Caustic soda: Outlook for Asia

Ron Van Santen

Director A.C.T.E.D. Pty Ltd

Caustic soda in perspective

Caustic soda, or sodium hydroxide, is one of the most important chemicals manufactured. It is also the only commodity chemical whose price can swing by a factor of fifteen on the spot market - from $30 to $500 per tonne. Even late last year it was as low as $80 recovering just a few months later to $200. It is a product that whilst not directly influenced by environmental issues, is closely linked however to the outlook for chlorine which is sensitive to the environmental debate. However its importance is not so much the demand for caustic in Asia, but the influence it has on the trade in chlorine chemicals, notably EDC, VCM and PVC. The imbalance in demand creates an opportunity for an Australian chloralkali producer using competitive energy.

Caustic soda is co-produced with chlorine by electrolysis in the ratio of 1.1 tonnes of caustic soda for every 1.0 tonne of chlorine. More than 95 per cent of all chloralkali production is based on the electrolysis of brine using one of three types of technology. In Europe, typical of an industrialised region, about 60 per cent of production is by the mercury cell, about 30 per cent by the diaphragm cell 10 per cent by the newer membrane technology cell. Worldwide the membrane cell technology represents about 20 per cent of production and nearly all new investment in chloralkali production.

There are some 500 major chloralkali producers worldwide with a nameplate capacity of 45 million tonnes of caustic of which one-third is produced by the United States as a competitive centre.

As shown in the next figure showing the uses of caustic, chemicals represent about one half the market for caustic.

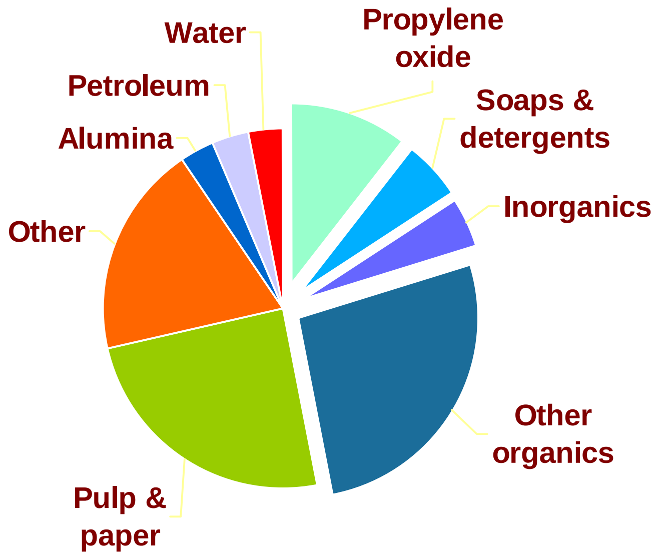

Figure 1 Chemicals represent one-half of market for caustic soda.

Trade

Of the 42 million tonnes per year of caustic soda produced, 16 per cent or 7 million tonnes per year is traded, of which 80 per cent is from the USA and Europe. Around 94 per cent of trade is in the liquid form - typically 50 per cent solid. Of the liquid trade, some 2 million tonnes per year is through deep sea ports and 5 million tonnes per year across borders. Nearly all the deep sea transport of caustic is for the alumina industries.

Solid

The solid form of caustic soda typically attracts a premium of between $100 per tonne and $200 per tonne over the liquid form (dry basis). The markets for the solid form are principally developing countries with infrastructure inadequate to handle the more difficult liquid. With improving infrastructure, the larger markets such as China and the CIS are shrinking leaving Algeria, Cuba and Africa as major destinations for solid caustic. Indonesia is now the only major user in Asia.

Being more expensive, world trade in the solid form of caustic is only about 400 000 tonnes per year and declining by around 8 per cent per year. About 225 000 tonnes, representing one-half the trade in the solid form, is supplied by Europe with the balance by Latin America, South Africa and India.

Liquid

For the very large liquid caustic soda market, trade is predominantly for the production of alumina most notably for Australia, which takes nearly one-half of deep sea trade, but also for Brazil, Venezuela, Surinam, Jamaica and Guinea. Other large importers, reflecting regional chloralkali imbalances, are Korea and Colombia.

Asia

As a generalisation, the Asian market is unable to absorb all the caustic soda it could produce to be self-sufficient in chlorine. It has to import chlorine chemicals with a deficiency that is growing. Accordingly, many Asian countries are exporters of caustic with higher power costs in a sense partly offset by the need for chlorine chemicals, notably PVC. Relatively high power costs restrain caustic exports to modest levels and generally at below home market levels to be competitive against the lower cost US and Saudi Arabian producers.

