of the potassium chlorate ($KClO_3$) process

Uses for waste sulphuric acid (copper sulphate ($CuSO_4$), zinc sulphate, iron-free alum, superphosphate etc.)

Stabilizer for household bleach solution

Recovery of sodium sulphate from evaporator salt

Manufacture of graphite anodes from Sri Lankan graphite (liason with Sri Lanka University and others doing this work)

Treatment of graphite anodes with rubber-seed oil

Upgrading of brine sludge for use in toothpaste, cosmetios and as a rubber filler

Manufacture of zinc oxide (ZnO) by the French process

Construction of an ice plant

Manufacture of laboratory chemicals

Manufacture of calcium chloride ($CaCl_2$) and development of new applications for it

Design of a large-scale production plant for ferric ohloride (Fe_2Cl_3)

Second expansion of PCC

Listed below are important jobs and problems that are connected with the second expansion of PCC:

Setting target dates and preparing net-work analyses

Decision as to the ultimate plant capacity after the second expansion has been completed

Specifications for the rectifier

Preparation of design and layout for the third cell room

Changes in cell design and other modifications in the cell rooms

Preparation of a detailed list of materials to be imported

Integration of two evaporators so as to achieve maximum oapacity and highest efficiencies

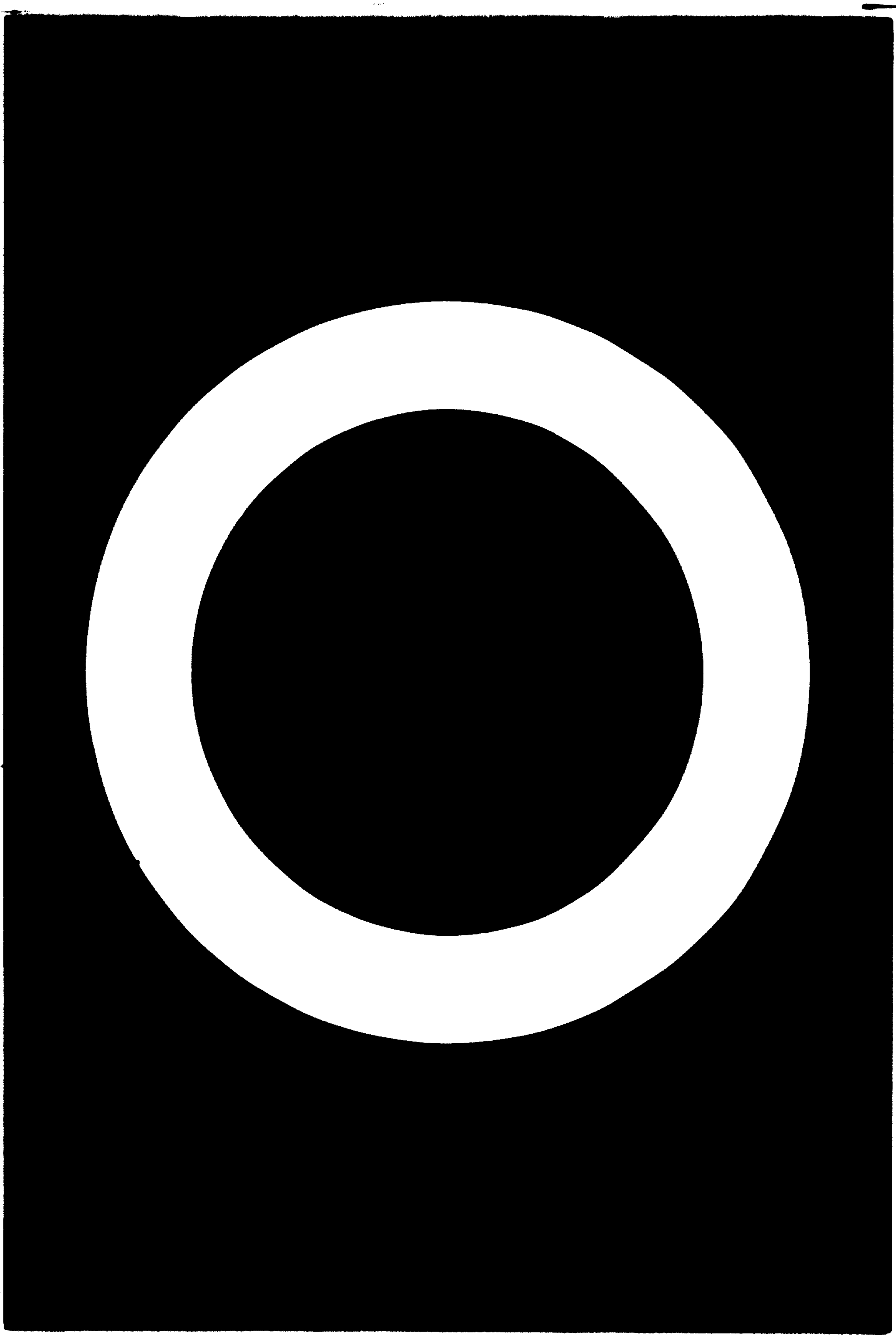
Integration of feed-water systems for the old and new boilers

Disposal of surplus chlorine

Transportation of large tonnages of liquid caustic soda, ferric chloride etc.

