Chlorine: World outlook

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Chlorine in perspective

Chlorine is used in half the world's commercial chemistry so it may be described as the most important industrial chemical. It is also, as shown in this presentation, very sensitive to environmental influences and of course the trend for caustic soda. Projections about prices and demand are complex.

Chlorine is a gas which support combustion, is highly corrosive, reactive and with high expansion potential. In other words, the risk factors for the transport of chlorine are very high and so in Europe its transport is practically prohibited. Not surprisingly, there is little trade in chlorine with bulk users normally located near their own production unit or with pipeline access to another plant. The description of chlorine prices and markets, as required for this topic, is therefore about the products related to, or derived from chlorine, rather than the substance itself.

More than 95 per cent of all chlorine is produced by the electrolysis of brine called the chloralkali process using three types of technology. The processes are; the diaphragm cell; mercury cell, promoted for phase out in Europe; and the new efficient ion exchange membrane cell representing nearly all new investments.

Other processes are used for special situations with some chlorine produced by electrolysis of hydrochloric acid waste by-product, while caustic soda can be produced by the caustification of natural or synthetic soda ash. These

alternative processes help balance demand between chlorine and caustic in some regions where there is a surplus of one over the other.

Worldwide there are some 500 chloralkali major producers with a nameplate capacity of 45 million tonnes of chlorine. About one quarter of production is in Asia and Oceana which is approximately the size of production in the USA.

Chlorine, and perhaps more importantly caustic, is key to an understanding of the manufacture and trade of EDC, VCM and hence PVC.

Understanding chlorine will help understand why there is a growing shortfall in chlorine chemicals in the Asian region and why that deficiency will grow. The currency problems only serves to slow a gap in chlorine that will reach 2 million tonnes of chlorine, say 4 million tonnes of vinyls. China for example will be importing around one-half of its chlorine needs before year 2005.

Demand and market profile

Worldwide chlorine is used in a range of applications with a shifting pattern of demand which are very important to understand.

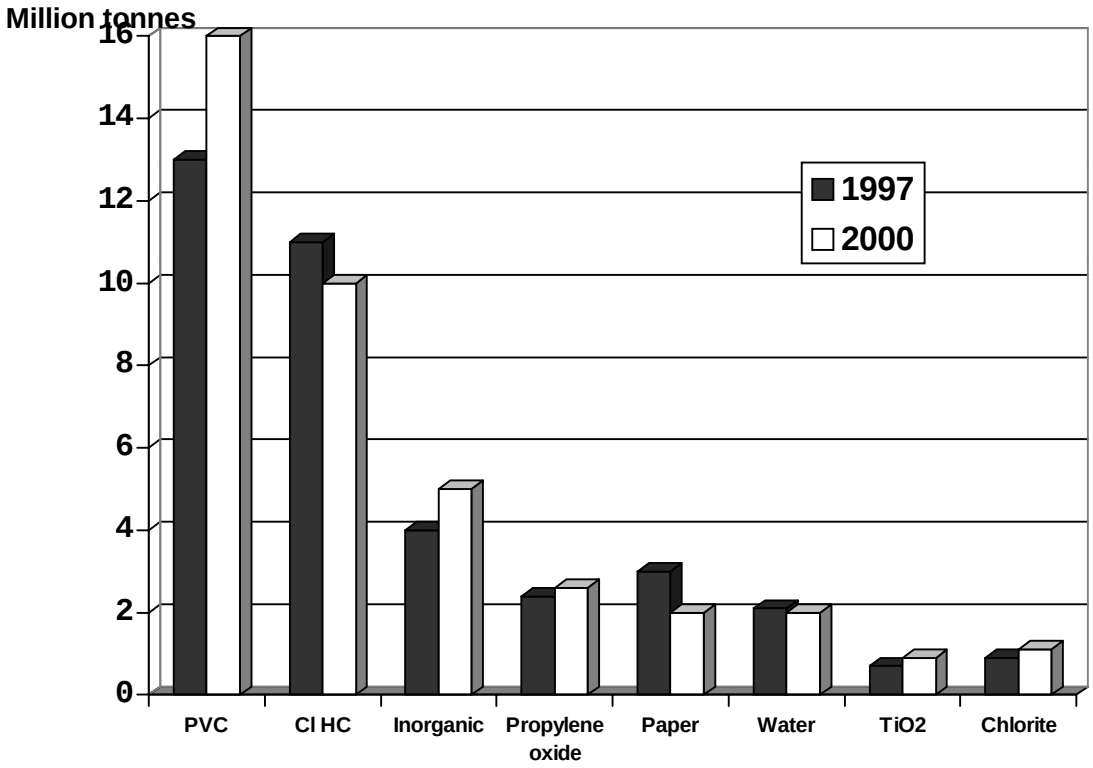

Figure 1 World chlorine production 1997 and projection to year 2000 in millions of tonnes of chlorine

The importance of PVC is clearly shown as also the fact that it represents strong growth contrasting with most other applications of chlorine. While PVC consumes about one-third of the chlorine produced at around 14 million tonnes of chlorine, by year 2005, PVC is projected to represent 50 to 55 per cent of chlorine use. PVC plastic is clearly vital to the world's chlorine industry, and hence the caustic, and of course, the large caustic-using industry.

This brings to issue the demand for PVC. As shown in the following graph, the volatile building sector represents more than three-quarters of demand for PVC. Put another way, construction influences some 40 per cent of demand for chlorine produced. This volatility reflects not only in chlorine chemical prices but also therefore for caustic soda.

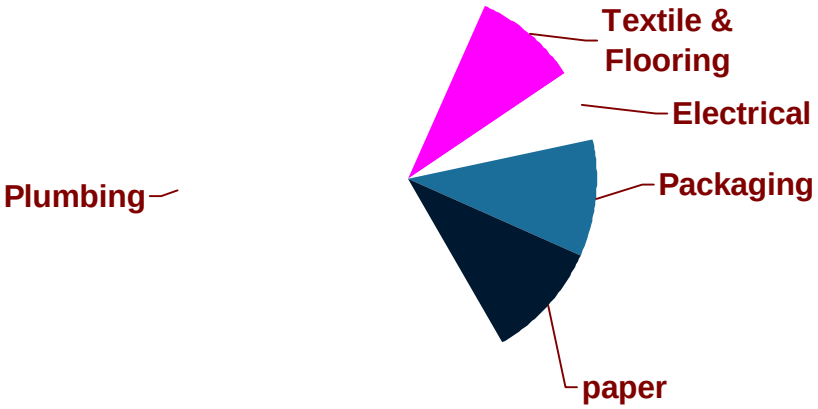

Figure 2 With more than two-thirds of demand for PVC for plumbing and electrical uses, showing why PVC demand is closely linked to the volatile construction sector.