The single largest destination for caustic soda trade is Australia that requires 1 million tonnes per year for its alumina industry. Currently supplied by Japan, Saudi Arabia, Europe and the USA, Australia will therefore be the major target for any new producer in Asia. If a new chloralkali plant is established, it could influence the world market and trade in caustic and chlorine.

Price shaping.

The world price of caustic soda is strongly influenced not only by demand for it, but also by the demand for the co-produced chlorine. However unlike chlorine, it also has floor and ceiling limits imposed by substitution with soda ash, both in use and in production.

The chlorine influence

Broadly, the price at which caustic is made available will be strongly influenced by the demand for the co-produced chlorine chemical. Chlorine, unlike caustic soda, cannot be stored so if the market for chlorine chemicals slows, as has recently occurred, caustic soda production is also reduced. As the demand for caustic is more stable, the price is increased. It comes back to whether the value of the electrochemical unit (ECU as the combined price of caustic soda and chlorine) provides a margin over the cost for the producer. Weak demand for chlorine as is occurring presently, serves to raise the price of caustic soda as its supply is restrained. In other words, the present increase in caustic prices is not so much driven by an increase in demand, but more by the fact that no new plants are coming on stream in the light of the weak chlorine market and steady growth in demand for caustic. The net effect is an increase in the value of the ECU - which is currently around $400.

The soda ash influence

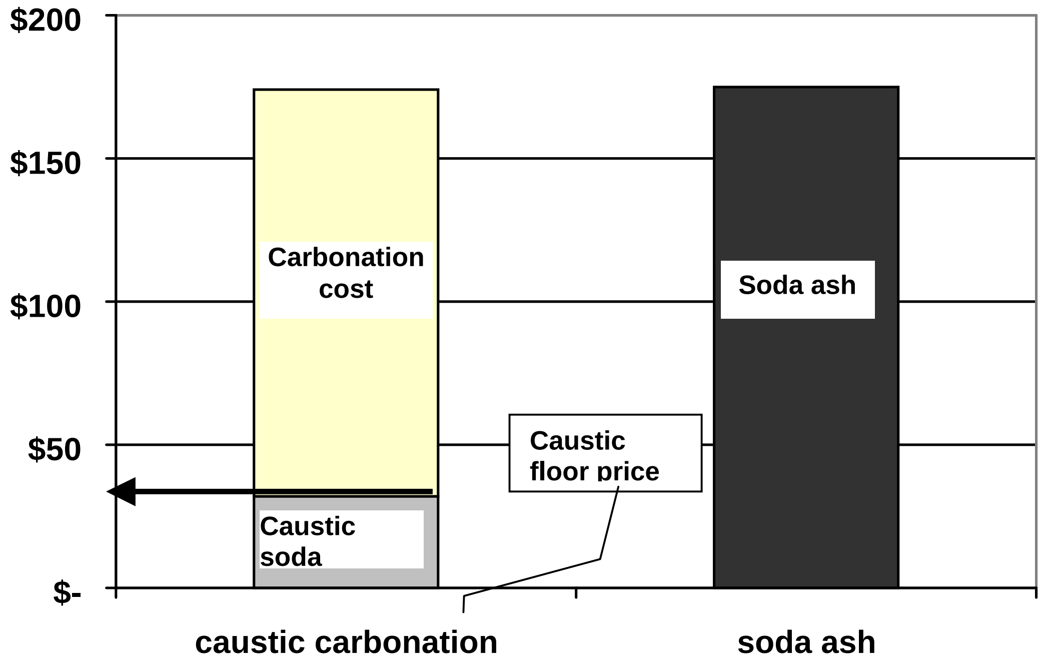

Figure 2 The floor price for caustic soda is cost of soda ash less cost of caustic carbonation.

The value of soda ash and other alkaline substitutes can replace caustic soda in many applications. Here soda ash is what economists call a consumption substitute. Caustic soda can also be converted to soda ash when the price of caustic is sufficiently low to provide a margin to cover the cost of its carbonation. Soda ash is here also a production substitute for caustic soda produced by electrolysis.

It is important to understand product substitution as it significantly influences the price of caustic soda. In alumina production, that uses the Bayer process, caustic soda is essential. In some applications caustic can be substituted by other alkaline chemicals such as soda ash, lime, potassium hydroxide, sodium sulfate and magnesium hydroxide. That substitution is also occurring in the US simply by the growth in demand for caustic being one per cent higher than chlorine. This imbalance in demand raises a deficit growing at around 100 000 tonnes per year which is met by soda ash.

Contract soda ash values (fob) have ranged from $120 to $200 per tonne, with spot prices down to $80 per tonne. As world capacity is around 42 million tonnes per year, about the same volume as caustic soda, there is scope for substitution that is only restrained only by price and suitability.

