

# Chittagong Caustic Soda Plant Rehabilitation Project

Report Date: March 2000  
Field Survey: February 2000

## 1 Project Summary and Japan's ODA Loan

This project aimed to replace facilities at the Chittagong Caustic Soda Plant<sup>1</sup> to remedy the dilapidation of the existing equipment and to cope with growing demand for caustic soda. It also aimed to solve various environmental problems by preventing the generation of mercury and the leakage of chlorine gas.

The ODA loan covered the entire foreign currency portion of raw salt & brine purification equipment, new gas-turbine generator, the conversion of electrolysis equipment and other equipment for the plant, and of consulting services.

Borrower	Government of People's Republic of Bangladesh
Executing Agency	Bangladesh Chemical Industry Corporation (BCIC)
Loan Amount	¥2,076 million
Loan Disbursed Amount	¥2,071 million
Date of Exchange of Notes	December 1988
Date of Loan Agreement	December 1988
Loan Conditions	
Interest Rate	1.0%
Repayment Period (Grace Period)	30 years (10 years )
Procurement	General Untied
Final Disbursement Date	December 1997



<sup>1</sup> The old plant, which used the mercury electrolysis method, was built with ODA loan in 1966. In 1973 the Japanese government required a change in the manufacturing method used in caustic soda plants (the mercury electrolysis method had to be stopped). The work of changing manufacturing methods was completed by 1987 in Japan. These moves in Japan were behind the JBIC assistance provided for this project, which converted the plant from the mercury electrolysis method to the ion-exchange membrane cell method.

## 2 Analysis and Evaluation

### (1) Project Scope

The prices tendered for this project were far above the anticipated project cost, leading to a review of the project implementation method (contract content etc.) and project scope. As a result, some of the works were implemented under the direct management of the executing agency. Also the purchase of generators (approximately ¥500 million) for independent generation was abandoned in favor of buying electricity from Bangladesh Power Development Bureau (BPDB), with the construction of a 33kV/11kV transformer substation and 33kV transmission lines (approximately ¥9 million).

The cancellation of the purchase of the plant's own generators was a measure intended to minimize the reduction in project scope necessitated by the cost overrun. JBIC concurred on the decision based on an explanation by the Bangladeshi side that if electricity was bought through a high-voltage line (33kV transmission line), there would be very little trouble with power outages (in 1984, the year before the implementation of the project, there were an average of 16 power outages per month (192 in the year) and the average monthly duration of operation stoppages was 10 hours and 54 minutes).

At present the average number of stoppages using the bought electricity is three per month, with stoppage time averaging two hours and 42 minutes per month (recorded figures for 1999, see Figure 1), and compared to the previous arrangement, in which electricity was supplied through low-voltage transmission lines (11kV) from a 33kV/11kV transformer outside the plant, the transformer inside the plant and the new transmission lines have produced an improvement in the power outage problem. However, the reliability of electricity supply from BPDB remains unsatisfactory and further measures should be taken to enhance the stability of purchased electricity supply.

#### Power Outages in 1999

Month	1999						2000	Average
	July	August	September	October	November	December	January	
No. of outages	2	3	4	0	5	6	4	3.4
Duration (min.)	79	169	220	0	44	460	N.A.	162

Source: CCC materials

Note: The average outage duration does not include that of January 2000.

### (2) Implementation Schedule

Implementation schedule was delayed by five years, relative to the plan. The cause of the delay was that the project cost yielded by tendering was far in excess of the anticipated project cost, leading to a review of the project implementation method (contract content etc.) and project scope. The review took time, and the executing agency had to engage in longer negotiations to reach a contract with the awarded tenderer. As a result, approval procedures in Bangladesh had to be repeated concerning some of the contract contents and changes in project cost. These factors caused a delay of five years before the construction works could begin.

### (3) Project Cost

As the project implementation method and scope had been altered, the foreign currency portion of the project cost remained within the planned value, but the local currency portion suffered a cost overrun of approximately ¥400 million. This arose because the tendered prices by both tenderers were far beyond the plan. Therefore some of the works which were initially counted within the foreign currency portion (the portion covered by ODA loan), were changed to implementation by local contractors at the Bangladesh government's expense, in local currency. As a result, the total project cost, in Yen terms, ended as 16% cost overrun.

This cost overrun was reached through competitive tendering and is therefore unavoidable, but it certainly posed a major obstacle to the implementation of the project. Through the commendable efforts of the executing agency and other related agencies it was possible to realize the project without major cuts in its scope, although the process led to major delays.

