Changes Within the Chloralkali Industry and their Impact on Salt Demand

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The chlorine industry is facing many changes concerning legislation on production and consumption. Alternatives to the chlorine route in the preparation of many intermediates is now in commercial processes. Several derivatives can be made using hydrogen chloride as feedstock. These changes have some impact on the quality, quantity and location of future salt demand.

INTRODUCTION

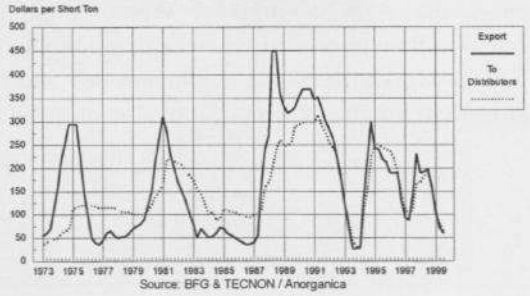
Salt is an important part of the chlorine industry but not as important as power costs in establishing the costs of generation of an electrochemical unit (ECU). Power is by far the most important cost element in chlorine production. Depending on technology the power consumption for the production of a ton of caustic soda can vary from 2,500 kWh to 3,500 kWh. With power at DM0.06 in parts of Europe this means a power cost of DM180 on average per ton of caustic soda produced. With vacuum salt in Europe at the DM50 per ton level the salt cost is around DM80. This therefore puts salt in perspective, that is, it is important but not as important as the power cost.

Salt is available in several forms: as brine, rock salt, vacuum salt and solar salt. Much of the Asian market for salt is supplied from Australia and Mexico at costs of around $30 per ton on CFR basis. Rock salt is cheaper than vacuum salt though many mercury cell plants prefer to use vacuum salt as it cuts the mercury sludges which would form during the brine resaturation stage. Many large complexes have their own brine system and as these have been exploited for many years they yield a valuable by-product namely the ability to store various chemicals in the salt caverns or salt domes.

With a trend to even larger worldscale units the ideal location for a chloralkali plant is access to deep sea loading facilities, access to cheap power and access to good quality and preferably cheap salt. Energy has become a more important factor over the years as chloralkali producers seek to cut costs of ECU production on a continuous basis.

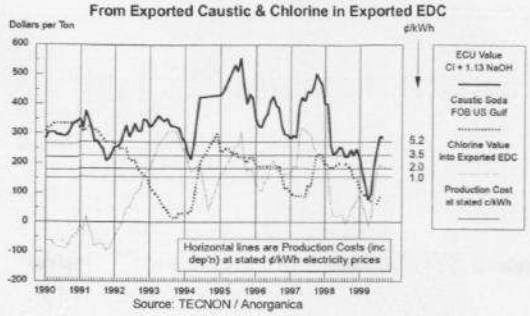
The chloralkali industry has to live with a very rigid rule of chlorine and caustic soda production. For practical purposes the production of 1 ton of chlorine yields 1.1 tons of caustic soda. This rule is fairly rigid in the case of salt electrolysis and results in demand for caustic soda needing to match the demand for chlorine. The caustic soda price is very volatile as the graph shows. As most of the chlorine produced is used on site there is a limited free market for chlorine. Such a market exists in the USA though an attributive value of chlorine can be calculated anywhere on the basis of the ethylene dichloride (EDC) price. Occasionally the "value" of chlorine can go up with the value of caustic soda though it is normal for one to go up and one to go down as part of the chloralkali cycle.

Figure 1
UNITED STATES EXPORT & DOMESTIC
CAUSTIC SODA PRICES



Source: BFG & TECNON / Anorganica

Figure 2
UNITED STATES - VALUE OF ECU
From Exported Caustic & Chlorine in Exported EDC



Source: TECNON / Anorganica

LEGISLATION & ENVIRONMENTAL PRESSURE

The chloralkali industry is under pressure on all fronts. The production of chlorine, the consumption of chlorine and the use of certain aspects of chlorine chemistry are all under investigation. Environmental pressure resulted in the phase out of chlorine consumption in the European pulp industry and chlorine is now gradually being phased out in the USA and elsewhere. Certain derivatives such as the chlorofluorocarbons have been phased out and the alternatives known as HFCs have quite a different demand for chlorine. Throughout the 1980s there were many closures in the industry though by the mid 1990s it was becoming apparent that the demand for chlorine in PVC would need new chlorine capacity.

