COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

Record No. 1969 / 44

Mineral Processing in Australia
Salt

by

Z. Kalix

Record No. 1969 / 44

Mineral Processing in Australia
Salt

by

Z. Kalix

MINERAL PROCESSING IN AUSTRALIA

SALT

by

Z. Kalix

Record No. 1969/44

CONTENTS

CONTENTS (Cont.)

SUMMARY

The current position of the Australian salt, caustic soda and chlorine industries is outlined with respect to domestic production, overseas trade, consumption, marketing and prices. Scope for additional processing including chlorine and caustic, unit costs of production, cost disabilities, caustic soda prices in selected countries and chlorine and caustic demand in non-Communist world are summarised. The conclusion is reached finally that present high cost of production combined with high transport cost suggest a poor export prospect for Australian caustic soda and chlorine.

INTRODUCTION

Following Cabinet Decision No. 189 of 1 May 1968, an interdepartmental committee consisting of representatives of the Department of Trade and Industry, Treasury, and National Development was set up to study the degree to which minerals produced in Australia are processed locally, and to explore possibilities for further processing.

At the initial meeting of the Committee convened on 5 June 1968 it was decided to compile a preliminary review of the current position of mineral processing in Australia and to indicate those sectors where additional processing seemed feasible. The Bureau of Mineral Resources prepared a conspectus of minerals produced in quantity in Australia and amenable to processing. A short list of minerals warranting further study was suggested. At the Committee's second meeting held on 15 July 1968 it was decided that the next step should be the preparation of more detailed papers on tin, titanium and salt processing.

This Record provides the relevant data concerning the domestic salt and chlorine and caustic soda industries; it provides a basis for further discussions rather than a set of definite conclusions.

Current position of the domestic industry

Salient statistics for the domestic salt industry in recent years are given in Table 1.

TABLE 1. SALT: SALIENT STATISTICS (tons)

	1963	1964	1965	1966	1967
Domestic production (e)	581,500	545,491	654,533	644,497	703,000
Exports	119,941	116,639	113,478	93,355	87,971
Imports	5,815	7,973	6,764	6,882	13,690
Apparent domestic consumption	467,400	436,800	547,500	558,000	629,000

The whole of the Australian salt production is harvested from solar evaporation pans and dry salt lakes; it is estimated that about 88 per cent of the 1967 production of 703,000 tons was from solar evaporation of sea water.

Table 2 gives the location and approximate production statistics for the various salt works.

TABLE 2 AUSTRALIAN SALT WORKS

Company	Location	1967 Production (000's tons)	Use
Queensland			
Central Qld. Salt Ind.	Rockhampton	37	Food (Refined)
Victoria			
Cheetham Salt Ltd.	Geelong and Laverton	119	Food (Refined) & Chemicals
South Australia			
ICI Alkali (Aust) P.L.	Dry Creek	328	Alkalis
B.H.P. Co. Ltd.	Whyalla	44	Alkalis & other chemicals
Australian Salt Co. Ltd.	Lake Bumbunga		Food
	Lake Fowler		Food (Refined)
Ocean Salt (Extended) P.L.	Port Agusta	144	Food
Waratah Gypsum P.L.	Stenhouse Bay		Chemicals
Olsson Industries Ltd.	Peesy Swamps		Food
Western Australia			
Esperance Salt Co. Ltd.	Esperance		Food
W.A. Salt Co.	Widgiemooltha	31	Food
Shark Bay Salt. P.L.	Shark Bay		Chemicals (Exports)

In response to increased demand for salt on overseas markets several companies are establishing solar evaporation facilities on the Western Australian coast and hold contracts to supply large quantities of salt to the Japanese market.

Table 3 gives the name of companies establishing new works, location, the planned annual capacity and the year when production might start.

