U. S. TRADE AND DEVELOPMENT AGENCY

EXECUTIVE SUMMARY

Bydgoszcz, Poland – Zachem Chlorine Expansion Study

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Executive Summary

Overview

This feasibility study was funded by a grant from the United States Trade and Economic Development Agency. The overall purpose of the study is to determine which of several options best meets the goals of increasing the chlorine production capacity at Zaklady Chemiczne ZACHEM (Zachem) located in Bydgoszcz, Poland. Zachem is interested in increasing the production of chlorine to meet the needs of a planned expansion in the production of their primary products. The potential for changing this acid back into its constituents, chlorine and hydrogen, for satisfying part of the needed chlorine expansion is one of the options to be explored in the study.

TDA is providing the financing for this study to enhance the probability that US goods and services can be used to accomplish this production increase.

Background and Project Goals

The Republic of Poland became an independent nation in 1990 and in that decade initiated an aggressive development program that enabled the country to transform its economy into one of the more robust in Central Europe. Poland joined NATO in 1999. On October 19, 2002, Ireland, last of the 15 present European Union members to vote, approved the December 2001 Nice Treaty. This approval paves the way for Poland to be admitted to the European Union in 2004. Accession to European Union status is regarded as a substantial recognition of the progress Poland has made in recent years.

Zaklady Chemiczne ZACHEM is one of the largest State owned enterprises in Poland and is the only Polish producer of toluene diisocyanate (TDI). TDI is primarily used for the manufacture of upholstery foams. Zachem has been producing its products in the city of Bydgoszcz for nearly 50 years. Bydgoszcz is a regional transportation and commercial hub in west-central Poland approximately 300 km East of Berlin, Germany. Bydgoszcz has a population of approximately 400,000.

Zachem's main chemical manufacturing facilities at Bydgoszcz include:

- Chlorine and caustic soda (chemical formula = Cl_2 and NaOH)
- Toluene diisocyanante (abbreviated TDI), (chemical formula = $CH_3C_6H_3(NCO)_2$)
- Epichlorohydrin (abbreviated EPI), (chemical formula = CH_2OCHCH_2Cl)

Zachem expects to have an expansion of the TDI production in operation by December 2002. When the plant is fully expanded, the local consumption of chlorine for both the TDI and EPI production plants and some other smaller customers will reach 120,000 MT/yr of liquid chlorine[1]. Presently the Zachem chlorine plant is capable of producing 45,000 MT/yr. The balance of the liquid chlorine demand is purchased and shipped in rail cars to the Bydgoszcz site.

[1] This production is equivalent to the production of 124,800 MT/yr of gaseous chlorine due to the small consumption of chlorine as a gas to produce NaOCl, HOCl, and HCL burner acid. The remainder of this report will refer to the desired 120,000 MT/yr production on a liquid chlorine basis.

The production of TDI and EPI produces byproduct hydrochloric acid (chemical formula = HCl). Presently this material is sold into the domestic and export market with the balance recycled into making some of the chlorine. As the TDI production is ramped up, a substantial excess of HCl will occur.

Finally, to assist the entry into the European Union, Zachem is interested in becoming compliant with the environmental requirements found in the European Commission's Integrated Pollution Prevention and Control (IPPC) document published in Seville, Spain in October 2000. These requirements are known by the shorter title "Best Available Techniques" or BAT. The existing chlorine production facility does not comply with the BAT requirements.

The present TDA feasibility study was commissioned to explore ways of meeting all these goals, namely:

- Expand the chlorine production to 120,000 MT/yr to meet the anticipated consumption at the Bydgoszcz site. There are also subgoals to eliminate the inbound shipment of chlorine by rail cars both to reduce the reliance on external sources for a critical feedstock, and to reduce the risk of chlorine emission during the transportation and unloading of rail cars.
- Develop technologies to reduce the reliance upon outside sales of HCl. Of special interest is the potential for recycling the HCl into chlorine by electrolysis.
- Any technologies presented for use at Bydgoszcz must be able to comply with the environmental requirements found in the EU IPPC document (BAT).

Technology Options
Three general technological choices are presented in this study: upgrading and continuing to operate the present diaphragm cell technology, installing HCl electrolysis to recycle the excess HCl, and performing a technology conversion to membrane cells. A total of eleven different combinations of these three technology choices were examined and the single best choice was singled out for more detailed evaluation. The combinations, advantages, disadvantages, and overall ranking are presented in the following Table – Technology Review. Additional details on the technology choices and options may be found in Sections 6-9 of this report. The preferred option was No. 7, the two step conversion to membrane cells.