So even though there is a decline in demand for chlorine for some applications such as in packaging and pulp and paper production, overall there is a small worldwide growth. Chlorine demand is increasing at around 2 per cent per year but with zero growth in some regions such as Europe and 4 per cent in the Asian region.

World per capita consumption of PVC is 3.8 kgs which is anticipated to be 15 per cent higher by year 2003 at 4.5kgs. While the per capita consumption is 13.5kgs in developed countries, it is only 1.5 kgs in the rest of world suggesting outstanding potential for growth.

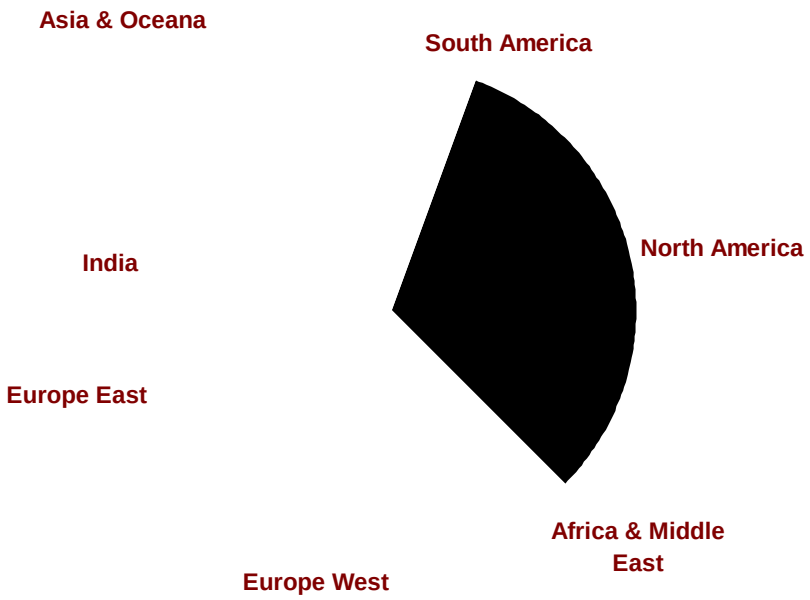

Figure 3 The regional distribution of world chlorine production of 44 million tonnes.

The environment and chlorine

Driven by environmental concerns, chlorine is being replaced in many applications. A notable example is in pulp bleaching where sodium chlorate, hydrogen peroxide, ozone, other bleaching technologies and a new delignification process are reducing the need for chlorine. Accordingly, while just ten years ago the pulp and paper industry used chlorine in the ratio with caustic at the ECU ratio of 1.0 to 1.1 caustic is now twice the ratio of chlorine and even higher in some countries. The US paper and pulp industry is being required to meet increasingly demanding chlorine emission controls that some industry experts believe could force that industry to become chlorine free. In

the interim, the industry may move largely to chlorine dioxide thereby reducing chlorine demand by 60 per cent. In Europe, one-third of chlorine is now recycled (mainly as hydrochloric acid) with only around 22 per cent now used to produce EDC and PVC, and with 2 per cent used for water and waste treatment.

Environmental and health concerns are also reducing its use in chlorofluorocarbons and other chlorinated solvents. The Montreal Protocol on "Substances that Deplete the Ozone Layer" has promoted the elimination of trichloroethane while the chlorofluorocarbons 11 and 12 are no longer produced in Western Europe. Accordingly since 1992, world production of these chlorine chemicals has halved to around 200 000 tonnes per year.

PVC too is being scrutinised for elimination with the environmental group Greenpeace promoting its elimination. The year 2000 Olympic Games in Sydney has eliminated its use where practical. A Swedish Commission too is proposing a ban in its trade and manufacture. Any pressure on chlorine, including the trade in PVC, will have direct implications on the world's caustic soda industry.

Chlorine cost issues

Chlorine is produced by the electrolysis of salt co-producing 1.1 tonnes of caustic soda per 1.0 tonne of chlorine. As these two chemicals are produced in fixed relationship and sold into different markets with variable prices, the cost of their production is included in the term Electrochemical Unit (ECU). The ECU is defined as the sum of 1.0 tonnes of chlorine and 1.1 tonnes of caustic and so avoids the question of allocations of production and overhead costs for the chloralkali manufacturer.

The cost of one tonne of chlorine is therefore the cost of one ECU from which the value of 1.1 of one tonnes of caustic soda is deducted. It is important to note that while the value of the ECU shows modest price movements, the value of chlorine and caustic soda move separately, often sharply and in opposite directions. The price of caustic soda has effective floor and ceiling values by substitution effects notably with soda ash. In contrast, the effective value of chlorine, included in EDC, VCM and PVC as the tradeable chlorine chemicals, has no direct positive floor price. The price of chlorine can even be driven to negative values during times of firm demand for caustic.