Chlorine is made using three technologies: mercury cell, diaphragm cell and membrane cell. Mercury cell is under pressure in most parts of the world and there are going to be legislative moves which will control production by this method. At first sight the legislation is unlikely to lead to large closures of capacity though there will be increased pressure to cut mercury emissions beyond an economic route. A company with a long lived chlorine demand would have to decide to convert to membrane or rethink the chlorine strategy. West Europe has about 6 million tons of mercury cell capacity. In the USA the workhorse is the diaphragm cell and this too has environmental implications as most of the diaphragm cell production is based on the use of asbestos diaphragms. Legislation in France has forced a conversion to the use of non asbestos diaphragms.

Much has been said of Europe cutting capacity by 2 million tons and with it an implicit importing of both EDC and caustic soda to meet any imbalance. Doubtless, the promoters of some projects in the Middle East see this as a long-term market. If 2 million tons of capacity were to close that would have a serious impact on salt markets. Legislation on diaphragm plants is also putting pressure on some salt systems. Diaphragm plants are a convenient source of vacuum salt for some producers. The vacuum salt is used in a tied in membrane or mercury cell plant. If the diaphragm unit is closed or converted to membrane that salt is lost.

In summary, the legislation and environmental impacts are going to be on the demand for pure salt to rise to meet the specification of new membrane units either as a direct consequence of conversion to membrane or as a loss of vacuum salt from the desalting unit in the caustic evaporator.

POWER COSTS & LOCATION OF NEW PLANTS

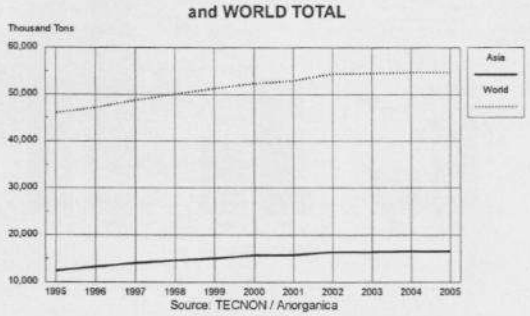
Power costs are an important factor in deciding on the location of a new plant. Currently the cheapest power costs are to be found in the US Gulf and in the Middle East. The US Gulf has plentiful salt supplies and salt is abundant in the Middle East though one of the new producers is likely to import salt initially.

The new producers are likely to have an impact on the trade flows of both EDC and VCM, possibly to the detriment of European producers already under pressure form high power costs and environmental pressure on mercury cell production.

In 1999 the effects of the Asian crisis were still apparent on the chlor-alkali market though the main losers in terms of business were the US producers

who lost out to the new producers of Asia. Europe also experienced a downturn in chlorine demand which was attributable to lost business in Asia.

Figure 3
BUILD UP OF CHLORINE CAPACITY IN ASIA and WORLD TOTAL



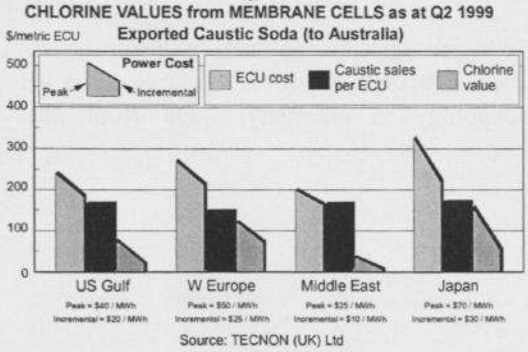
Source: TECNON / Anorganica

The build up of capacity is shown in the capacity graph.