TABLE 3 NEW SALT PROJECTS

Company	Location	Planned annual production capacity ('000's tons)	Start of Production
I.C.I.A.N.Z.	Bajool	150-450	1968
Leslie Salt Co.	Port Hedland	475-1,000-2,000	1969
Dampier Salt Ltd.	Dampier	650-1,000	1970
Exmouth Salt P.L.	Exmouth Gulf	1,500	1970
Texada Mines (Aust.) Ltd.	Lake MacLeod	3,000	1969
Norseman Gold Mines N.L.	Lake Lefroy	150-500	1969

Overseas Trade - Exports

The principal overseas markets for Australian salt are Japan, New Zealand, Fiji, Papua-New Guinea and adjacent Pacific islands.

Depending on the establishment of new production centres in Western Australia for the export of salt, the volume of Australian trade in this commodity should increase sharply in the short term. Some observers now expect that the salt industry in Western Australia alone will be exporting about 5 million tons by 1978.

Details of exports of salt in recent years are shown in Table 4.

TABLE 4 EXPORTS OF SALT (tons)

	1965	1966	1967	1968
Table salt and preparations:				
Indonesia	59	2	100	-
New Zealand	-	33	1,667	193
Papua/New Guinea	84	97	206	192
Polynesia (French)	81	71	105	79
Others	41	163	337	69
Total	265	333	2,415	533
Value f.o.b. ($'000)	24	22	72	29
Salt, n.e.i.:				
Japan	97,057	72,904	75,637	210,746
New Zealand	11,015	12,784	5,888	6,416
Papua/New Guinea	450	440	512	634
Fiji	773	1,063	1,127	764
Others	3,918	5,831	2,398	5,761
Total	113,213	93,022	85,562	224,321
Value f.o.b. ($'000)	584	519	391	825
Grand Total	113,478	93,355	87,977	224,854
Total value f.o.b. ($'000)	608	541	463	492

Imports

Although domestic salt resources are more than adequate to meet local demand the limited refining capacity, the effect of seasonal conditions and possibly discriminatory "fashion buying" have resulted in continued imports of salt for certain uses.

Statistics supplied by the Commonwealth Bureau of Census and Statistics indicate that all States import salt to a varying degree; New South Wales and Victoria imports exceed those of any other State.

Imports of salt are shown in Table 5.

TABLE 5. IMPORTS OF SALT (tons)

	1965	1966	1967	1968
Table salt in packs -				
U.K.	46	9	2)	
Others	6	6	5)	7
Total	52	15	7	7
Value, f.o.b. ($'000)	13	19	4	3
Salt n.e.i. -				
U.K.	5,813	6,503	6,313	5,962
Others	899	364	7,370	1,941
Total	6,712	6,867	13,683	7,903
Value f.o.b. ($'000)	106	120	178	116
Grand Total	6,764	6,867	13,690	7,910
Total value, f.o.b.	119	130	182	119

No detailed statistical information is available concerning the consumption of salt by all industries in Australia, but it is reasonable to assume that it approximates closely to apparent consumption, which for recent years is shown in Table 1.

Consumption of salt by the chemical industry and by salt refineries as recorded by the Commonwealth Bureau of Census and Statistics is shown in Table 6.

TABLE 6 CONSUMPTION OF SALT (tons)

	1963/64	1964/65	1965/66	1966/67
Industrial chemicals	297,842	346,472	364,356	412,679
Salt refining	205,413	215,825	219,533	205,968

The predominance of the chemical industry in the use of salt in recent years is obvious from the table.

Consumption of salt by the soap and candle industries as recorded by the Commonwealth Bureau of Census and Statistics is shown in Table 7.

TABLE 7 CONSUMPTION OF SALT BY THE SOAP AND CANDLES INDUSTRIES (tons)

	1963/64	1964/65	1965/66	1966/67
Soap and candles	4,255	4,241	4,860	4,051

Other major usages for which statistics are not available are canning and preserving foodstuffs, butter, cheese and other dairy products, hides and leather treatment, livestock and general farm use.

Sodium hydroxide and chlorine

In the chemical industry salt is the basic raw material for the manufacture of three major chemicals; sodium carbonate (soda ash), sodium hydroxide (caustic soda) and chlorine.