Soda ash therefore helps establish floor and ceiling values for caustic soda which in turn effects chlorine values.

Consumption substitution

To illustrate, a floor price for caustic soda is formed as some users of soda ash, such as producers of paper and pulp, and phosphates, will convert to caustic soda when prices are low. Another floor price promoter is that at around $40 per tonne, caustic soda can be converted to soda ash by a carbonation process at around $130 per tonne to produce soda ash valued at around $170 per tonne.

This process became viable during the early part of 1997, when caustic prices fell to around $80 per tonne, about 0.5 million tonnes of caustic soda was converted to soda ash, representing a shift of around 1 per cent of demand. Such a crossover could reach 1.0 to 1.5 million tonnes per year - around 3 per cent of the market. Given that even a 1 per cent deficiency or surplus in caustic soda can influence prices, including that of the co-product chlorine, the substitution potential with soda ash presents an important influence on the caustic soda industry. The more recent sharp upturn to over $200 per tonne has eliminated that source of consumption substitution so that soda ash will impact as a production substitute by caustification.

Production substitution

Again the substitution effect is felt in the development of ceiling values as soda ash can be converted to caustic soda at prices of around $300 per tonne with a soda ash price no higher than $170 per tonne. Here soda ash is a production substitute. This relationship is shown in the next figure.

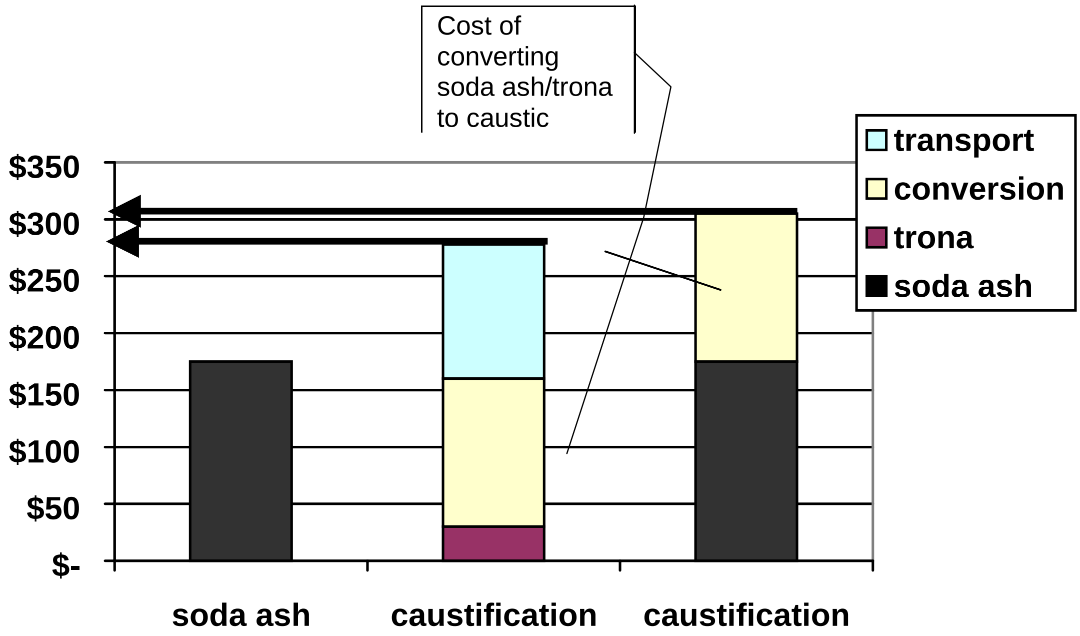

Figure 2 The ceiling price of caustic is determined by the cost of caustification cost of trona (plus transport from remote regions or from synthetic soda ash.

Substitution in use is also relevant to development of the ceiling value of caustic. With a rise in the price of caustic soda, some users will begin to use soda ash. Even in the application for alumina, there is some price sensitivity with tendency to use higher grades of bauxite with higher caustic soda prices and vice versa.

Therefore unlike its co-product chlorine, the price of caustic is prevented from being driven to negative values by direct or indirect relationship with soda ash.

Of course having indicated soda ash as a potential substitute in some applications, it is important to understand that this chemical too has it own price structure.

Soda ash price structure

The production of soda ash has been dominated by the Solvay process using stable priced mined raw materials (salt, limestone and coal). However since the early 1970s, a deposit of 47 billion tonnes of trona (a natural source of soda ash) in Wyoming in the USA has been mined. Trona now represents all production of soda ash in the USA with other suppliers in Africa and Turkey. These natural deposits place a ceiling price for soda ash of around $170 to $180 per tonne including freight costs of around $45 per tonne.