Economic Evaluation of the Chosen Option
The economic evaluation appears in the full version of the Final Report. This information was classed as confidential and cannot be included in the public version of the report.

Financing Options
Evaluation of the financial options for the construction of the plant expansion is regarded as confidential information and has been removed from the public version of the final report.

TECHNOLOGY REVIEW

OPTION No.	DESCRIPTION	ADVANTAGES	DISADVANTAGES	RANKING
1	Shutdown existing plant and buy all products.	No capital cost. Easy to do. Well understood. Buying chlorine from a Former Soviet Union supplier may result in favorable prices. Meets BAT.	High Operating cost. Needs a large rail car fleet. Disposal of HCl is difficult. Does not meet the goal of reducing chlorine shipments.	10
2	Continue to run the existing plant at 45,000 MT/yr and buy the balance of the products	Minimum capital cost. Easy to do. Well understood. Buying chlorine from a Former Soviet Union supplier may result in favorable prices.	Does not meet BAT. Disposal of excess salt or HCl is difficult.	Not considered a viable option since it does not meet BAT.
3	Upgrade the existing plant to 60,000 MT/yr and buy the balance of the products.	Modest capital cost. Easy to do. Well understood. Meets BAT. Buying chlorine from a Former Soviet Union supplier may result in favorable prices.	Does not meet the goal of reducing chlorine shipments. Caustic quality is standard diaphragm grade.	6
4	Convert the plant to 60,000 MT/yr membrane cells and buy the remainder of the products.	Moderate capital cost. Meets BAT. Caustic quality improved to membrane grade. Buying chlorine from a Former Soviet Union supplier may result in favorable prices.	Does not meet goal of reducing chlorine shipments. Membrane cells require considerable training to run successfully.	8
5	Upgrade the existing plant to 60,000 MT/yr and install 60,000 MT/yr of diaphragm cells.	Meets BAT. Well understood process. Ammonia processing improves caustic quality. Self sufficient in chlorine supply.	Substantial capital cost. Ammonia process requires training. Environmental risks higher due to presence of ammonia on site.	5
6	Upgrade the existing plant to 60,000 MT/yr and install 60,000 MT/yr of membrane cells.	Meets BAT. Sell membrane cell quality while using diaphragm cell material for HCl treatment. Self sufficient in chlorine supply.	Substantial capital cost. Membrane cell operation requires training.	4
7	***Convert the plant to membrane technology in two 60,000 MT/yr steps.***	***Meets BAT. Sell best quality membrane cell grade caustic and use catholyte for HCl treatment. Self sufficient in chlorine supply. Uses latest technology in the industry. Capital requirements are spread over several years.***	***High capital cost. Membrane cell operation requires training. Occupies a new plant site.***	*1*
8	Shutdown the existing plant and build one 120,000 MT/yr plant using membrane cells.	Meets BAT. Sell best quality membrane cell grade caustic and use catholyte for HCl treatment. Self sufficient in chlorine supply. Uses latest technology in the industry.	Slightly lower capital cost than in #7, but it is spent in a short period of time. Membrane cell operation requires training.	2
9	Shutdown existing plant and build one 60,000 MT/yr HCl electrolysis plant.	Environmentally best option. Meets BAT.	Substantial capital cost. Does not meet the goal of reducing chlorine shipments. No caustic soda sold, low product sales revenue. HCl process requires training.	9
10	Upgrade the existing diaphragm cell plant to 60,000 MT/yr and install 60,000 MT/yr HCl electrolysis plant.	Meets BAT. Caustic sold is treated with ammonia for quality improvements.	High capital costs. Occupies a new plant site. Ammonia and HCl processes require training. Environmental risks higher due to presence of ammonia on site. Does not completely meet goal of chlorine self -sufficiency	7
11	Convert the existing plant to 60,000 MT/yr membrane cells and install one 60,000 MT/yr HCl electrolysis plant.	Meets BAT. Sell best quality membrane cell grade caustic. Self sufficient in chlorine supply. Uses latest technology in the industry.	Highest capital cost. Integrating two new technologies into the site will require extensive retraining to run successfully. Occupies a new plant site.	3

Contractor and Subcontractor Identification

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