One of the major requirements for the efficient production of soda ash in Australia is a large scale plant with bulk handling facilities. All local production is presently derived from one plant in South Australia (see Table 9) yet the market is claimed to be too small to permit full economies of scale to be achieved. It appears that this chemical could offer opportunities for the further processing of salt if larger scale plants were used. There are no new major uses in sight for soda ash; although it can be used in alumina production, as an alternative for caustic soda, the latter is now favoured.

Caustic soda can often be used as a substitute for soda ash and the tendency of overseas producers to dispose of surplus caustic soda at marginal prices (see "Chlorine and caustic soda in non-Communist worlds" pages 16 and 17) has depressed the demand for soda ash.

This study will consider the production of caustic soda and chlorine from salt.

The electrolytic process for the direct production of caustic soda and chlorine from common salt continues to gain in importance as a consumption outlet for salt. Caustic soda is produced in this process by the electrolysis of saturated salt solution. Approximately 1.75 tons of salt requires 3,000-4,000 kWh electricity (depending on the cells used) for a yield of 1.15 tons of caustic soda and 1.00 tons of chlorine.

Domestic production of caustic soda and chlorine in recent years is given in Table 8.

TABLE 8 PRODUCTION OF CAUSTIC SODA AND CHLORINE (tons)

	1964/65	1965/66	1966/67	1967/68
Caustic soda	68,800	75,220	91,009	98,190
Chlorine	47,988	53,002	67,587	75,763

There are eight plants making caustic soda in Australia. Seven electrolyse salt and produce chlorine as a co-product and hydrogen as a by-product. The eighth plant also makes caustic soda by reacting quicklime with soda ash. Some details of the plants are shown in Table 9.

TABLE 9 AUSTRALIAN CAUSTIC SODA AND CHLORINE PLANTS (1968)

Company	Location	Process	Caustic Soda Capacity (tons/yr)	Chlorine Capacity (tons/yr)
ICIANZ Ltd.	Osborne, S.A.	Soda ash and quicklime	16,000	-
	Osborne, S.A.	Electrolysis (mercury)		
ICIANZ Ltd.	Botany, N.S.W.	Electrolysis (mercury)	66,000	57,400
ICIANZ Ltd.	Yarraville, Vic	Electrolysis (mercury)		
Union Carbide Aust. Ltd.	Rhodes, N.S.W.	Electrolysis (diaphragm)	7,500	6,500
Dow Chemicals Ltd.	Altona, Vic.	Electrolysis (mercury)	6,900	6,000
Aust. Paper Manuf.	Maryville, Vic.	Electrolysis (mercury)		
Assoc. Pulp & Paper Mills Ltd.	Burnie, Tas.	Electrolysis (mercury)	11,600	10,100
Aust. Newspaper Mills	Boyer, Tas.	Electrolysis (mercury)		
		TOTAL:	108,000	80,000

Overseas Trade

Normally there is no overseas trade in chlorine due to the nature of the product which necessitates its being transported in the form of liquified gas in expensive containers.

Exports of caustic soda, mainly to New Zealand are shown in Table 10.

TABLE 10 EXPORTS OF CAUSTIC SODA

	1964/65		1965/66		1966/67		1967/68	
	Quantity (tons)	Value f.o.b. ($'000)	Quantity (tons)	Value f.o.b. ($'000)	Quantity (tons)	Value f.o.b. ($'000)	Quantity (tons)	Value f.o.b. ($'000)
Caustic Soda	1,737	146	2,005	154	2,259	175	2,839	151

To meet the continued growth of demand not fully satisfied by expansion of Australian production capacity, imports of caustic soda are increasing.

Imports, principally from the United States and Japan in recent years are shown in Table 11.

TABLE 11 IMPORTS OF CAUSTIC SODA

	1964/65		1965/66		1966/67		1967/68	
	Quantity (tons)	Value ($'000)	Quantity (tons)	Value ($'000)	Quantity (tons)	Value ($'000)	Quantity (tons)	Value ($'000)
Caustic soda	4,352	361	10,893	668	68,898	3,969	99,540	3,370

Consumption

The principal use of caustic soda in Australia is in the extraction of alumina. It is also used in the manufacture of soap, wood-pulp, rayon, for refining mineral and vegetable oil and in reclaiming waste rubber.