Development of the large-scale use of ferric chloride

Development of the use of hydrochloric acid for rubber coagulation.



Annex I

PUBLICATIONS, REPORTS AND OTHER WORK OF THE EXPERT[a] RELATED TO THE PROJECT

A. Publications

Some recent developments in the chlor-alkali industry. Chemical Age of India, June 1972.

Carbon black. Chemical Age of India, July 1974.

Some problems of development of a basic chemical industry in Sri Lanka, Technical Journal of the University of Peredinjya, 1974

The chlorine wash column. Chemical Age of India, October 1975.

Caustic embrittlement. Chemical Age of India, April 1976.

Titamium metal. Iron and Steel Journal of India, February 1976.

Chlorine ton containers. Chemical Age of India, May 1976.

Steam jet ejectors. Chemical Age of India, in press, 1977.

Sodium hypochlorite cell. Chemical Age of India, in press, 1977.

B. Major independent reports to PCC

Second caustic chlorine project: a preliminary report. May 1971.

Feasibility study - PVC project, February 1972.

Production of gypsum in Sri Lanka. April 1972.

Report on the development of a basic chemical industry in Sri Lanka. November 1972.

Electrolytic caustic soda chlorine plant operator's manual. 1976.

C. Special independent reports to PCC

Manufacture of ultramarine blue. September 1972.

"Pirisudu" products. February 1973.

Processing of crude glycerine to refined product. February 1973.

---

a/ Jayout D. Adhia.

Recovery of glycerine (crude) from soap lyes (British Chemical Corp.). April 1973.

Hypochlorite bleach in place of hydrogen peroxide at Veyangoda Mills. April 1973.

Manufacture of alginates from Sri Lanka seaweed. April 1973.

Iron oxide stains. May 1973.

Recovery of Epsom salts from solar salt bitterns. September 1973.

Methane from sewage. January 1974.

Asian industrial survey for regional co-operation. January 1974.

Steam jet ejectors. January 1975.

Insulation for caustic evaporators. April 1975.

Graphite anodes (manufacture from Sri Lanka graphite). May 1975.

Salt-based industries in Sri Lanka. August 1975.

D. Committee reports on which the expert collaborated

The manufacture of synthetic fibres

The manufacture of PVC

Manufacture of Epsom salt from bitterns

Panel on titanium

Report on the manufacture of benzene hexachloride (BHC)

The manufacture of calcium chloride

Report on the chemical panel

Coconut-shell distillation

E. Technical Committees on which the expert served.[b/]

Development of the basic chemical industry

Committee on chlorine bleach for the plant of National Textile Corp. at Veyangoda

---

b/ No formal reports were submitted, but some of the projects were executed.

Rayon

Essential oils and flavouring agents

High-grade lime

Gypsum and plaster of Paris

Soda ash

Zinc oxide from waste zinc

Alginates

Ultramarine blue

Replacement of expeller units at the Oils and Fats Corporation, Seeduwa

Safety matches: the creation of additional production capacities and quality control

Manufacture of stains

Wood charcoal

Peanut butter

Titanium slag project

F. <u>Special advice given to other corporations</u>

Effluent disposal, National Textile Mills (Thulhiriya Mills)

Effluent treatment, National Paper Corporation (Embilipitiya Mills)

Chemical recovery and recausticization plant for the National Paper Corporation (Embilipitiya Mills)

Sludge (lime) burning plant of National Paper Corporation (Embilipitiya mills)

Specifications and selection of bids for chlorine tonners for National Paper Mills.

Annex II

SIX-VOLUME BOX FILE OF NOTES SUBMITTED BY THE EXPERT TO THE CHAIRMAN OF PCC

Topic	Volume and page
Acid cooler	III 243; V 18
Administrative report	III 110; IV 16, 250
Air dryer	III 62, 217; IV 106, 108, 113; V 22
Alginates	IV 62, 91
Ammonia compressor	III 18, 208, 215, 272; VI 105
Apatite	IV 341
Apprentice scheme	I 44
Asbestos diaphragm	I 313, 339, 355; IV 257; V 147, 177, 200, 331; VI 112
Asian industrial survey	IV 199, 214, 215
Bakelite	IV 102
Basic chemical industry	IV 1, 22, 24, 149, 316; V 148, 255
Benzene from Refinery	I 51
Boiler (packaged)	IV 163, 324
Books for library	I 121
Bostic sealing compound	V 304
Brine heating	I 251, 273
Brine purification plant	V 302, 354
Brine tanks - concrete	IV 110
Calcium carbide	IV 97; VI 78
Calcium chloride	I 26, 68, 319, 334; II 1, 85
Capital budget	I 19; IV 288
Carbonation of caustic liquor	I 125
Carbon black	V 28
Cathodes	III 9
Caustic soda concentration versus steam consumption	II 1; IV 65
Caustic cooler	V 337
Caustic embrittlement	VI 14

Annex III

THE CAUSTIC EVAPORATOR PLANT OF THE FIRST EXPANSION

When the present report was being prepared (July 1976) it seemed certain that the new caustic evaporator plant of the first expansion project would not be ready for operation before the departure of the expert. He therefore compiled the following observations in the hope that they would be of use in commissioning this equipment. Indeed, the final five-week period of the mission of the expert was devoted to this task. (As noted in the section PCC: "first expansion" of chapter I, the ereotion work for the evaporators and other plants connected with the first expansion of PCC was not ompleted on schedule, despite the fact that the task had been entrusted to a reputed engineering firm and that there was a penalty clause in the contract.)