The cost of the electrochemical unit can be calculated using the power cost and the salt cost. From the ECU cost the value of the chlorine can be established. In many cases it is usual to use the caustic soda price in the market to establish a credit and then deduct this from the ECU costs. It can be seen that if caustic soda is valued at $300 in the market then the cost of production of chlorine can be negative. If caustic soda is at the $30 level then costs of chlorine are high. If caustic soda is at the $30 level this implies a surplus of the product so there is an interest in keeping supplies of caustic low by encouraging the recycling of HCl in the system. This topic is covered later in the paper.

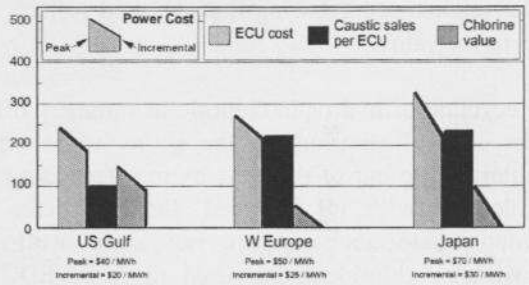
Developments in technology include the direct chlorination of ethane to make VCM and the development in Japan of the gas diffusion electrode. EVC is developing the former while MITI is encouraging the latter. Commercial application of these technologies is some years away but they will have an impact on the location of new chlorine plants in the future.

Figure 4
CHLORINE VALUES from MEMBRANE CELLS as at Q2 1999
Exported Caustic Soda (to Australia)



Source: TECNON (UK) Ltd

Figure 5
CHLORINE VALUES from MEMBRANE CELLS as at Q2 1999
Domestic Caustic Soda



Source: TECNON (UK) Ltd

DEMAND FOR CHLORINE

Chlorine demand can be broken down into three main sectors each using about one third of the total demand. These are inorganic, vinyl chain and non-vinyl organic.

In the vinyl chain the chorine ends up in the final product, in the non vinyl chain chlorine is used to make an intermediate though chlorine does not itself end up in the final product. In the inorganic sector chlorine can be used in two ways, as an intermediate in the production of titanium dioxide through the chlorine route or in the final product.

In many end uses of chlorine there is an involvement of hydrogen chloride in the scheme. Hydrogen chloride or hydrochloric acid is released during chlorinations. There are 2 options regarding the use of the HCl. It can be recycled to be used as a chlorine source or it can be placed on the market.

The choice of options frequently depends on the capacity to recycle the hydrogen chloride or the state of the market for the acid. Ideally the hydrogen chloride can be used as a feedstock for more EDC production or methyl chloride production. If the HCl is to be put into the acid market it ought to reflect the value of the chlorine.

It was stated above that the value of the chlorine is a function of the state of the caustic soda market. It is therefore in a chlor-alkali producer's interest to restrict the supply of caustic soda by increasing the recycling of hydrogen chloride. This also has the benefit of cutting the supply of hydrochloric acid to the market and ensuring that the acid reflects the chlorine value.

Recycling of hydrogen chloride in summary offers the chlor-alkali producer the ability to get more chlorine use out of the cells by in effect using the chlorine twice. It is used first to make an intermediate such as an isocyanate with the hydrogen chloride being used to make EDC or methyl chloride.

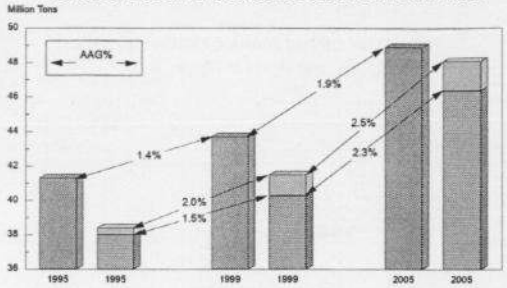
Recycling of hydrogen chloride can therefore cut the need to build more chlorine capacity and can cut the need to use more salt.