#### Comparison of Original Plan and Actual

Item	Plan	Actual
<b>1. Project Scope</b>		
Raw salt & brine purification facilities	New construction of secondary raw salt & brine purification facilities	As planned
Gas turbine generator	1 set of 4MW	33KV transmission lines (15km) Establishment of 33KV/11KV substation
Electrolytic facilities	Conversion from mercury electrolysis method to ion-exchange membrane cell method (20t/day)	As Planned

Electrolytic facilities	Conversion from mercury electrolysis method to ion-exchange membrane cell method (20t/day)	As Planned
Expansion of liquid chlorine facilities	13.5t/day	As planned
Renovation of other existing facilities	Expansion of pure water facilities	As planned
Consulting Services	18.0M/M	As planned
<b>2.Implementation Schedule</b>		
(commencement to completion)	October 1989 to September 1991	August 1994 to April 1997
<b>3.Project Cost</b>		
Foreign currency	¥2,076 million	¥2,071 million
Local currency	78 million Taka.	292 million Taka.
Total	¥2,419 million	¥2,813 million
Exchange Rate	1Taka = ¥4.40	1Taka= ¥2.54
		(Annual average exchange rate at the time of conclusion of renovation work contract in 1994)

#### **(4) Project Implementation Scheme**

The executing agency was Bangladesh Chemical Industry Corporation (BCIC) under the supervision of Ministry of Industry. In addition to this project, BCIC was involved in a number of other ODA loan projects, including several fertilizer plants. It was able to respond flexibly to the expansion of project cost described above, although the process took time. Consultants contributed to the project from the F/S stage, and the contractors had all the skills required for a project of this type. Their performance was satisfactory. The delay was unavoidable because the project implementation method and scope had to be reviewed following cost overrun.

#### **(5) Operations and Maintenance Scheme**

This project is operated by Chittagong Chemical Complex (CCC) under the supervision of the executing agency, BCIC. CCC has a workforce of 636, of whom 241 work in the manufacturing division and 203 work in the maintenance division. Operation and maintenance follows the manual produced by the contractor mentioned above. In addition to regular daily maintenance, the equipment is comprehensively inspected and overhauled for about ten days per year.

#### **(6) Operations and Maintenance**

The plant's operation rate since the project was completed has not risen above 60% due to stagnating demand for its products. The drop in sales was caused by the closure of production at the paper pulp plant which was the CCC's major customer. The pulp plant was under the management of the executing agency, and it bought from CCC preferentially at fixed prices set by the executing agency. Domestic demand for caustic soda in Bangladesh today is at a relatively high level of 25,000 tons per year, but the average unit price of CCC's caustic soda is 28,981 Taka/ton. In the general market, price competition from cheap imports (21,000 Taka/ton) is intense and CCC is unable to capture a large sales volume. The executing agency and CCC should make efforts to improve their business position, including cutting their costs in order to lower their sale prices.

Despite their new transformer and transmission lines, the reliability of the electrical supply from BPDB remains unsatisfactory and impedes the smooth operation of the plant. Specifically, there are an average of 3 stoppages per month due to power outages, and severe voltage surges cause transformer breakdowns and damage the ion transfer membranes. Therefore BPDB, the executing agency, CCC and other related agencies should confer and devise measures which can be taken to deliver the necessary improvement in the stability and reliability of electrical supply.

The maintenance of the equipment includes regular inspections according to the manual prepared by the contractors, and there are no significant problems.

#### **(7) Environmental Considerations**

The rehabilitation of plant equipment has eliminated the leakage of chlorine gas and air pollution in and around the plant site, which is a major environmental improvement. Chlorine gas is constantly monitored by chlorine gas sensors, which were installed as part of this project at five locations in the plant in order to prevent a recurrence of environmental pollution. The conversion from the mercury electrolysis method to the ion-exchange membrane cell method has removed the need for mercury in the process, yielding another major environmental improvement. The old plant, where the mercury electrolysis method was used, has already been demolished and the processing and recovery (decontamination) of residual mercury has been completed. JICA expert is still being dispatched to the site on a short-term basis under ODA loan activation scheme for the monitoring of mercury residues in the soil and water. The executing agency and CCC, with the guidance of JICA expert, should establish a scheme for continued monitoring of residual mercury.

## (8) Project Effects and Impacts

### (i) Production Capacity Improvement and Movements in Production Volume

As Table 1 and 2 below show, the implementation of this project greatly increased the production capacity of CCC plant, but sales volume is still stagnating for the reasons described in "(6) Operations and Maintenance". Production of caustic soda and liquefied chlorine have not reached the planned levels. Demand for hydrochloric acid is rising and production has exceeded the planned volume.