In the case of chlorine a significant part is used in the production of polyvinyl chloride. Other main uses include the manufacture of organic chlorine compounds, widely used as solvents in dry cleaning, for bleaching paper pulp and textiles, in sterilizing drinking water, for the production of synthetic hydrochloric acid and in metallurgical chlorination processes.

Although statistical data concerning consumption of caustic soda and chlorine are not complete, close estimates are available.

By using statistics of Australian production of caustic soda and chlorine and adding imports of these products less exports, apparent consumption can be estimated and is shown in Table 12.

TABLE 12. CONSUMPTION OF CAUSTIC SODA AND CHLORINE (tons)

	1964/65	1965/66	1966/67	1967/68
Caustic soda				
Production	68,880	75,230	90,986	98,190
Imports	4,352	10,893	63,848	99,540
Exports	1,737	2,005	2,259	2,839
Availability	71,495	84,118	152,575	194,891
Apparent Consumption -				
by alumina industry (a)	17,868	27,186	93,746(b)	128,877
by general industry	53,627	56,932	58,829	66,014
Chlorine				
Production	47,988	53,003	67,683	75,763
Availability	47,988	53,003	67,683	75,763

(a) Assuming caustic soda usage of 0.1 tons for every 1 ton of alumina estimated to have been produced in Australia.

(b) Estimated. Includes 30,000 tons inventory build-up in alumina industry.

It is estimated that approximately 40 per cent of chlorine production is used currently in the manufacture of polyvinyl chloride.

Regarding future demand it is estimated that caustic soda requirements of alumina producers will show a growth of more than 10 per cent per year while the non-alumina sector rather less than 10 per cent.

Total Australian demand of caustic soda by alumina producers estimated by I.C.I.A.N.Z. is expected to be 106,000 tons in 1969 and 132,000 tons in 1970.

Growth of the chlorine market has varied in recent years between 10 per cent and 30 per cent but it is expected to continue to grow over 1969-72 at an annual rate of 15 per cent.

Marketing and prices of chlorine and caustic soda

By arrangement I.C.I.A.N.Z. purchase for resale some quantities of caustic soda produced by Dow Chemicals Pty. Ltd. and also purchase surplus caustic soda for this purpose when it is available from Union Carbide Australia Ltd. Caustic soda is sold in three forms - as solid, flake or petal, and aquaeous solutions in varying concentrations. Full details of current Australian selling prices for caustic soda are given in Table 13.

TABLE 13 AUSTRALIAN SELLING PRICES OF CAUSTIC SODA (98% NaOH)

	$/Ton
Liquid - bulk	
1-5,000 tons/year or over	116.75-134.75
Solid - drums	
1-5,000 tons/year or over	119.00-133.00
Flake/Petal - drums	
1-600 tons/year or over	148.00-156.00

Details of current Australian list prices of chlorine are given in Table 14.

TABLE 14 AUSTRALIAN SELLING PRICES OF CHLORINE

		$/Ton
- Drums (a)	Adelaide	182.70-225.80
	Sydney	147.90-191.00
	Melbourne	155.90-199.00

(a) Metropolitan area delivered f.o.r./f.o.b. 1-1,000 tons or over.

- Cylinders

Vic. (ex Yarraville)	18c/lb. delivered Metropolitan Area f.o.r./f.o.b. Melbourne
N.S.W. (ex Botany)	18c/lb. delivered Metropolitan Area f.o.r./f.o.b. Sydney
Qld. (ex Botany)	19c/lb. ex store Brisbane
S.A. (ex Osborne)	19c/lb. delivered Metropolitan area f.o.r./f.o.b. Adelaide
W.A. (ex Osborne)	19c/lb. ex store Perth.
Tas. (ex Yarraville)	19c/lb. ex store Launceston and Hobart

Scope for additional processing of crude salt

Domestic processing of crude salt is currently confined to the chemical industry for the production of alkalis and to salt refining for human consumption (see Table 6).

Japan and New Zealand are the only net importers of salt in the south-east Asian region. The type of salt imported by these countries is not separately recorded in the "Statistical Summary of the Mineral Industry" compiled by the Institute of Geological Sciences, London, but it is understood that New Zealand imports consist of table salt (mainly from the United Kingdom) and that Japan imports crude salt.