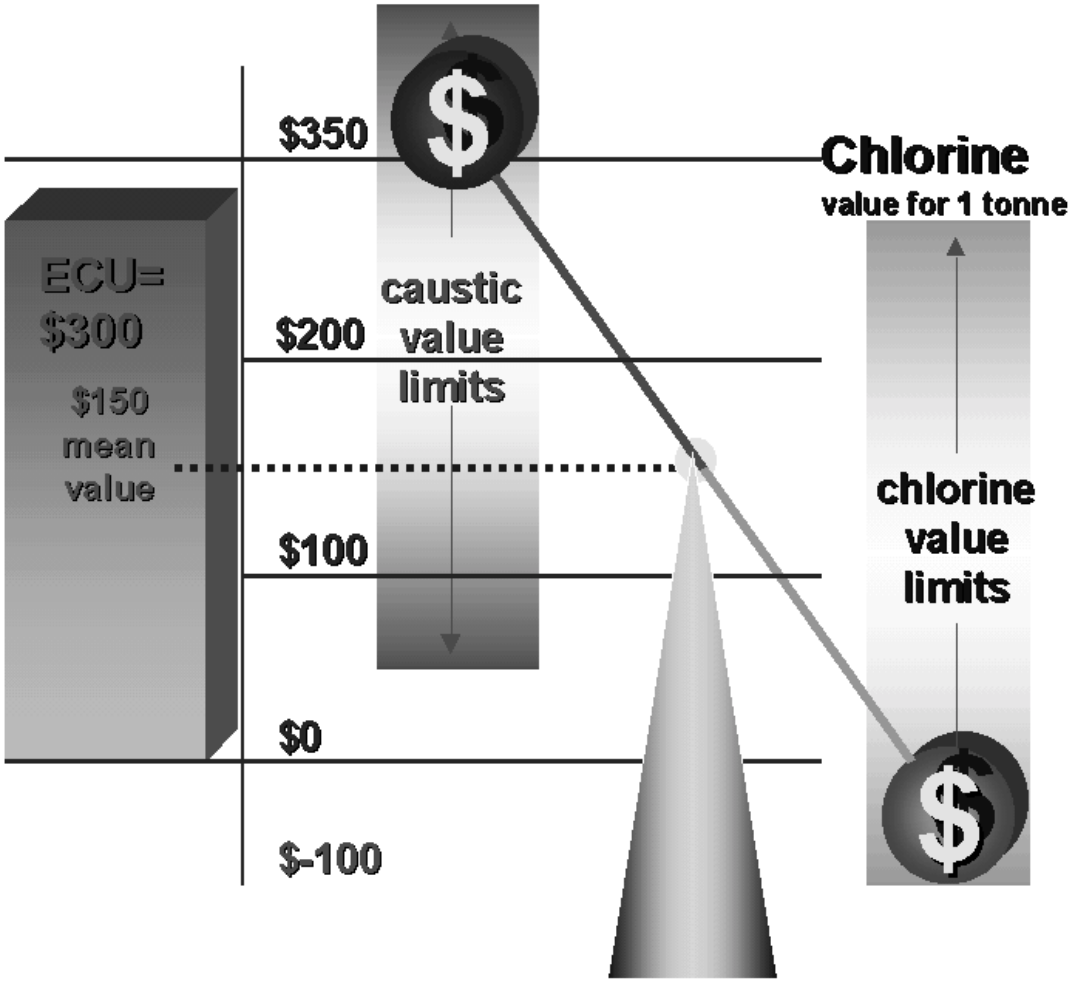

Figure 4 The relationship of the prices of chlorine and caustic soda. It shows the values moving in opposite directions about half the mean value of the ECU.

The ECU

The ECU is sensitive to the cost of power cost of capital with the other variables relatively similar and constant between locations. Its only raw

material cost is low cost salt. Based on that, the cash cost value of the ECU can be loosely described as being approximately 2.5 times the value of the power in $MWh plus around $170 to $200 to cover the other variable and fixed costs. This then empirically describes a typical world class membrane cell where power represents around 40 per cent of one ECU, (or on average of course that level of significance in chlorine or caustic).

Power

Some 3.2MWh of power is used per ECU in the more common diaphragm cells - about 10 per cent less in the newer membrane cells. Representing at least some 40 per cent of the production cost, even higher on a cash cost basis, power is clearly an important influence on competitiveness. Between regions, there are often large variations in power costs, sometimes by a factor of three or more ranging from $70 per MWh in SE Asia to as low as $25 off-peak in the USA. Accordingly ECU values can differ by $110, or around $55 per tonne of caustic or chlorine by power costs alone. Allowing for other variables, the price of the ECU can range from $230 per ECU in the Middle East, to around $370 in Japan. In Japan, with its high cost power, it represents 65 per cent of the variable cost of production.

Again these variations are based on peak value of power that are sometimes more than twice than their incremental value. Using incremental power or off-peak power, can reduce the cost of the ECU by up to $140 or by around $70 per tonne of chlorine.

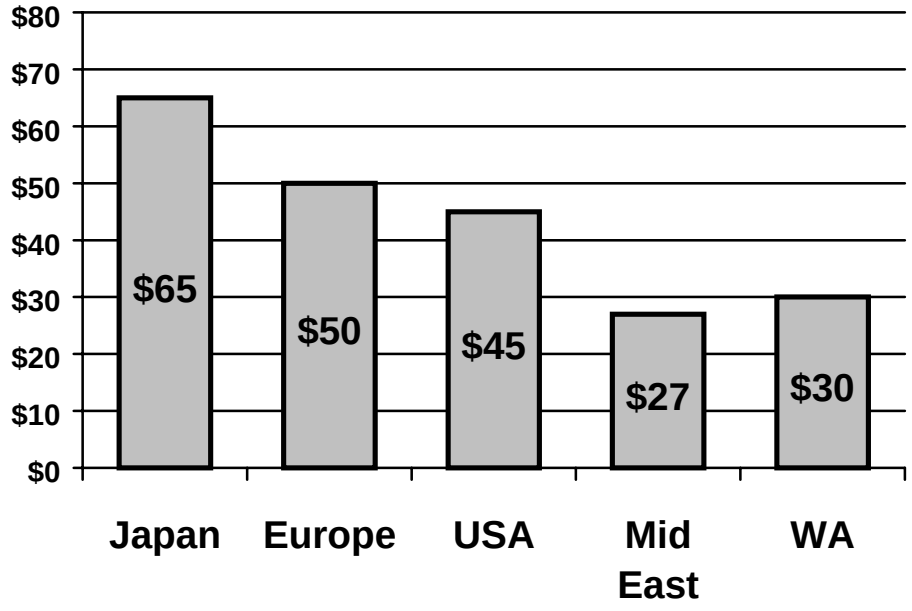

Figure 5 Power costs in Mw/hr in important producing regions. Western Australia (WA) is included as a potential producer in the region.

Thus variations between regions, and the use of peak or incremental power can promote a variation of 20 per cent or more on the estimated cost of producing chlorine. Of course, the scale of manufacture provides another variation of up to 20 per cent promoting most new export-oriented plants (ie. other than those dedicated to producing chlorine for local use), to be at world scale of at least 300 000 tonnes per year capacity. The variations impact on the cost of chlorine and shaping the pattern of world trade in chlorine chemicals.

The value of chlorine

Again the effective cost of manufacturing chlorine is that deduced from the joint cost of its production with caustic soda, the ECU, from which the value of caustic soda is subtracted. Obviously, as the value of caustic soda can vary

substantially - by a factor of up to ten - the value of chlorine reflects that variation. Unlike caustic soda with its floor and ceiling values, the effective cost of chlorine can fall to negative values. In the next figure, the value of chlorine was, calculated from EDC prices.

The formula for this calculation was:

> EDC cash production cost ($ per tonne) = 0.285 ethylene value + 0.725 chlorine value plus fixed and variable costs. Again the cash cost basis excludes depreciation and capital costs.

The chlorine value is therefore 1.37 EDC value - 0.39 ethylene value less $40 (as an estimate of fixed and variable costs).

In Asia, with low demand for caustic soda, chlorine prices can represent as much as 80 per cent of the value of the ECU. In contrast with a higher value for caustic soda in other regions, the chlorine cash value to the manufacturer can even be negative, most notably in the Middle East and USA. Very competitive, chlorine chemicals can be anticipated from a possible chloralkali investment in Australia with prospects for negative effective chlorine values. The next illustratively shows the relationship of the cost of power with possible minimum values of chlorine at times of high caustic values. The issue here is not the actual values, but the comparative values which exceed the cost of transport between the regions. In other words, this figure shows extremes of the potential trade threat in chlorine chemicals.