As previously described, the Wyoming producers may convert soda ash to caustic soda and, while supplying only 2 per cent of the US caustic market, they have a direct effect on its price. The producers contribute to the floor price by being the lowest cost producer and who cease to manufacture when the price of soda ash falls too low without chlorine production to offset caustic soda losses. A floor price of around US$40 is established by soda ash.

Prices and cycles

There are indications of seven year cycles in caustic as measured by prices, profits or cash flows, with the most recent bottom being 1992/93.

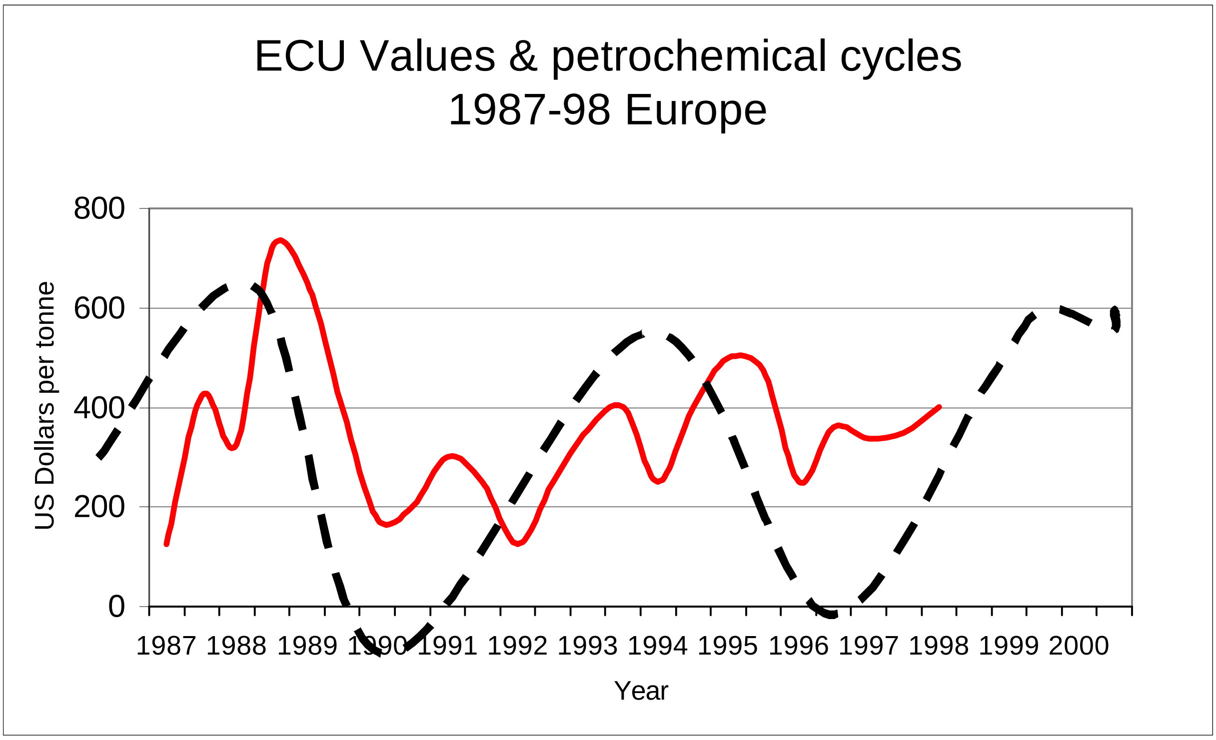

Figure 3 the ECU value shows cyclical movement with a seven year cycle and smaller two year cycles.

Thus there is a ceiling and floor price for caustic, determined by substitution in use and production, and with the price of soda ash or trona linked thereby to the market for chlorine. The combined price of caustic and chlorine, expressed as the ECU, is more stable reflecting economic cycles.

The price history confirms a ceiling price for caustic of around $350 and a floor price of $40 per tonne (but with short-term break-throughs). These floor and ceiling prices are influenced by new investments, production and consumption substitution effects, and by the demand for the co-produced chlorine.

The price of caustic is very unstable and difficult to predict with any certainty or qualification. If caustic demand grows at same rate as chlorine, then the price movements will be similar. But if the demand for PVC falls, as has happened with the slow-down in Asia, caustic prices will move higher (and of course with lower chlorine prices). This is more by little new supply coming on stream in the face of growing demand for caustic. In other words, a slight variation in **relative** demand has an amplified impact on prices. The price relationship is therefore unstable. Again caustic soda does not incur negative prices due to the substitution affects with soda ash - in contrast again with chlorine which does not have such close consumption or production substitutes.

Variations in demand, corresponding with economic cycles as important short term influence on chlorine and caustic prices reflecting in the peaks and troughs of the ECU values. The individual price movements are complex.

