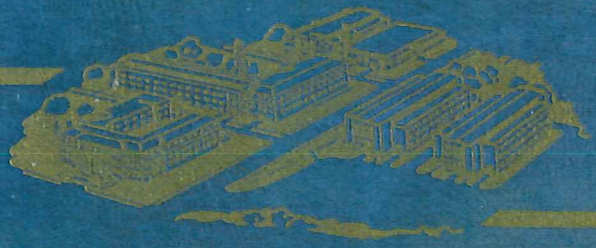
PROGRESS REPORT

A STUDY ON INTERNATIONAL MARKETS
FOR CHLORINE AND CAUSTIC SODA

to

THE STATE ELECTRICAL AUTHORITY
REYKJAVIK, ICELAND

May 15, 1956



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by

D. A. Riley, R. W. Hale, and D. D. Moore

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May 25, 1956

Dr. Jacob Gislason
Director General
The State Electrical Authority
118 Laugaveg
Reykjavik
Iceland

Dear Dr. Gislason:

We are forwarding six copies of the first of two scheduled reports relating to markets for chlorine and caustic soda in Eastern United States, Eastern Canada, and Western Europe.

This first report concerns mainly the United States, for which certain of the data for the year 1955 have recently become available. We also have developed a considerable amount of information on the other countries, except that 1955 quantitative data are still incomplete or lacking. We shall gather this information as it becomes available. These other countries will then be the principal subject of the second report.

In studying the markets in North America and Western Europe, we find that we are simultaneously encountering market information pertaining to the remaining countries of the world as well. The world's principal importing areas for sea-borne caustic soda and chlorine are Latin America, the Mediterranean-African region, the Middle East, and the Far East. These regions might thus appear to be of particular interest to you, and in our second report we therefore propose to include also such data on them as is concurrently obtained during our investigations of Western Europe, Canada, and the United States.

In this first report, more basic information on production is given than will be carried in the later report. Future work will place more emphasis on marketing factors and market shifts. Certain comment on the United States markets and market outlook is being held in abeyance until the second report, pending completion of some studies now in progress by the Chemical Market Research Association.

We would welcome any comments or suggestions that you may have regarding this report.

Sincerely,

David D. Moore

David D. Moore
Chief
Industrial Economics Division

DDM:jpl
Enc. (6)

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INTRODUCTION

Iceland is considering the manufacture of chlorine and caustic soda by electrolysis of brine obtained from steam evaporation of sea water. The products would be marketed mainly in other countries, and the purpose of this project is to review possible markets.

The United States is the world's largest producer of chlorine and caustic soda, and also a leading exporter. However, Western Europe exports larger quantities, mainly from Great Britain, Western Germany, France, and Italy. Most commerce in caustic soda and chlorine is to destination points outside Europe and North America.

This report deals with production and markets for the United States only; other countries and market trends will be the principal subject of a second report.

UNITED STATES CHLORINE AND CAUSTIC SODA MARKETS AND TRADE

Summary and Conclusions

United States imports of chlorine are mostly from Canada, and in 1955 jumped to over 10, 000 tons*, a higher figure than usual; but annual exports are much greater. Less than 450 tons of caustic soda are imported annually, mostly from Sweden, while quantities on the order of 225, 000 tons are exported. United States consumption of chlorine and caustic soda is rising steadily, but production capacity is keeping pace and planned increases will be ample for the expected demand in the years immediately ahead. Chlorine capacity will probably continue to be slightly in excess of domestic need, while caustic soda capacity will continue to be in greater excess, the surplus production being for export. An analysis of the destinations of United States exports sheds considerable light on the international market areas and prices.

The United States has no over-all lack of electric power or salt, although available electric power is in short supply in the northeastern chlorine-caustic-producing center at Niagara Falls.

The largest volume marketing opportunities for chlorine and caustic soda lie in certain countries other than the United States – in Central and South America, in those countries on the continents of Europe and Africa bordering the Mediterranean Sea, and the Far East. Some European countries are importers, largely by rail, but partly by sea.