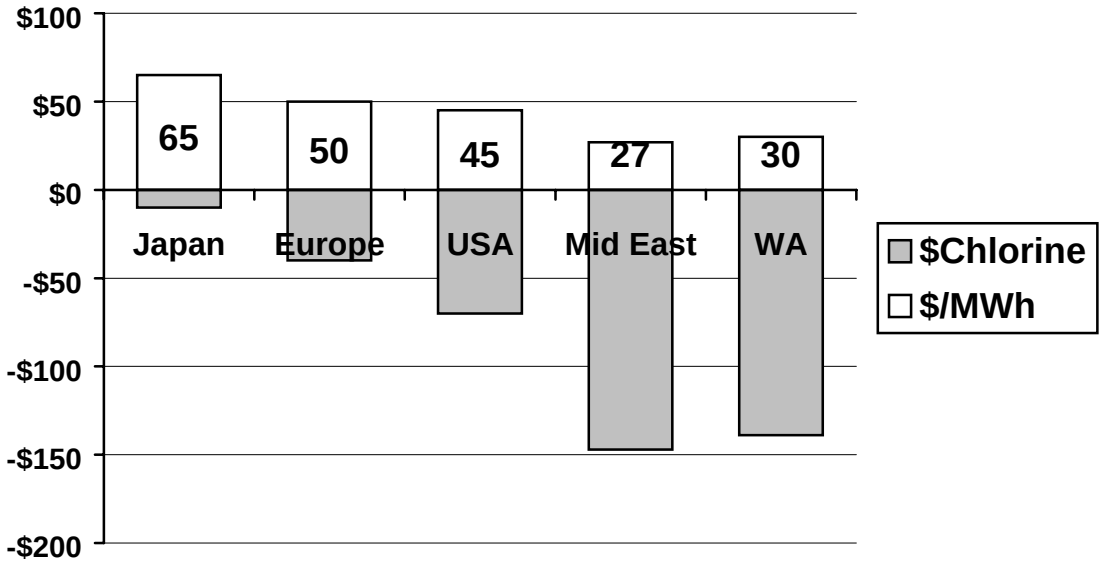

Figure 6 Power costs and potential minimum chlorine prices (effective calculated from EDC) in different regions.

The potential for low value chlorine values cannot be overstated. Investors seeking to establish a chloralkali business should be mindful of the prospects for a new chloralkali plant in Australia integrated into a petrochemical venture.

While prices vary significantly over time, there is evidence of a seven year cycles with the most recent bottom in 1992/93, illustrated by prices, profits or cash flows.

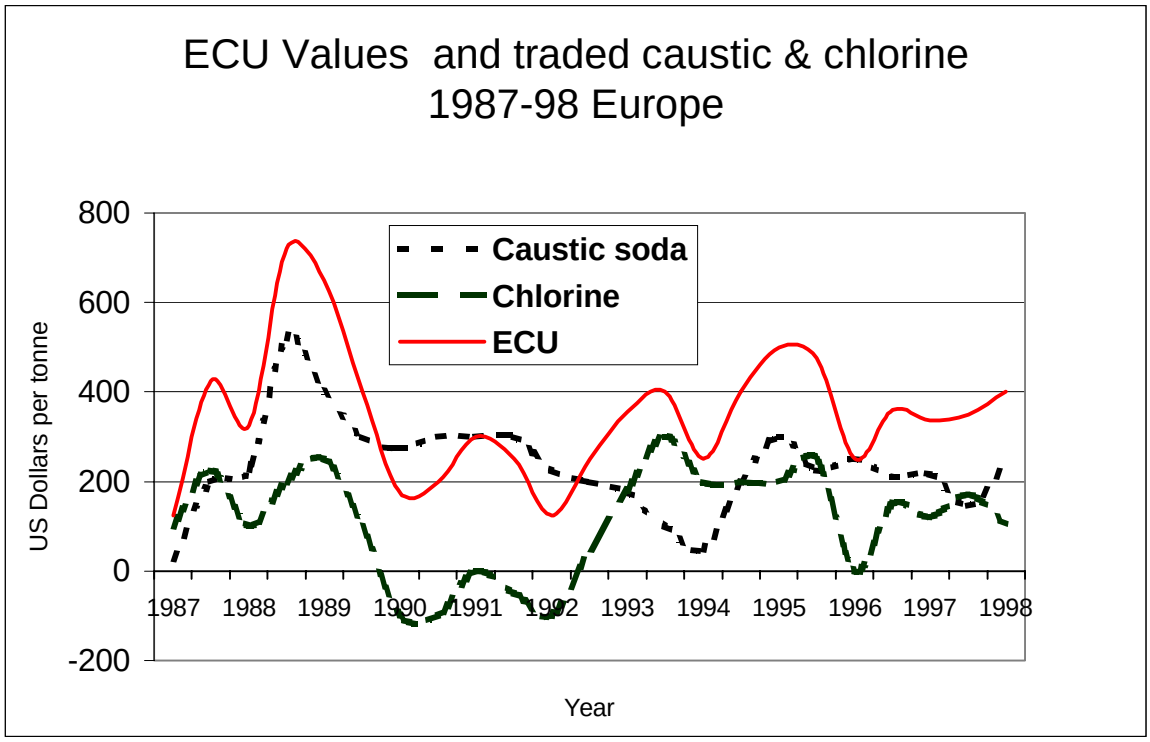

Figure 7 A ten year profile of caustic, effective chlorine and ECU values in Western Europe.

As shown in the figure, from 1987, the prices of chlorine and caustic soda began to diverge with a caustic soda shortage and a surplus of chlorine. In 1993 the trend reversed with caustic and chlorine prices falling reversing again in 1994 so that by end 1996, caustic prices were $275 to $325 per dry metric tonne and chlorine around $165 per tonne. Shortly after, caustic prices fell sharply to below $100 per tonne with chlorine prices remaining firm. Again it is worth noting that spot prices and contract prices for the chlorine can be very different. For example during 1997, while chlorine chemical values have remained firm, the spot price for chlorine had fallen to $80 per tonne in the US Gulf Coast regions. It is presently close to zero values in Asian markets with EDC prices being negotiated at $120 to $140 per tonne.

Of course in trade, the price of chlorine has been deduced from the value of EDC which is 72 per cent chlorine. The next figure shows the price of EDC in the Asia Pacific region has ranged from as high as $400 to as low as $100 per tonne.