It has already been noted that some observers expect that the salt industry in Western Australia will be exporting, by 1978, about 5 million tons of crude salt mainly to the Japanese chemical industry and chiefly as feed for chlorine/caustic plants.

The question may now be asked whether it would be feasible to replace all or part of our Australian salt exports by processed material and then benefit from the added value of the product. The question leads to an examination of power and general costs in the production of chlorine and caustic in Australia. Since power costs are critical, the Gladstone area in Queensland where there is a potential for cheap power is to be especially kept in mind in the exercise.

As Imperial Chemical Industries of Australia and New Zealand Ltd. is the only producer of chlorine and caustic soda for the market in Australia, their unit cost of production is taken as a basis. This is shown in Table 15.

TABLE 15. I.C.I.A.N.Z. - CHLORINE/CAUSTIC SODA COST OF PRODUCTION(a)

Factory cost	(mixed ton)
Direct material, local and imported	$ 74.51
Direct labour	$ 14.22
Factory expense, depreciation (b)	$ 18.40
Other, (variable & fixed) (c)	$ 56.86
Total cost chlorine/caustic	$163.99
Less net realisation caustic soda	$ 76.01
Net factory cost - liquid chlorine packed	$ 87.98
Add Administrative Expense (chlorine sales only) fixed (d)	$ 12.47
Selling and distribution expense (f) (chlorine sales only)insurance and transport cost	$ 1.56
Other (variable and fixed)	$ 23.18
Total cost to make and sell liquid chlorine, Packed	$125.19

(a) Volume of production, present level of output, 57,400 tons of chlorine.
(b) Include depreciation on plant 15 per cent on prime cost.
(c) Include factory expenses such as supervision, maintenance, process stores, services, etc.
(d) Include central I.C.I.A.N.Z. administration allocated in total.
(f) Include direct cost of marketing, central I.C.I.A.N.Z. services, interstate freights, local cartage, works general overheads and others.

The specific cost components in "direct material"(local and imported) are shown in Table 16.

TABLE 16 I.C.I.A.N.Z. - CHLORINE/CAUSTIC SODA COMPONENTS OF "DIRECT MATERIAL"

Description	Unit Usage	Cost per unit of output	Purchases Unit	Purchases Price
Salt	1.83	$22.99	Ton	$12.56
D.C. power	3,500 kWh	$37.09	kWh	$0.0106
Other such as graphite, mercury, barium chloride, soda ash, caustic soda, etc.	Variable	$14.43	Variable	Variable

Cost disabilities

When manufacturing chlorine and caustic soda in Australia the local producers are faced with a number of disabilities vis-a-vis their counterparts in many of the industrially advanced nations of the world.

These disabilities can briefly be categorised as:

(1) Raw materials
(2) Power costs
(3) Scale of operations

(1) Raw Materials

In Europe and North America, salt is mined at all the main centres of production whereas in Australia, the entire salt production is obtained from the solar evaporation of sea water, natural brines, etc. The laying out of extensive salt saltfields

is required for the efficient operation of the solar evaporation process and a large capital investment in the appropriate equipment must also be made to harvest the salt production. Although salt production is established in Queensland, Victoria and South Australia, there is little doubt that the main areas of production will be located in Western Australia, particularly in the north-west of the State.

The estimated cost of salt and freight is shown in Table 17.

TABLE 17 ESTIMATED COST OF SALT AND FREIGHT COMPONENTS OF SALT FROM WESTERN AUSTRALIAN PORTS INTO GLADSTONE

Cost of salt	$4.00 per ton
Freight W.A. port to Gladstone, say	$16.00 per ton
Stevedoring, port dues, insurance, stacking and miscellaneous	$3.50 per ton
Total	$23.50 per ton

(2) Power Costs

In the electrolysis of saturated salt solution approximately 3,500 kWh of electrical power are consumed per mixed ton of chlorine and caustic soda produced. At the present time, I.C.I.A.N.Z. is using power at their Botany plant obtained from the State Electricity Commission of N.S.W. at a cost of 1.06 cents/kWh. Cheap power is potentially available in the central Queensland coast area surrounding Gladstone where in the Moura coalfields open cast steaming coal overlies the coking coal that is at present being worked for export. If total demand for electricity at Gladstone were to rise to a level where the construction of a large modern power station of 800 megawatts would be justified, a lower power rate between 0.4 cents and 0.7 cents has been quoted as a possible rate that could be available.