General economic downturns involve reduced building activity seen in a reducing demand for PVC, and hence chlorine. As such, a downturn reflects in falling chlorine values but which place an upward pressure on the price of caustic. Reduced economic activity also reduces the demand for caustic such as the demand for aluminium produced from alumina-using caustic. It is only that the alumina industry is a relatively small user so that the overwhelming balance of effect on caustic prices is felt through the important PVC industry but in opposing directions.

Expectations can also influence the price of caustic. Thus for example an expectation of low prices could promote alumina producers to begin to use lower grades (high silicate) of bauxite that requires more caustic. Anticipations influences the caustic industry directly through the previously described substitution in production and in consumption with soda ash. The relationship is complex and all too apparent when reviewing intermediate term projections by industry specialists that often fail to materialise, and that is of course if those projections have not been heavily qualified to provide an escape after the event.

More than economic conditions are involved. A long term and permanent upward shift in caustic prices could be promoted by any ban on PVC. Many environmental groups, even a Swedish government funded commission, is promoting its replacement, as has partly occurred for the Sydney 2000 Olympic Games. A consequent reduced market for chlorine would depress chloralkali activity promoting a long term increase in the price of caustic though again within the floor and ceiling values determined by soda ash. The ECU could of course remain unaffected though a consequent lowering in the price of chlorine could promote a permanently higher price of caustic.

Thus the well being of the PVC industry is important to the caustic industry. Reduced demand for PVC, following any ban, will serve to raise the price of caustic - perhaps on average by up to a factor of two.

Alumina and Australia

The alumina industry is an important influence on the trade in caustic soda. The world's alumina industry requires some 3 million tonnes per year of caustic soda and represents 8 per cent of production. An alumina producer however is often the largest single consumer of caustic soda even if only a minority market segment.

Caustic soda is used to extract the aluminium oxide from the bauxite mineral that occurs in varying grades. It therefore uses between 0.03 tonnes and 0.16 tonnes per tonne of alumina produced. Caustic typically represents around 8 to 15 per cent of the production cost, though sometimes as high as 25 per cent with low alumina prices. It is worth noting that the choice of bauxite grade processed to alumina is sensitive to the price of caustic soda so there is a small price elasticity of demand.

Current prices of traded caustic are difficult to obtain as the alumina industry purchases about 80 per cent of its requirements on long terms contracts, with the balance on the spot market to test the market. Contracts negotiated with Australian users have been around $200 (fob) per tonne late 1996, falling to around $120 in the first half of 1997 and more recently back to $180.

Australia is the largest producer of alumina producing 13 million tonnes per year and supplying about 30 per cent of the world's alumina. Typically 0.07 tonnes of caustic is required per tonne of alumina so that 0.9 million tonnes of caustic are required in Australia. Australia is consequently the single largest importer of caustic soda, requiring nearly one-half of the world's deep-sea trade.

The country therefore has a very important influence on the world's caustic trade and with recently announced plans for alumina expansion, it will grow. Production of alumina, and hence the demand for caustic, is expected to continue to grow at 3 per cent per year for several decades.

The prospect for a new chloralkali project for Australia.

Australia imports some 900 000 tonnes of caustic soda for use in the large alumina industry of which around two-thirds is imported by the state of Western Australia. Current production in Australia is only 80 000 tonnes per year from eight small operations dedicated to chlorine production. An 80 000 tonne mercury cell plant, operated by ICI was closed down in 1997 to be replaced by a much smaller membrane technology plant. At that time, ICI ceased production of EDC for export having previously closed down its VCM plant. The company now owns an interest in a VCM importing operation to produce PVC. Without a significant home industry but with a large home market, Australia is clearly an important potential influence in the world's caustic soda market, and potentially therefore on the chlorine industry in the Asian region.

Western Australia is a very large gas exporter supplying 10 per cent of world trade in liquefied natural gas. Plans are for a doubling of production to 20 million tonnes per year by year 2003. Since deregulation, very competitive gas prices of around US$1.30 per gigajoule (ie. about same per MMBTU) are achievable in the home market. The state is also a very competitive exporter of salt suitable for the chloralkali operations with production facilities alongside the gas exporting installation. There is therefore obvious potential for a world-class chloralkali manufacture.

The government of Western Australia is now actively promoting an integrated petrochemical plant by releasing a Registration of Interest process. While the State Government will not assume any interest in the venture, it owns land and will probably provide some infrastructure assistance. The registration process thus ensures the Government understands relevant issues and will promote the relevant initiatives to promote the venture. In so doing it has found that the process has stimulated more interest than had hitherto been indicated. It is not clear to what extent the federal government will be involved given no recent industry specific initiatives beyond reductions of import tariffs, taxation and other fiscal initiatives.