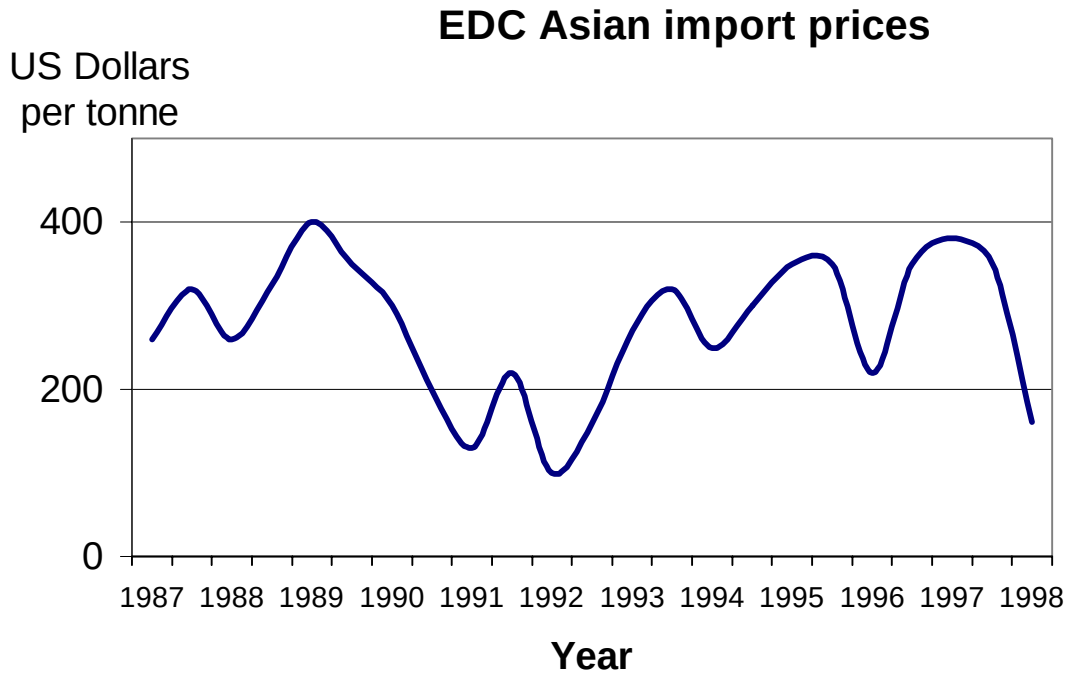

Figure 8 Ethylene dichloride values in Asia (cif) showing major downturn beginning late 1997.

Clearly, in subtracting the cost of ethylene, one can easily show as in this figure that the effective value of chlorine was as low as negative $100 per tonne. Negative values are again emerging with current values of $0 being negotiated again in Asia. A new producer coming on stream in Australia will provide more downward pressure on chlorine prices. It is the local caustic soda market that is the primary focus, the chlorine is a by-product. Such a situation would clearly accentuate the trend to importing the chlorine chemical in favour of manufacture in many high cost parts of Asia.

The importance of vinyl and the value of chlorine

The vinyl chain is the real engine of growth for chlorine as it represents some 35 per cent of the world demand for chlorine whose significance as a chlorine-user grew by 10 per cent per year. As indicated previously, that is not to say the demand for PVC has grown sharply, but only that the demand for the other uses of chlorine has grown slower or has even declined.

As chlorine is hazardous to transport, there is virtually no deep sea transport. Accordingly worldwide, chlorine is moved as the organic derivatives PVC, VCM or EDC that collectively represents some 85 per cent of the trade in chlorine. A further 10 per cent of trade is represented by other chlorine chemicals, notably methylene chloride, chloroform and chloroprene.

During 1996, in the Asia region including Australia, the value of trade in PVC, EDC and VCM, amounted to $1.2 billion per year. Of this, PVC represented 50 per cent, VCM 40 per cent and EDC 10 per cent with some 80 per cent supplied from the USA and Europe. The trade in chlorine represents about 1.4 million tonnes or 10 percent of consumption in the region (ie. some 2.5 million tonnes per year of EDC, VCM or PVC).

EDC however requires a local ethylene source, which while it too can be imported, the cost of its transport and storage is high. Of course VCM has higher transport and storage costs which having been as low as $80 per tonne, today is around $120 per tonne from USA to Asia. At this level, while double the cost of EDC, it is comparable on a chlorine basis. The choice is therefore sensitive to the value of ethylene, and of course the EDC required to produce the VCM. Some countries like Japan import EDC while exporting VCM reflecting their surplus ethylene production capacity. The recent currency shifts has created unusual situations distorting the economics of manufacture. For example though haven fallen 20 per cent in US dollar terms, the price of imported VCM, has risen in local currency terms above the home market price of PVC. This anomaly is promoting exchanges of EDC for VCM between local manufacturers and an overall reduction of vinyls imports. The profile of vinyls trade can be described as fickle.

The prospect of an investment in Australia should be noted. With the closure in 1996 of ICI's VCM synthesis plant, Australia has become one of the larger

importer of VCM in the region together with Thailand. Australia imports some 180 000 tonnes of VCM per year, equivalent to 100 000 tonnes of chlorine. As it is also the largest importers of caustic soda in the region, it points to Australia's potential as a major chloralkali producer given its large gas reserves. A potential investment in Western Australia would produce some 450 000 tonnes of chlorine. Even if the local market were to be supplied by the project, some 75 per cent, or some 350 000 tonnes of chlorine, would be exported. The venture could therefore represent 25 per cent of foreign trade in chlorine chemicals in the region in year 2003.

Demand and trade

The key to the future for chlorine, and of course caustic soda, is the outlook for PVC that represents the major and, more importantly, growing application for chlorine.

While world demand for PVC is projected to grow at around 2 per cent per year, it will be around 5 per cent in the Asia-Pacific region. Accordingly, over the next five years, some 40 per cent of the world's capacity increase in PVC manufacture is anticipated to be in this region, with demand growing to 50 per cent of world capacity. This is promoting major imbalances reflecting relative costs of production. The USA and Middle East with a surplus of chlorine, and a growing deficit in the Asia-Pacific region. Though contingent on the confirmation of all the announcements for investments in chlorine chemicals, a deficit of 2 million tonnes per year of chlorine is projected by year 2000.

Of course this is an aggregate description of chlorine flows. Some countries can be importers of EDC and exporters of VCM. Japan has responded to a recession in their home market for PVC with an export drive to dominate the VCM trade in the region. Even though importing EDC, Japan has replaced the US as the main foreign supplier to markets such as Taiwan and Korea. VCM exports presents a way of reducing surplus ethylene capacity even if net importer of chlorine.

The growing deficit in PVC capacity in Asia will be met by imports of VCM/EDC which can be anticipated to double to represent one-half of the world's trade. Net imports of VCM are projected to increase from the current level of 1.2 million tonnes per year, to 1.6 million tonnes per year and EDC to 3 million tonnes by year 2003. Of course all this depends on the relative price of VCM compared with PVC and the pattern of protection (import tariffs) provided for the process steps. Chlorine chemicals imports can be anticipated to be around 2 million tonnes per year as chlorine around year 2000 - representing an increase of 70 per cent.