The potentially favorable area for sale by Iceland to the United States would be the industrial centers along the United States Atlantic seaboard, including Boston, Providence, Philadelphia, Wilmington, Baltimore, and most notably the New York City vicinity. It is estimated that at least 430, 000 tons per year of caustic soda move to United States East Coast markets by water transport from sections of the country bordering the Gulf of Mexcio in the South and the Great Lakes in the North. However, the United States imported only 438 tons of caustic soda in 1955.

For chlorine, the Great Lakes region of the United States (eventually to be accessible by way of the St. Lawrence Seaway) may also offer a limited market, inasmuch as Canadian provinces along this route sell chlorine to the United States in quantities varying from about 2500 tons (1954) to 10, 000 tons (1955).

*In the United States and Canada quantities are normally reported in short tons of 2000 pounds, as distinguished from practice in Great Britain where the long ton of 2240 pounds is employed, and in Iceland and continental Europe where the metric ton is in use. One short ton equals 0. 9072 metric tons.

In some cases, it might be feasible for Iceland to supply needed caustic and chlorine to consumers more or less directly in exchange for such types of caustic or chlorine consuming manufacturers' products as Iceland may wish to obtain.

Production and Capacity

United States production of chlorine has risen from 2.08 million short tons in 1950 to 3.41 million short tons in 1955. During the same period total production capacity has grown from 2.15 to 3.96 million short tons per year as of January 1, 1956, according to the most recent estimate of the United States Department of Commerce. In 1955, the 3.41 million tons were produced as follows:

3.14 millions tons by electrolytic coproduction of caustic soda and chlorine

0.05 million tons by electrolytic coproduction of caustic potash and chlorine

0.14 million tons from electrolytic production of metallic sodium

0.05 million tons from hydrochloric acid or metal chlorides other than sodium or potassium

0.03 million tons from the reaction of nitric acid with salt.

Primary production of liquid caustic soda rose from 2.5 million short tons in 1950 to 3.9 million short tons in 1955. In the latter year, 0.5 million pounds were dried for sale or use in solid form, the remaining consumption being as water solution. Because demand for chlorine has grown at a more rapid rate than for caustic soda, almost all caustic soda units installed in the last two decades have employed electrolytic processes, rather than the older lime-soda process, which yields no chlorine. The percentage of caustic soda produced electrolytically has thus gradually risen, reaching about 88 per cent of the total in 1955.

Total United States producing capacity for caustic soda as of January 1, 1956, has been estimated at about 4.57 million short tons per year. As of February, 1956, over-all chlorine production was reportedly operating at 96 per cent of capacity and caustic soda at 93 per cent.

New plant construction costs have been rising and are now being estimated at about $120,000 for each daily ton capacity of salt-electrolytic chlorine. With each ton of chlorine, 1.125 tons of caustic soda, computed as 100 per cent NaOH, are produced.

Selling Prices

United States' selling prices of chlorine and caustic soda, along with other chemical prices and manufacturing costs, rose at intervals during the period 1950 to 1954. Prices for these two chemicals were steady through 1954, until the most recent increases, which occurred in late 1955. Table 1 gives spot price quotations for the period 1954 to date. Long-term, large-volume contracts will frequently be at prices perhaps 5 to 10 per cent lower than those shown.

TABLE 1. MANUFACTURERS' QUOTED SELLING PRICES FOR CAUSTIC SODA AND LIQUID CHLORINE IN THE UNITED STATES, 1954 TO 1956

	Year 1954 and January to October, 1955	October, 1955, to May, 1956
Liquid Chlorine		
In cylinders, carload lots, at works, per pound	$0.09-1/2	$0.10-1/4
In single-compartment tank cars, at works, per 100 pounds	2.93	3.05
In multiple-compartment tank cars, 5 cars or more, at works, per 100 pounds	3.80	3.92
Caustic Soda		
Liquid, 50%, in seller's tank cars, at works, dry basis, per 100 pounds	2.70	2.80
Liquid, 70%, in seller's tank cars, at works, per 100 pounds	2.80	2.90
Solid, in drums, carload lots, per 100 lbs	4.25	4.50

Source: Oil, Paint and Drug Reporter.