Various options have been promoted by potential venturers which include the production of 500 000 tonnes per year of caustic soda integrated into a polyolefin or glycol plant. If established, it could supply 80 per cent of the state's requirements for caustic with all of the chlorine applied to the production of EDC/VCM for the export market. In perspective, its production would represent 25 per cent of the world's deep-sea transport of caustic. It could supply 40 per cent of Asian trade in chlorine chemicals. The plant would be located in the Pilbara region of the state and is referred to as the Pilbara Petrochemical Project, or PPP.

It is important to note that the plant would be located at an isolated northern region of the state. Although close to the gas, it would be some 1 500 km north of its caustic soda market near the state capital Perth. It is however worth noting that there is some prospect for developing the Mitchell Plateau bauxite deposit which is closer to proposed venture. For the immediate however, high transport and infrastructure costs works against its development.

The project is not only remote from other petrochemical sectors and markets, it would be a largely a greenfield site with high development, infrastructure and construction costs. These penalties would have to be offset by competitive gas and a freight advantage over imports for the market for caustic soda.

It is possible, if not probable that the State Government will fund some of the relevant infrastructure to enable the project given precedence with its support for other projects. This leaves the question of the availability of ethane.

With current exports of LNG tied to performance contracts, ethane cannot be extracted from current contracted supplies without costly penalties. These penalties arise from reducing the energy density of the gas, as stripping ethane increases the proportion of the less energy dense methane. This requires the ethane to be extracted from domestic gas supplies, and perhaps from future new export contracts. There are two gas lines that begin where the petrochemical project would be located near Dampier - one being a line to Bunbury and a smaller line to the mining region of Kalgoorlie. Based on current flows, the two lines could provide 500 000 tpa of ethane with near 100 per cent extraction. It should be noted that extracting near all available ethane is more costly than extracting up to 65 per cent which avoids lower temperatures and the removal of carbon dioxide gas that increase production and capital costs.

The question is how much ethane is required? The PPP project is predicated on the market for caustic and not the chlorine. The chlorine cannot be used locally and therefore to be exported, has to be converted to VCM or EDC.

Adequate scale for chloralkali production, say 500 000 tpa of caustic would require the production of some 690 000 tonnes of EDC that would use only 200 000 tpa of ethylene - a competitive ethylene plant would produce substantially more. Even if the chlorine is exported as the less favoured VCM, the project would still only require 400 000 tonnes of ethylene. For the project to be competitive, the PPP would requires a larger ethylene throughput than required for chloralkali project. There has to be an additional and competitive outlet for the surplus ethylene other than for EDC or VCM.

One contender for the project is Shell, who in partnership with the world largest chloralkali producer Dow would produce the ethylene and a complementary ethylene product. The most favoured complementary ethylene product being methyl ethyl glycol used in polyester production for which there is fast growing demand in Asia. It is perhaps worth noting that Shell is also a key partner in the State's gas production facilities providing a strategic benefit to the PPP. Not surprisingly this proposed partnership is seen as the most likely to succeed.

In September 1997, Dow Chemical and Shell announced interest in a A$1bn venture to begin 2003. It would involve;

- 450 000 tpa of ethylene production - joinly owned and operated;
- 400 000 tpa monoethylene glycol by Shell;
- 690 000 tpa of (EDC) by Dow;
- 500 000 tpa of caustic soda by Dow.

As previously indicated, total gas production as well as domestic gas production is scheduled to double within five years. Also helping the supplies of ethane is that Wesfarmers and Orica producers of ammonia in Australia, have both expressed interest in producing ammonia (and ammonium nitrate and urea) plants. The required methane drawn from the gas supplies would provide for some additional ethane - about one-tenth by mass of methane used - say 80 000 tonnes.

The current (March 1998) list of companies that have been included in the Government's shortlist are BP, Dow with Shell, Hanwha, Orica and Krupp Uhde. The preferred company will have the right to present a formal development proposal for the project.

Another potential player is Hanwha Corp which is interested to take a share in BP Chemicals' planned ethylene cracker project with its proposed chloralkali and ethylene dichloride project. Hanwha proposes a 500 000 tonne per year of caustic soda and 620 000 tonne per year of EDC. BP proposes a 450,000 tonne per year cracker. Hanwha is also promoting the participation of Wesfarmers in an ammonia project.

Is the plant likely?

There are cost factors favourable to the project.

The cash cost of an electrochemical unit on a cash cost basis in the region of the proposed project in Western Australia was estimated by Chem Systems in 1996 at US$230. This cost compares favourably with $212 per ECU in the US Gulf

Coast to above $300 in Asia. Of course the more recent devaluation of currencies has brought the cost down in Asia closer to the rest of the world. Western Australia too has become marginally more competitive.