IMPACT OF HCL RECYCLING ON REAL CHLORINE GROWTH

It has been estimated that between 1 million tons and two million tons of new HCl will be recycled in the next few years. This means that between 1.1 million tons and 2.2 million tons of caustic will not be produced with the apparent chlorine growth in demand. This also means that there will not be a new market for salt of between 1.7 million tons and 3.4 million tons of salt.

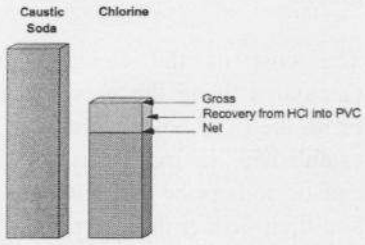
We show the forecast of chlorine and caustic soda growths in a graph. We can also identify those projects in the future which will have chlorine being used in the production of MDI or TDI and the HCl being recycled to make EDC in the future. Sites in Europe which are efficient in hydrogen chloride recycling are Botlek in the Netherlands and Antwerp in Belgium. In other locations there is increased awareness of the need to use more HCl as a feedstock for EDC. One example is Geismar in the US Gulf. Consideration is being given to the siting of an isocyanate unit in Qatar which will return the hydrogen chloride to the EDC/VCM

Figure 6
WORLD CHLORINE vs CAUSTIC SODA CONSUMPTION



Source: TECNON (UK) Ltd

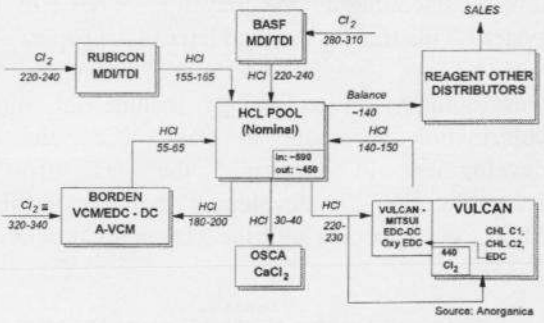
Figure 7
Key to
WORLD CHLORINE vs CAUSTIC SODA CONSUMPTION



Source: TECNON (UK) Ltd

complex of the Qatar Vinyl Company.

Figure 8
GEISMAR, La - 2005 LOOK



Hydrogen chloride can itself be electrolysed in the Uhde process. Bayer is a large user of this technology in Germany. De Nora also has

technology to offer in this region and Du Pont has patented a process for HCl electrolysis.

In summary the recycling of hydrogen chloride can reduce the real demand for chlorine. There are benefits to the producer in being able to control caustic soda and acid output though it does reduce the demand for salt.

CHLORINATION WITHOUT THE NEED TO PRODUCE CAUSTIC SODA

In addition to the increased use of hydrogen chloride in many chlorination schemes there is also production of chlorine without the use of salt. Magnesium production from magnesium chloride liberates chlorine though with the exception of the new plant in Israel most magnesium producers have a closed chlorination system.

Chlorine can also be produced from the electrolysis of potassium chloride. In this case the co-product is KOH. Several caustic soda producers are also involved in the production of caustic potash and can vary the ratio of the outputs of each depending on the market. If the caustic soda market is poor then more KOH can be produced. This can therefore cut the salt demand while increasing the demand for KCl.

FINAL CONCLUSIONS

New plants for the production of chlorine are being built in non traditional locations, for example the Middle East and Asia. The salt supply will therefore change as these units come on stream and other producers have to react to new market conditions.

There will be continued pressure on the costs of production especially if new technologies such as the direct chlorination of ethane and the gas diffusion electrode are successful.

More hydrogen chloride will be recycled cutting the demand for new chlorine production.

Salt demand will be related to the caustic soda production rather than the apparent demand for chlorine.

Chlor-alkali producers have to live with a volatile caustic soda market and will take steps to ensure the production of caustic soda is in line with demand.