Consumption

A quantitative summary of United States supply and disposition of chlorine and caustic soda for 1954 and 1955 is shown in Table 2.

TABLE 2. UNITED STATES SUPPLY AND DISPOSITION OF CHLORINE AND CAUSTIC SODA, 1954 AND 1955

Short Tons of 100% Cl_2 or NaOH

	1954	1955
Chlorine		
Production	2,895,100	3,407,935
Imports	2,599	10,319
Exports[a]	35,000	40,417
Caustic Soda		
Production	3,393,879	3,904,438
Imports	294	438
Exports	235,304	225,186

Source: Chemical and Rubber Division, Business and Defense Services Administration, United States Department of Commerce

(a) Chlorine gas only. Liquefied chlorine not reported separately from other liquefied gases exported.

The present United States use pattern for chlorine is estimated as follows:

Use	Per Cent of Total
Chlorinated solvents, including perchlorethylene, trichlorethylene, and carbon tetrachloride	17
Ethylene oxide (largely for detergents) and propylene and ethylene glycols (largely for antifreeze)	11
Pulp and paper	14
Insecticides and herbicides, including DDT, and benzene hexachloride	9
Plastics and resins, including vinyl chloride and vinylidene chloride	9

Use (Continued)	Per Cent of Total (Continued)
Refrigerants and propellants, including Freon and methyl chloride	8
Tretraethyllead automotive antiknock fluid	4
Water and sewage treatment	3
Synthetic glycerol	3
Miscellaneous	22
Total	100

It is estimated that 1956 consumption of caustic soda, in terms of 100 per cent NaOH content, should be about as follows:

Use	Per Cent of Total
Chemical processing	31
Rayon	13
Petroleum refining	8-1/2
Pulp and paper	7-1/2
Export	6
Cleaners (modified sodas, lye, and other alkalis)	6
Textile processing	5-1/2
Soaps	5
Cellophane	5
Metal processing (chiefly aluminum)	2-1/2
Vegetable oil refining	1-1/2
Reclaimed rubber	1-1/2
Miscellaneous	7
Total	100

Imports

Tables 3 and 4 show the quantity and value of United States imports of chlorine and caustic soda by country of origin for 1953, 1954 and 1955. The United States imported only $131,305 worth of caustic soda in 1955, mostly from Sweden. Imports of chlorine, which have been almost wholly from Canada, increased fourfold in 1955, reaching $675,031. However, this 1955 increase may have been in some measure due to labor strikes which temporarily stopped output at two chlorine-caustic plants in Ohio and Michigan during the year.

TABLE 3. QUANTITY AND VALUE OF UNITED STATES IMPORTS OF CHLORINE, BY COUNTRY OF ORIGIN, 1954[a] AND 1955[a]

1954			1955		
Country of Origin	Pounds	U.S. Dollars	Country of Origin	Pounds	U.S. Dollars
Canada	5,074,800	172,025	Canada	20,571,921	671,267
West Germany	121,332	6,995	Other than Canada	66,138	3,764
Switzerland	908	1,440			
Total	5,197,040	180,420	Total	20,638,059	675,031

Source: United States Department of Commerce

(a) Preliminary figures. Data prior to 1954 not available.

Import Tariffs

Our interpretations of the current United States tariff regulations are that chlorine imported into the United States from Iceland would be subject to a duty of 12-1/2 per cent ad valorem, and caustic soda to a duty of one-fourth of a cent per pound. These interpretations would require verification by United States customs authorities.

Exports

Preliminary figures on the quantity and value of United States exports by country of destination are available for 1954 for chlorine gas and for all types of caustic soda. These figures are given in Tables 5 and 6, respectively. Exports of liquid chlorine are not reported separately from other liquefied gases, and hence are not available, but it seems probable that exports of liquefied chlorine exceeded those of chlorine gas. Within the country, some 85 per cent of shipment tonnage is in the liquid form.