The status of market demand, projected production capacity, the deficit or production surplus is shown in the following table for year 2000.

Country	Demand	Capacity	Surplus/Deficit production PVC	Imports of EDC/VCM expressed as PVC	Total vinyls imports	Vinyls imports/demand
Japan	2200	2900	700	-1200	-500	-0.23
Taiwan	1200	1500	300	-500	-200	-0.17
China	2800	1800	-1000	-500	-1500	-0.54
India	850	900	50	-600	-550	-0.65
South Korea	950	1100	150	-1000	-850	-0.89
Thailand	650	750	100	-500	-400	-0.62
Indonesia	450	650	200	-300	-100	-0.22
Philippines	130	10	-120	-150	-270	-2.08
Vietnam	100	8	-92	?	-92	-0.92
Malaysia	190	380	190	-300	-110	-0.58
Total	**9520**	**9998**	**478**	**-5050**	**-4572**	**-0.48**

Table 1 PVC Demand and production projected year 2000 in '000s tonnes (EDC expressed as VCM) and vinyl imports expressed as ratio of domestic demand.

The PVC trade balance is summarised in the following graph.

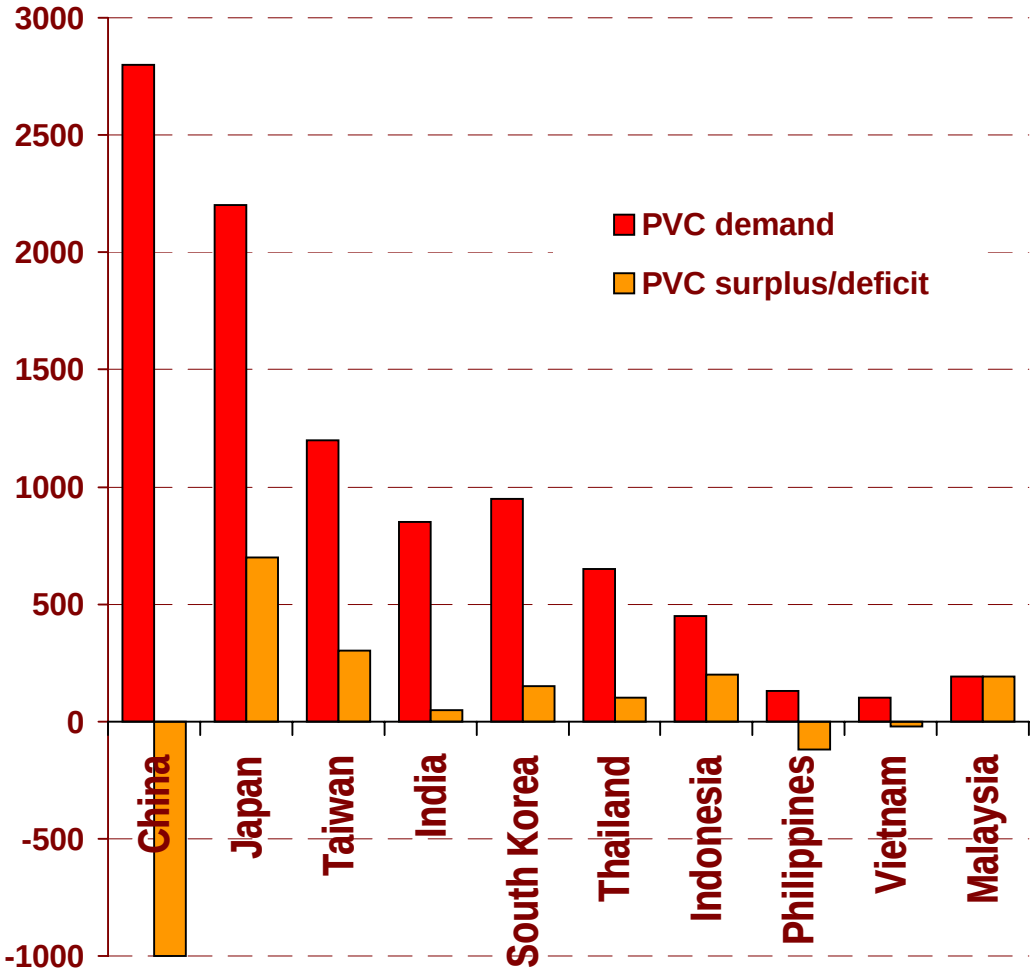

Figure 9 PVC markets and imports of PVC projected to year 2000 in tonnes per year.

Of course this shows the trade in PVC resin - VCM is only one small step away and close to that, its precursor, EDC. The following graph shows a more interesting extended profile of markets and trade, again projected to year 2000.