(3) Scope of Operations

A plant with a chlorine production capacity of 100,000 tons per year is commonplace in the United States and fixed costs savings resulting from this scale of operation compared to a plant the size of Botany operations (that is around 50,000 tons per year) are estimated at approximately $10.00 per mixed ton of chlorine and caustic soda.

Taking into account the important factors of cost of salt, transport, and power in conjunction with the assumed scale of operations at Gladstone versus unit costs in the I.C.I.A.N.Z. plant at Botany, theoretical cost savings at Gladstone are shown as positives in Table 18.

TABLE 18 COST ANALYSIS, GLADSTONE VERSUS I.C.I.A.N.Z. PLANT

	Gladstone	I.C.I.A.N.Z. Plant
	$ mixed ton of chlorine/caustic	$ mixed ton of chlorine/caustic
Lower cost of power		
0.4c/96 (a)	+22.5	
0.7 c/96 (a)		+11.6
Delivered cost of salt	-20.0	-20.0
Approximate savings in fixed costs resulting from the scale of operations	+10.0	+10.0
	+12.5	+ 1.6

(a) Cents per unit of power and allowing for conversion losses of 4% for A.C. to D.C.

However, before too much importance is attached to cost savings that might be made, these economies need to be examined against the prices of caustic soda in overseas countries.

Details of U.S.A., U.K. and Dutch solid caustic, liquid caustic and flake caustic prices are given in Table 19.

TABLE 19 CAUSTIC SODA PRICES IN SELECTED COUNTRIES ($ PER TON)

	U.S.A. (1)	U.K. (2)	HOLLAND (3)
Solid caustic soda f.o.b.	104.17	77.10	72.39
Liquid caustic soda f.o.b. (as 100%)	55.85	52.0	52.20
Flake caustic f.o.b.	112.26	79.66	80.24

(1) Oil Paint and Drug Reporter - 15th April, 1968.
(2) I.C.I. Mond Division U.K. price (50 ton lots, one year contract)
(3) Lowest price quoted to I.C.I. Rosenberg.

CONFIDENTIAL

Although the present analysis of possible costs at Gladstone suggest that the total cost of chlorine/caustic per mixed ton could be as low as $151.5 compared with I.C.I.A.N.Z. figure of $163.99 (see Table 15) it still does not seem low enough to be competitive on the world caustic market even if all co-product chlorine could be sold locally.

An alternative of local supply of salt foam brines near Gladstone should also be considered. Assuming salt cost of $6 at the works and power cost of 0.4 cents per kWh, the cost of mixed ton of caustic/chlorine might be reduced to $120 which shows more promise.

The development of an alumina industry in Australia in recent years has opened up new horizons for the further processing in Australia of salt. Approximately 7.5 tons of caustic soda is required for the production of 100 tons of alumina. I.C.I.A.N.Z. estimates that by 1970 the estimated production of alumina will be around 1.76 million tons which will need a total of 132,000 tons of caustic soda of which an estimated 19,000 tons will be available from local sources.

There seems to be an opening for domestic produced caustic soda if the co-product chlorine could be sold in Australia. One alternative in this regard could be if Botany chlorine requirements were to be serviced from Gladstone. Apart from practical problems (e.g. suitable sites for unloading, storages, etc.) the economics of the project are such that no cost savings could be achieved.

A further alternative that has been examined by I.C.I.A.N.Z. is the possibility of producing certain chlorine derivative products at Gladstone. The manufacture of ethylene dichloride would be a likely product in view of the growing modern market for development of PVC manufactures. Ethylene must either be manufactured or brought into Gladstone. The transport of ethylene requires a specialised tanker and again because of storage problems, only small vessels can be used. It is unlikely that the cost of final product could be competitive.