TABLE 4. QUANTITY AND VALUE OF UNITED STATES IMPORTS OF CAUSTIC SODA, BY COUNTRY OF ORIGIN, 1953 THROUGH 1955

1953			1954(a)			1955(a)		
Country of Origin	Pounds	U.S. Dollars	Country of Origin	Pounds	U.S. Dollars	Country of Origin	Pounds	U.S. Dollars
Sweden	623,120	93,193	Sweden	563,904	83,430	Sweden	627,472	94,414
Canada	12,639	683	Canada	24,000	1,112	Not determined(b)	249,288	36,891
Total	635,759	93,876	Total	587,904	84,542	Total	876,760	131,305

Source: United States Department of Commerce

(a) Preliminary figures.
(b) May also include Sweden.

TABLE 5. QUANTITY AND VALUE[a] OF UNITED STATES EXPORTS OF CHLORINE GAS,[b] BY COUNTRY OF DESTINATION, 1954[c]

Country of Destination	Pounds	U.S. Dollars
Canada	65,525,240	1,793,729
Venezuela	1,824,417	121,650
Mexico	1,754,906	86,743
Columbia	156,150	15,535
Netherlands Antilles	149,861	11,883
Panama Canal Zone	134,798	16,646
Dominican Republic	101,850	13,202
Costa Rica	88,950	13,302
Honduras	82,310	20,003
Phillipine Rep.	60,000	2,760
Panama	36,500	3,106
Brazil	33,000	3,340
Ecuador	15,000	2,985
Saudi Arabia	12,450	2,227
Belgium	8,300	3,119
Bahamas	8,100	1,210
Haiti	4,500	1,189
Cuba	1,800	985
Total	70,002,632	2,114,163

Source: United States Department of Commerce

(a) The value is reported as of time and place of export from the United States. Thus for overseas shipments the value reported includes freight charges from the producing plant to the port of export, but does not include ocean freight charges or foreign import duties.
(b) Data on liquid chlorine exports are not available separately from other liquefied gases.
(c) Preliminary figures. Data prior to 1954 not available.

TABLE 6. QUANTITY AND VALUE[a] OF UNITED STATES EXPORTS OF CAUSTIC SODA, BY COUNTRY OF DESTINATION, 1954[b]

Country of Destination	In Packages of 50 Pounds or More				In Packages Under 50 Pounds		Total	
	Solid Caustic Soda		Liquid Caustic Soda					
	Pounds	U. S. Dollars	Pounds	U. S. Dollars	Pounds	U. S. Dollars	Pounds	U. S. Dollars
Canada	12,629,000	485,393	119,655,394	3,032,106	1,550,936	31,933	133,835,330	3,549,432
Mexico	37,043,051	1,358,879	8,804,941	252,117	263,078	28,936	46,111,070	1,639,992
Central America								
Nicaragua	539,700	18,921	--	--	2,400	119	542,100	19,040
Honduras	500,750	18,830	--	--	31,200	4,080	531,950	22,910
El Salvador	505,675	27,171	--	--	--	--	505,675	27,171
Guatemala	333,250	12,929	--	--	35,000	1,138	368,250	14,067
Panama	271,600	11,756	--	--	87,750	11,480	359,350	23,236
Costa Rica	20,000	1,565	--	--	39,000	5,120	59,000	6,685
British Honduras	--	--	24,500	1,176	--	--	24,500	1,176
Canal Zone	8,000	436	--	--	8,740	1,225	16,740	1,661
South America								
Brazil	146,655,218	4,973,850	--	--	14,985,612	2,053,612	161,640,711	7,027,462
Argentina	41,153,250	1,608,579	--	--	--	--	41,153,250	1,608,579
Columbia	9,989,450	325,877	--	--	111,600	14,299	10,101,050	340,176
Venezuela	2,947,550	129,946	1,936,240	48,890	240,425	17,201	5,124,215	196,037
Peru	3,001,000	96,430	--	--	44,000	1,500	3,045,000	97,930
Ecuador	1,244,400	43,630	--	--	168,700	19,901	1,413,100	63,531
Chile	1,263,540	44,415	--	--	--	--	1,263,540	44,415
Uruguay	1,037,600	35,527	--	--	--	--	1,037,600	35,527
Bolivia	861,800	35,539	--	--	--	--	861,800	35,539
Paraguay	67,600	2,732	--	--	--	--	67,600	2,732
Surinam	32,000	1,568	--	--	--	--	32,000	1,568
Caribbean								
Cuba	6,111,525	216,228	31,728,144	826,600	267,016	29,366	38,106,685	1,072,194
Netherlands Antilles	--	--	7,000,000	176,750	--	--	7,000,000	176,750
Dominican Rep.	358,400	11,376	--	--	3,165	3,540	361,565	14,916
Trinidad	140,000	7,000	--	--	--	--	140,000	7,000