The stagnation in production volumes of caustic soda and liquefied chlorine is largely due to external factors, such as the production stoppage at the paper pulp plant under the management of the executing agency, which was large customers before. In future the executing agency and CCC will have to make themselves competitive in the open market in order to expand their sales volume.

**Table 1: Increase of Production Capacity**

	Production capacity	
	Before the project	After the project
Caustic soda	4,500 t/year	7,000 t/year
Liquefied chlorine	3,600 t/year	4,600 t/year
Hydrochloric acid	1,800 t/year	3,000 t/year
Bleaching powder	1,200 t/year	600 t/year

Source: JBIC materials and CCC materials

**Table 2 : Movements in the Production Volume**

Item	FY	Production volume		
		Plan	Actual	
			97-98	98-99
Caustic soda	6,600 t/tear	3,908 t/tear	4,119 t/tear	
Liquefied chlorine	4,455 t/tear	2,057 t/tear	1,733 t/tear	
Hydrochloric acid	1,749 t/tear	3,948 t/tear	5,909 t/tear	
Bleaching powder	550 t/tear	354 t/tear	315 t/tear	

Source: JBIC materials and CCC materials

Note: 1) Fiscal year by Bangladesh in July - June.

2) Project completion was April 1997 (FY1996).

### (ii) Environmental Improvement

#### (a) Elimination of Gas Leakage

The rehabilitation of equipment has eliminated chlorine gas leakage, ending atmospheric pollution in and around the factory site, which is a major environmental improvement.

#### (b) Cessation of Mercury Generation

The conversion from the mercury electrolysis method to the ion-exchange membrane cell method has removed the need for mercury in the process, yielding a substantial environmental improvement.

The old plant, which used mercury, was carefully dismantled, and the lower foundations were covered over with concrete to prevent the dispersal of mercury. Approximately seven tons of mercury was recovered from the old electrolysis tanks. Nine tube-wells were drilled to monitor mercury seepage into the soil, and JICA expert has been dispatched to the site since November 1998 on a short-term basis under ODA Loan activation scheme for the monitoring of mercury residues. This is an example of effective cooperation between JBIC and JICA.

Recent findings from CCC surveys of residual mercury concentrations around the plant are as shown in the table below. Although all recoverable mercury has been recovered, the mercury problem has still not been solved, and the executing agency and CCC, with the guidance of JICA expert, should establish a scheme for continued monitoring of residual mercury.

(Unit: PPM)

Measurement Point	Quantity of mercury detected
Waterway by the rail bridge at the southeast of the plant	1.274000
Main drainage channel	0.268800
Upstream of waterway	0.000089
Mosque inside the factory	0.000920
DDT plant inside the factory	0

Source: CCC materials

Note: Bangladesh's environmental standard for mercury is 0.01PPM maximum.

## (9) Improvement in Productivity

The implementation of this project yielded the following productivity improvements:

### (i) Consumption of Electricity Per Unit Production

After this project the electricity consumption per ton of caustic soda produced fell from 4,195kWh (before the project) to 3,155kWh, a reduction of 1,040kWh.

### (ii) Consumption of Raw Materials Per Unit Production

The consumption of halite, which is the raw material, per ton of caustic soda produced has fallen from 2.00 tons (before the project) to 1.66 tons.

### (iii) Extension of the Service Life of Plant Facilities etc.

Before the project, leakage of chlorine gas led to rapid and severe corrosion of plant facilities, but the replacement of factory facilities ended the leakage of chlorine. It is expected that the change will lead to longer service life for plant facilities and reduce repair costs.

## (10) Financial Internal Rate of Return (FIRR)

When the Financial Internal Rate of Return (FIRR) for this project was recalculated after the project, the result was 4.5%, compared to 8.8% at the time of the appraisal. The FIRR was reduced because of the project cost overrun, and increased opportunity costs caused by the prolonged production stoppage due to the lengthened implementation schedule.

## (11) Other Points

The contractor provided the factory workers with technical guidance, and the project succeeded in transferring new technology (the ion-exchange membrane cell method) to Bangladesh. Furthermore, based on the experience gained in this project, BCIC is planning to switch to the ion-exchange membrane cell method at the Karnafuri Plant, which still uses the mercury electrolysis method. This demonstrates that BCIC acquired skills and experience in a new technology through the implementation of this project.



Plant Facilities after Renovation



The Site of the Former Plant.  
Tube Well in the Picture is serving for Mercury Monitor  
The Processing and Recovery (decontamination) of Residual Mercury has been completed.