Production of titanium tetrachloride is another possible area of production that has been examined by I.C.I.A.N.Z. Titanium tetrachloride is manufactured by the action of chlorine on rutile in the presence of coke and apparently the reaction is carried out nowadays in a fluidized bed. As titanium tetrachloride is a liquid which reacts extremely rapidly with moisture, it must therefore be transported in sealed tanks and a special tanker would be required. The titanium oxide process only requires make-up chlorine equivalent to about 10 per cent of the $TiCl_4$ handled, and would therefore have to be produced for sale overseas in order to be a substantial consumer of chlorine. Under such circumstances, a buyer would be dependent for this essential raw material upon a distant source of supply along with a difficult transport and storage problem.

Chlorine and caustic soda demand in non-Communist world.

Besides higher Australian prices for caustic soda there are other important considerations.

Due to the increased chlorine demand in Western Europe, U.S.A., and Japan, a large surplus of caustic soda has developed in these countries, and thus large users are placed in an exceptionally favourable position to secure low prices for caustic. In meeting the demand for chlorine, manufacturers are producing caustic soda in quantities which are considerably in excess of domestic requirements. Moreover, because of the power and salt cost involved, and the scale of manufacture, these low realisations for caustic are not so significant a factor in the economics of overseas chlorine manufacture as they are in Australia. Countries such as Brazil, whose chlorine industry is of a similar scale to that of Australia, have a complete embargo on imports of caustic soda.

The extent of excess production in caustic soda is shown in Table 20.

TABLE 20 NON-COMMUNIST WORLD CAUSTIC SODA PRODUCTION, CONSUMPTION AND SURPLUS ('000 tons per year)

	1965			1970		
	U.S.A.	West Europe	Japan	U.S.A.	West Europe	Japan
Electrolytic caustic soda production	6,900	3,648	1,245	9,410	5,020	1,800
Domestic demand	5,490	3,538	1,251	7,350	4,470	1,600
Surplus	1,410	110	- 6	2,060	550	200
Total surplus		1,514			2,810	

The cost of chlorine in Australia is over twice that prevailing in major chlorine producing countries overseas, but because of the nature of the product, which necessitates its being transported in the form of liquified gas in expensive containers, it is more expensive to import chlorine than to produce it domestically. It is I.C.I.A.N.Z. experience in exporting chlorine from Australia that because of the hazardous nature of the cargo, supplies can be interrupted because the carriage of these cargoes is subject to availability of deck space.

As a matter of interest I.C.I.A.N.Z. has recently investigated chlorine/caustic production at Gladstone, following discussions with the Queensland Department of Industrial Development and Japanese interests. The price offered by the Japanese was about $45 per ton c.i.f. Japan and their estimated freight in specially constructed vessels in continuous operation was $35 per ton. This would give an ex-factory selling price of chlorine of $10 per ton and clearly such a realisation would make the venture uneconomic.

CONCLUSIONS

World surplus of caustic soda affects the cost of chlorine and our present high cost of production combined with high transport costs suggest poor export prospects for Australian caustic soda and chlorine; under present conditions we can continue to produce part of domestic demand for caustic (under tariff protection) and chlorine but can export raw salt only.

In the rough analysis of cost, the cost of power and of transport of salt from source of supply to processing plant seem critical; it would appear that both, not one, need to be significantly reduced to provide any real hope - indicating a target of power costs of about 4 cents per kWh at a source of supply of salt.

The prospects for power costs as low as these are presently better in Eastern Australia, whereas the main supplies of salt are situated in Western Australia.

This preliminary analysis therefore emphasises examination in the short term of the possibilities of salt processing at Gladstone based on local brines rather than on distant salt supplies; such a project might provide significantly cheaper caustic/chlorine for domestic use apart from export possibilities.

In a somewhat longer term, the potential for low cost power near major sources of salt in W.A. should be kept under examination.

The manufacture of chlorine/caustic soda has essentially the same difficulties in Australia as certain other joint products such as rutile/zircon or lead/zinc in that the viability of production depends on the possibility to sell both products.