TABLE 6. (Continued)

Country of Destination	In Packages of 50 Pounds or More				In Packages Under 50 Pounds		Total	
	Solid Caustic Soda		Liquid Caustic Soda					
	Pounds	U. S. Dollars	Pounds	U. S. Dollars	Pounds	U. S. Dollars	Pounds	U. S. Dollars
Caribbean (Continued)								
Bahamas	31,600	2,140	--	--	--	--	31,600	2,140
Barbados	20,000	930	--	--	--	--	20,000	930
Jamaica	10,500	772	--	--	--	--	10,500	772
Iceland	102,000	3,807	--	--	25,350	3,473	127,807	7,280
Europe								
Finland	7,052,500	221,426	--	--	--	--	7,052,500	221,426
Irish Free State	70,000	2,170	--	--	--	--	70,000	2,170
Portugal	14,000	532	--	--	--	--	14,000	532
Africa								
Egypt	3,767,600	108,136	--	--	--	--	3,767,600	108,136
Union of South Africa	1,085,600	46,909	--	--	--	--	1,085,600	46,909
Liberia	3,900	510	--	--	123,750	17,220	127,650	17,730
Belgian Congo	--	--	--	--	5,000	4,875	5,000	4,875
Angola	--	--	--	--	1,500	1,008	1,500	1,008
Middle East								
Iran	837,900	33,427	--	--	--	--	837,900	33,427
Iraq	448,000	13,440	--	--	--	--	448,000	13,440
Lebanon	110,600	4,150	--	--	--	--	110,600	4,150
Israel	70,000	4,021	--	--	--	--	70,000	4,021
Kuwait	62,500	4,167	--	--	--	--	62,500	4,167
Saudi Arabia	40,000	1,916	--	--	--	--	40,000	1,916
Far East								
Indonesia	19,420,441	595,209	--	--	2,505	1,002	19,422,946	596,211
Korean Rep.	2,630,900	94,560	207,200	8,288	--	--	2,838,100	102,848

TABLE 6. (Continued)

Country of Destination	In Packages of 50 Pounds or More				In Packages Under 50 Pounds		Total	
	Solid Caustic Soda		Liquid Caustic Soda					
	Pounds	U. S. Dollars	Pounds	U. S. Dollars	Pounds	U. S. Dollars	Pounds	U. S. Dollars
Far East (Continued)								
Phillipine Rep.	2,035,900	69,941	--	--	87,218	11,986	2,123,118	81,927
Thailand	530,000	22,653	--	--	20,800	2,457	550,800	25,110
Japan	114,300	7,500	--	--	--	--	114,300	7,500
British Malaya	40,000	1,916	--	--	--	--	40,000	1,916
Taiwan	20,000	870	--	--	--	--	20,000	870
Other	18,000	1,027	--	--	--	--	18,000	1,027
Totals	301,250,781	10,710,251	169,356,419	4,345,927	18,104,626	2,265,471	448,711,826	17,321,649

Source: Computed from preliminary figures of the United States Department of Commerce.

(a) The value is reported as of the time and place of export from the United States. Thus for overseas shipments, the value reported includes freight charges from the producing plant to the port of export, but does not include ocean freight charges or foreign import duties.