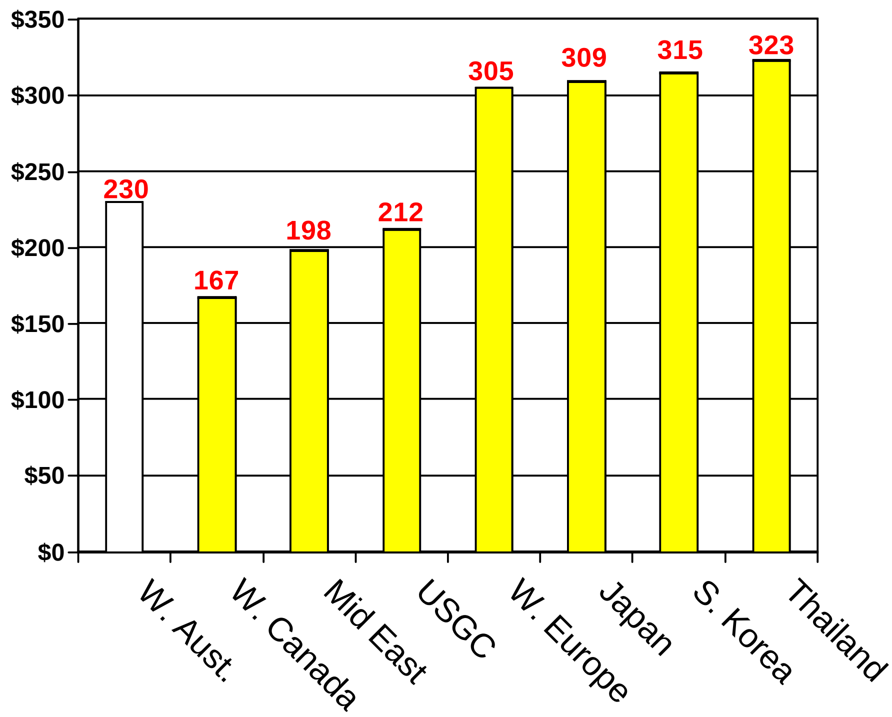

Figure 4 The cost of ECUs by region. (Chem Systems Nov. 1996)

Again the production cost excludes the costs of transporting caustic and chlorine, and costs of construction and infrastructure.

While the state of Western Australia is a major salt exporter, prices are still higher than the USA with their low cost salt dome deposits. The project would however benefit from the $7 to $10 per tonne freight cost saving to Asia thus saving around $5 to $7 per ECU. The proposed project is also disadvantaged from being isolated from a national electricity grid to take up any surplus power generated by co-generation.

Thus when distribution and capital costs are included, the costs is above the US Gulf Coast benchmark and the Middle East. Transport costs of around $30 to $35 per tonne for caustic soda to the local market could be assumed, $60 per tonne to the Asian markets for EDC or if VCM is produced, $45 per tonne to an Australian port and $75 per tonne to Asian markets. Construction costs too are some 10 per cent higher than the US Gulf Coast and Saudi Arabia, and though comparable to Indonesia, are around 30 per cent higher than Thailand. High infrastructure costs, including power/steam co-generation power too should be considered as penalties for this greenfield project.

It is worth noting that nearby the proposed project, BHP has commenced construction of a Direct Reduced Iron plant that has incurred a well publicised building cost blow out of around 60 per cent. It does not contribute to confidence in projections of construction costs in the region even if special circumstances are claimed. Also important in considering its prospects, are the favourable terms offered by competing regions in Asia where tax holidays and other concessions have been provided to investors.

The combined competitive advantage is summarised in the following figure. This chart demonstrates the key competitive factors to the operations net competitive advantage.