The funds for the expansion of PCC were obtained through a loan granted by the Overseas Development Administration (ODA) of the United Kingdom. All plant and machinery had therefore to be purohased in Great Britain. Sinoe the production of caustic soda there is dominated by a single firm (ICI Ltd), know-how for a special plant such as the caustio soda evaporator needed here is not widespread. Only two British firms made acceptable tenders for the evaporator, and both of them had their oonsultants in the United States of America.

During the execution of the order by the successful tenderer (Messrs. Robert Jenkins), a lack of co-ordination between the suppliers and their consultant in the United States was notioeable. Furthermore, the suocessful tenderer's knowledge of the operation of the plant appeared to be inadequate for putting it into commission. Consequently, it is likely that a number of difficulties in the operation of the plant will arise. The observations that follow were made with this situation in mind.

Evaporation and the handling of slurries

In this new plant, the basic prinoiples involved and the general process of evaporation followed are the same as in the Escher Wyss evaporator, with which the operating personnel have oonsiderable experience. The major difference is in the handling of the salt that crystallizes out during evaporation. The salt separation system in the new evaporator is of an improved type, but as it is radically different from the earlier system, it may give rise to certain problems during the commissioning of the Plant.

All of the salt that crystallizes out in both effects is finally removed from second effect (weak liquor) as a slurry. The slurry must be as thick as possible so as to achieve the highest economics in evaporation and the recovery of caustic soda. The higher the concentration of solids in the slurry, the greater are its tendency to plug the pipes. Except for occasional experience with brine purification sludge, the processes used by PCC have not included the handling of slurries, and it may take some time to acquire the necessary experience. However, the optimization of the slurry concentration may be left for a later period, after other and more pressing problems have been solved.

The centrifuge

The centrifuge in the new evaporator plant is of a continuous type. Once the operation has been mastered, it can give excellent results in dewatering the salt. The thickness of the cake and the stroke of the pusher can be varied, and working at optimum conditions could mean both a low caustic soda (NaOH) content of the cake and decreased use of wash water. Control of cake thickness increases the recovery of NaOH, and control of the pusher stroke reduces the steam consumption for evaporation. The best adjustments of these two factors would differ according to the type of salt crystals (coarse or fine). Great attention should be paid to the optimization of centrifuge operation in order to get the best results. The maintainance of this centrifuge also will require special attention particularly at general manager level.

Crystallization of the salt

The great advantage of the new evaporator is that it can achieve proper crystallization of the salt. For this purpose, however, it must be operated continuously and, once equilibrium has been reached, the concentration changes in the respective effects should be negligible.

Dechloratation

The dechloratation unit should be commissioned as early as possible so as to improve the quality of the finished product. The optimum quantity of sodium sulphite (Na_2SO_3) required will have to be determined at plant-scale operation. Possibly, about a 20% excess (over stoichiometric) will be required in order to remove 90 to 95% of the chlorate in the cell liquor. The temperature (and corresponding pressure) should be maintained at 190° to 200°C.

<u>The barometric leg</u>

The tank provided for the barometric leg may require some modifications. They have been discussed with the civil engineer and others.

<u>The ejector</u>

The ejector has been already operated at the old evaporator, and there will be no problem of getting proper vacuum in the new one. Working at the highest vacuum (690 mm Hg) will give the highest heat economy and high capacity for the evaporator. Corrosion will also be kept to a minimum.

<u>Maintenance of capacity</u>

The capacity of the new evaporator is much higher per unit of heating surface than the Escher Wyss evaporator. This results primarily from the forced circulation of the liquor through the heat exchangers. In order to maintain the evaporator capacity, the pumps will have to be maintained at top capacity and efficiency.

<u>Spare parts</u>

Sufficient supplies of spare parts will have to be obtained (locally where possible, imported when necessary) to keep the centrifuge, the circulation pumps and other equipment in good working condition.

<u>Steam consumption</u>

The guaranteed steam consumption is rather high. Attempts should be made to achieve a much lower value.

<u>Plant modifications</u>

Whenever there are difficulties in the commissioning of a new plant, there is a temptation to effect modifications to achieve quick solutions to the initial difficulties. Such modifications often work, although the plant would have operated better and more efficiently without them in the long run.

It is necessary to exercise due restraint in carrying out expensive and time-consuming changes in plant design or process. For the same reasons, it is advisable to return to the original plant design and mode of operation even if hasty modifications have apparently solved the operational problems. The mild steel liquor-circulating pipes in the first effect may develop leaks at the welded joints owing to brittleness caused by caustic soda. It would be best to replace these joints with nickel pipes after discovery of the first leakage.

C-723

79.01.16