(b) Preliminary figures.

The United States export figures by country are revealing as to the location of international markets, form of shipment, and selling prices. The destination countries shown are the main importing countries other than the British Commonwealth nations. The latter import largely from, and frequently have differential import tariffs favoring, the United Kingdom.

In general, Western Europe is an important additional source of chlorine and caustic soda for countries that also obtain part of their requirements from the United States.

The bulk of United States chlorine-caustic soda exports to countries other than Canada is produced in Texas, Louisiana, and Alabama.

Regional Factors and Captive Consumption

It would be expected that shipments from Iceland would enter the United States at ports on the Atlantic Ocean or the Gulf of Mexico. Also by 1959, with the anticipated progress of construction along the St. Lawrence Seaway, all ports on Lake Ontario and Lake Erie (i.e., as far west as Detroit) should be open to ocean-going shipping during the ice-free months. A great part of United States markets for chlorine and caustic lie at or near these Atlantic, Great Lakes, or Gulf ports, but most domestic production is also in these areas. The United States chemical industry, now located preponderantly in the East, is gradually expanding southward and westward. The Niagara Falls, New York area, long a major producing point for chlorine and caustic soda, has fallen behind in recent years because of the shortage of, and rising rates for, electric power in the region, and because of the shifting markets. Major producing gains have taken place in the Texas-Louisiana area and in Virginia and West Virginia.

Latest available Bureau of the Census figures on regional production are for the year 1953 and are listed in Table 7.

Chlorine

About 70 per cent of all chlorine produced in this country is for captive use, i.e., is consumed by the manufacturing company and not sold as such. For example, Dow Chemical, by far the largest producer, reserves the great bulk of its output for its own use in manufacturing magnesium, vinyl chloride, chlorinated solvents, ethylene oxide and glycol, and other products.

Columbia-Southern Chemical Corporation, second in production, is the leading seller, much of its merchant chlorine moving by barge. Kaiser Aluminum and Chemical Company will consume its own caustic production

TABLE 7. UNITED STATES PRODUCTION OF CHLORINE AND CAUSTIC SODA BY REGION, 1953

Short Tons of 100% Cl_2 or NaOH

Region	Chlorine Production	Caustic Soda Production
New England, Total	32,332	35,864
Middle Atlantic, Total	347,107	372,379
New York	334,816	(a)
Other	12,291	(a)
North Central, Total	584,219	782,861
Ohio	153,110	--
All Other Than Ohio	431,109	--
Michigan	--	483,115
All Other Than Michigan	--	299,746
South Atlantic, Total	425,654	548,911
Virginia	118,898	(a)
Other	306,756	(a)
South Central, Total	1,137,956	1,223,964
Texas	779,572	--
All Other Than Texas	358,384	--
Louisiana	--	289,328
All Other Than Louisiana	--	934,636
Mountain and Pacific, Total	270,011	298,505
United States Total	2,797,279	3,262,484

Source: United States Census Bureau

(a) Not available.

in processing bauxite to alumina, but has announced that it will offer the chlorine for sale. The chlorine output of Frontier Chemical Company's plants is also largely for the open market.

Diamond Alkali Company uses its chlorine production at Pasadena, Texas, in the manufacture of vinyl chloride and other organics. This plant also furnishes chlorine by pipeline to adjacent operations of the Shell Chemical Company for the manufacture of tetraethyllead, synthetic glycerol, and chlorinated insecticides. Solvay's chlorine is essentially captive since it goes mainly to other manufacturing divisions of the parent company, Allied Chemical and Dye. An exception is Solvay's new Brunswick, Georgia, facility which sells to the pulp, paper, and textile industries in that area. Monsanto, Hooker Electrochemical, Du Pont, Pennsylvania Salt, Olin Mathieson, Stauffer Chemical, and Niagara Alkali all use their own chlorine in the manufacture of such products as glycols, solvents, insecticides, and other chlorine-containing organics.