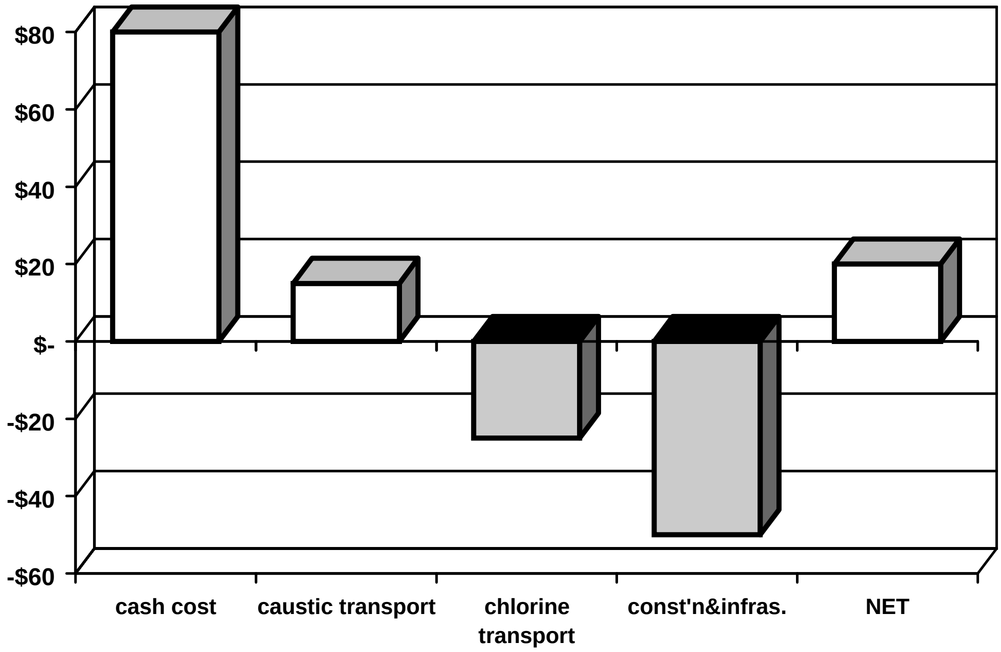

Figure 5 The sources of advantage and disadvantage estimated on a 500 000 tonne chloralkali unit measured as $ per ECU.

So while W.A. is competitive on a cash cost basis, the advantage is reduced when transport and construction and infrastructure costs are included. Thus while there is a transport advantage for the caustic soda, it is more than offset by the cost of transporting the EDC and the recovery of the penalty of higher construction costs and infrastructure which leaves only a small and contentious advantage (of around $20 per ECU, say 5 per cent). Again Australia does not offer tax concessions as available in competing regions so that that this small margin of advantage is effectively negated from the perspective of any potential investor. Therefore, without the taxation and other incentives provided in competing regions, the infrastructure related assistance provided by the state government will be an important influence in its prospects for establishment.

With the government of Western Australia having issued a prospectus, with expressions of interest from companies including the largest chloralkali producer in the world, Dow Chemicals, the progress of this project should be closely monitored by any chloralkali producer. Taking all the factors into account, our estimate is that the plant has at best a 50 per cent prospect for establishment by year 2001 and government help appears to be important.

It is worth considering that the project, if construction commenced during 1999, would come on stream close to the peak of the next chloralkali cycle that we estimate around year 2001. It would however also come into production with a softening of VCM exports from Japan as a dominant exporter to the region with its production capacity more fully utilised in supplying their home market.

It is also worth noting that Australia imports all its PVC requirements as VCM with some 240 000 tonnes per year imported through Victoria, on the other side of the continent. That operation, Australian Vinyls Corporation, is also for sale. Given the present shortage of ethylene, it is probable the chlorine would be used to produce EDC rather than the VCM. In any event, even if Australian demand for imported PVC was met by the plant, it would still only use 100 000 tonnes per year of the chlorine produced leaving three-quarters of available chlorine to be exported to other regions. Whatever the destination, the world market and regional trade for chlorine and caustic would be significantly influenced by the PPP.

The PPP is an important project for Australia perhaps far more than recognised within Australia. The project is important

Conclusion

Clearly, the outlook for caustic soda is being shaped by a complex range of influences including substitution in use from other alkaline chemicals; substitution in production from soda ash; the demand for chlorine for PVC; the cost of power; and potential developments such as in Australia. There are also underlying cycles and regional trends. Regional factors in turn are reinforced by import tariffs and currency shifts.

The key for an increasingly competitive future, is therefore for competitive power, adequate scale of operation, efficient integration into a petrochemical complex, and for all, the outlook for PVC resin in response to environmentally motivated concerns. In the intermediate term, there will be pressure on smaller high cost producers from newer large scale competitive producers. Regional factors are very important. Asian countries such as China, which have traditionally been importers of caustic soda, are now beginning to export. China in particular is restructuring its petrochemical industries. Small inland ethylene manufacturers using acetylene, are being replaced by large operations on the coast with surpluses exported.

However the key of course is the cost of energy that overrides the shaping of the world's chloralkali industry. The low energy regions, of which Australia is now part, will be moving their surplus chlorine as EDC to the growing markets in Asia. Remember that for many, Australia included, the chlorine will be exported at opportunistic values and sometimes at negative values!

European producers will be affected as well. With 60 percent of their chlorine produced from mercury cell, they are not sufficiently competitive or profitable to invest in more cost-effective processes. There is some investment in the US, but for this region, the Australian producer will have the greatest impact.

Caustic soda therefore has a future closely linked to not just chlorine but also increasingly the world's PVC industry.

August 1998