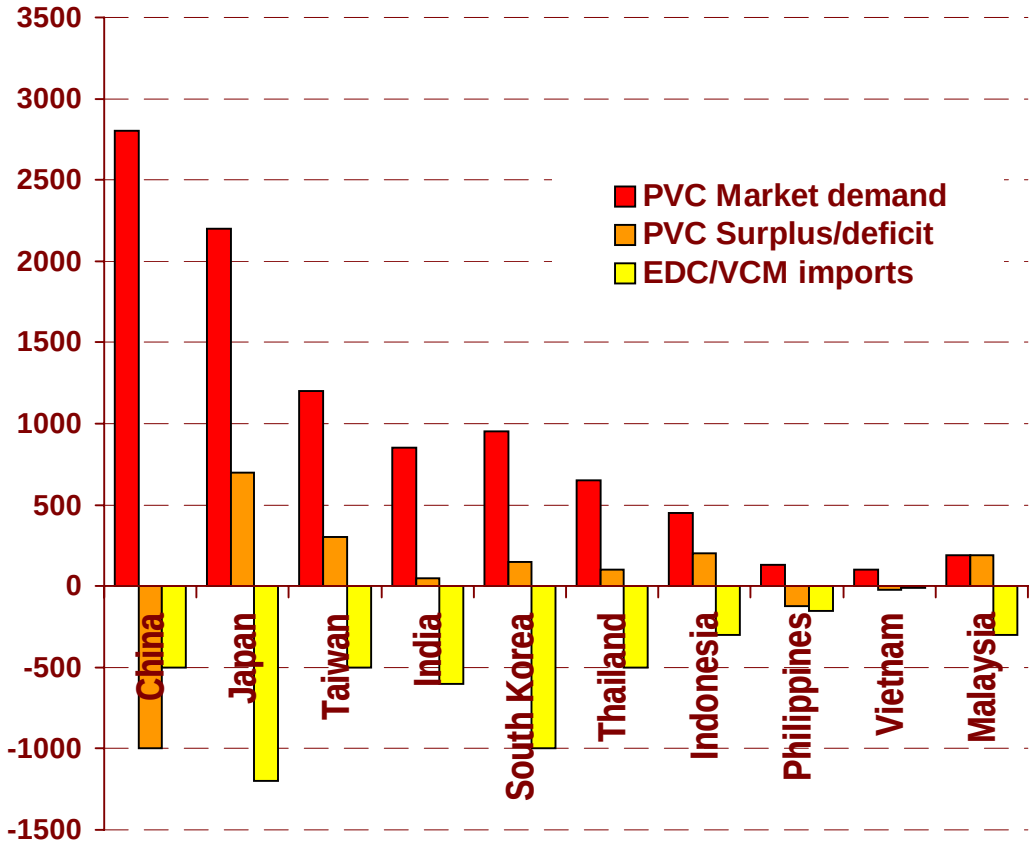

Figure 10 PVC year 2000 projections of markets and trade in tonnes. Also shows imports of PVC precursors EDC and VCM with EDC expressed as tonnes VCM produced projected to year 2000.

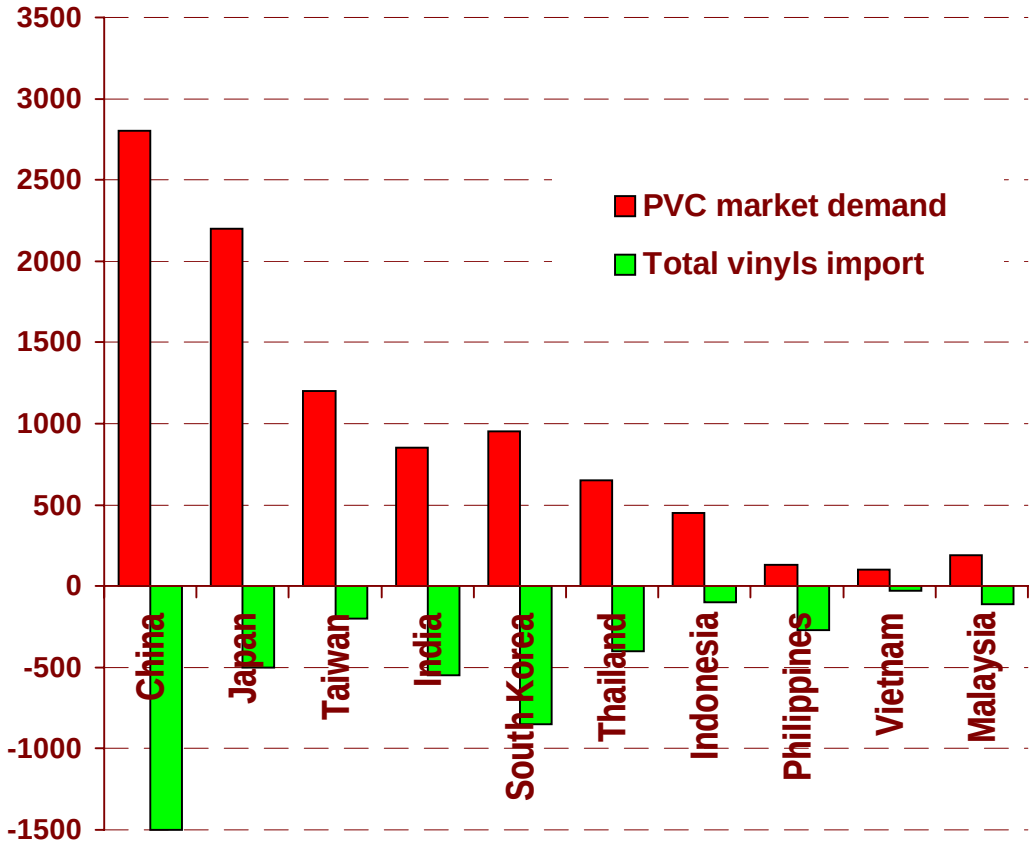

Figure 11 PVC demand and the net total of imported vinyls (PVC, EDC and VCM) in 000's tonnes projected to year 2000.

Clearly countries that export PVC resin, generally import an even greater amount of EDC/VCM. Some like China largely imports the resin whereas others like Japan. Taiwan and India import its precursors. Countries that are net importers of chlorine, can also be exporters of VCM to utilise surplus ethylene or VCM capacity. The choice is influenced by strategic initiatives that promoted underutilised capacity, but often also by import tariffs that favoured one activity over another, or at least the production of PVC from imported EDC or VCM.

By year 2003, the region will import 6 million tonnes of vinyls of which some 80 per cent will be as the PVC precursors EDC and VCM. Some countries such as India will be net exporters of PVC resin, but a net importer of chlorine.

This raises an important issue of why Asia is projected to continue to import chlorine chemicals and in increasing amounts. The answer is simply determined by the demand for the co-produced caustic soda. Indeed caustic soda is the pivotal influence with a production profile shaped by the demand in the home market, by import tariffs and the cost of the ECU.

This is illustrated in the following figure.

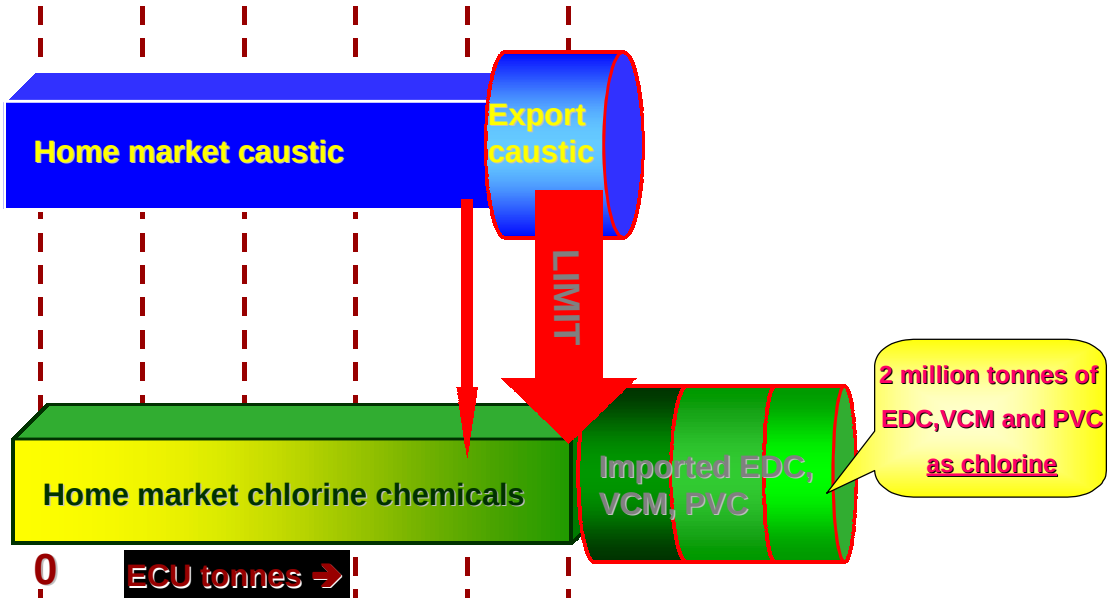

Figure 12 The home market for caustic determines the chlorine available for the manufacture of EDC/VCM. High ECU costs in Asian region limits exports of caustic soda that would serve to extend chlorine production.