Westvaco's plant in West Virginia supplies chlorine by pipeline to the nearby Carbide and Carbon Chemicals Company under a long-term contract.

The paper and pulp industry in the United States, an important purchaser of both chlorine and caustic, now manufactures about one-third of its own chlorine requirements. The chlorine-caustic production of Maine and New Hampshire is for captive consumption in this industry, as is the Weyerhaeuser Timber Company's production in Washington State, the Kimberly Clark Company's in Wisconsin, and the output of the various plants of West Virginia Pulp and Paper Company, of Champion Paper and Fibre Company, and of several other very small plants. The Chlorox and Zonite Companies use their chlorine production for the manufacture of bleaches and disinfectants, while the Ethyl Corporation uses its chlorine for the manufacture of tetraethyllead and chlorinated insecticides. The entire chlorine output of General Aniline & Film's new Linden, New Jersey, facility will be consumed by the company in varied chemical manufacture.

Caustic Soda

By contrast, only about 20 per cent of caustic soda production is for captive consumption. In the important Gulf Coast producing region, from Texas to Alabama, only about 15 per cent of the caustic soda generated is consumed. The surplus is shipped by low cost barge or other coastal shipping up the Mississippi River, to the country's eastern coast, or is exported. Judging from trade estimates, caustic soda figures for this gulf region are of the following order of magnitude:

	Annual Tons
Consumed in the area	190, 000
Barged up the Mississippi River-Ohio River Illinois Waterway Network	550, 000
Shipped via Intercoastal Waterway to U. S. Atlantic Coast	390, 000
Exported via rail to Mexico and via sea to other foreign countries	170, 000
Total produced in the area	1, 300, 000

Because transportation by water is much cheaper than by rail, producers in this area are able to compete along the east coast against nearer inland producers.

On inland waterways, caustic soda is moved by barge to the important Chicago area market not only from the Gulf Coast, but also from such Great Lakes producing points as Niagara Falls, New York, and Wyandotte and Montague, Michigan, as well as from the Mississippi River site at Calvert City, Kentucky.

An estimated 40, 000 to 50, 000 tons per year of caustic soda move from Great Lakes points via the New York State barge canal system to the concentrated market in the New York City-North New Jersey coast area.

Outlook

The United States 1955 production for both chlorine and caustic soda was at a record high, and the prospect is for continued increases in coming years.

The growing demand for chlorine and the consequent increase in electrolytic capacity in recent years has led to the expectation that the resulting United States total (electrolytic and lime-soda-process) caustic soda output would be excessive by early 1955. This expectation did not materialize, however, mainly for the following reasons:

(1) Exports in 1954 and 1955 have increased materially over the 132, 000 tons exported in 1953.

(2) The viscose rayon industry, largest single user of caustic soda, is showing steady growth in the production of rayon

staple, high tenacity tire cord, and cellophane. (Manufacture of one pound of rayon consumes 1.5 pounds of caustic soda).

(3) More caustic soda is being used in lieu of soda ash in the aluminum industry. As an aluminum source, natural cryolite is being challenged by synthetic cryolite, each ton of which consumes three-fourths of a ton of caustic soda.

(4) Decreasing amounts of soda ash are being converted to caustic soda.

(5) At Freeport, Texas, Dow Chemical Company has been converting some electrolytic caustic soda into soda ash.

The lime-soda process provides a degree of flexibility in the United States chlorine-caustic balance. At least one former lime-soda-process manufacturer, Diamond Alkali Company, has abandoned production of caustic soda from soda ash, and other producers have gradually reduced such production in favor of electroylsis.

The over-all demand for chlorine continues to grow, spurred by the steady expansion of all of its consuming industries (page 5), although recent growth in phenol and glycol production has favored processes not using chlorine. Among the most recent favorable developments are the promising outlook for foam plastics, which consume chlorine, and the likelihood that important markets will materialize for titanium metal, refined via titanium tetrachloride.

Further comment on the chlorine-caustic outlook in the United States is being withheld, pending completion of some studies now in progress by the Chemical Market Research Association.

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