In Asian countries the market for caustic soda is smaller than for the co-produced chlorine. While in some low cost regions such as the USA and the Middle East, caustic is exported, higher ECU costs in Asia limits exports to marginally priced levels. Consequently the less competitive Asian regions are increasing the imports of chlorine.

Naturally the more caustic can be exported, the less vinyls need to be imported. In other words, caustic soda exports are enhanced by import tariffs and lower ECU costs promoted by scale and more competitive power costs.

The mix between the choice of vinyls is strongly influenced by;

- the import tariff regime, that might support the polymerisation of VCM in place of the import of the resin;
- internal freight arrangements that might promote the cheaper to transport and chlorine-dense EDC; and
- the cost and availability of ethylene required for EDC for conversion to VCM.

As a generalisation and subject to the above, lowering import tariffs, from say from 30 per cent levels to 10 to 15 per cent by year 2000 and 10 per cent by year 2002, will promote the greatest proportional growth of imports of PVC, a little less in VCM and the least in EDC. Again, imports will grow faster than domestic production, and EDC will represent the largest volume source of vinyls as a chlorine dense medium.

While the mix of imports of vinyls varies between regions, the percentage chlorine imported by Asian countries will grow with increasing investment in low cost centres such as the Middle East and, perhaps, Australia. This despite the rationalisation of older and smaller operations including the conversion of acetylene based ethylene plants in inland China and the shift to competitive scale industry on its coastal regions will slow. The overall trend for increasing imports will continue though the mix of chlorine chemicals will vary between regions.

There are many reasons contributing to the different trade profiles. China for example imports most of its vinyls as PVC resin which is less demanding on supporting infrastructure than its precursors EDC or VCM. Some countries

promote their export performance in PVC resin though they may import its close precursor VCM enabled by an import tariff regime that allows profitable exports at below the home market prices. Such exports are above the variable cost of production even if below home market prices. Put another way, their export capacity is cross-subsidised by consumers in their home market, paying tariff-inflated prices. A reduction of tariffs will lead to reduced export activity.

Presently many Asian countries are operating intrinsically high cost operations partly offset by lower labour costs. Being in their first phase of development, the current recession and, for some countries, high tariffs and depressed currency values, serves only to slow their eventual upgrading or replacement with more efficient units. For the present, small high cost production and generally with limited integration into downstream production, is being offset by low labour costs and import tariffs. Rationalisation is required in a number of countries, including those taking pride in their exports of PVC paid for by home market consumers paying tariff inflated prices for PVC. Of course the process of rationalisation is not confined to Asia, North America and Europe will also see extensive rationalisation of less efficient operations.

The second phase of industrial development - that of large scale plants - has already begun in some countries helping slow the pressure to import the chlorine chemicals.

The third phase of integration into world-scale operations is beginning to occur exemplified by the proposed Australian chloralkali centred petrochemical project in the state of Western Australia.

These developments, that serve to reduce costs and improve efficiency, are however also occurring with more general increased economic development that demands more PVC for plumbing, electrical goods and construction. As exemplified by the growth in chlorine imports, industrialisation fails to keep up

with the growing local market for PVC. The restraint being the limited market for caustic, which because of high ECU costs, is not competitive against chlorine producing regions, notably the USA and the Middle East. These cycles are summarised in the following chart. The upper line shows increasing imports despite increased industrialisation at improving efficiencies.

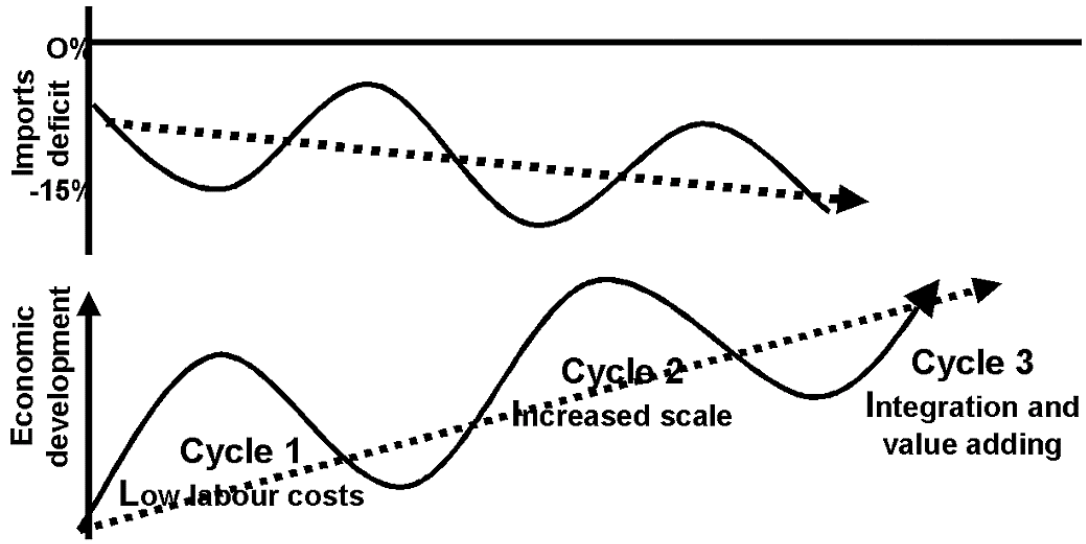

Figure 13 Increased economic development, with faster growth for caustic than chlorine, serves to place pressure on the imports of vinyls.

Naturally the lower currency values recently experienced in Asia serves to raise the cost of imports and slow the rationalisation process to favour large-scale low cost operations- the underlying trend to import chlorine chemicals will however continue. By year 2003, the Asian region will represent 50 per cent of the world trade in the vinyls, EDC, VCM and PVC - this despite Asia representing some 40 per cent of new capacity being installed around the world.

Thus while in 1996 some 80 per cent of Asian PVC demand was supplied by the domestic production of chlorine, by year 2003 it is projected to fall to below 50 per cent. Some 5 million tonnes of vinyls, of which 80 per cent will be EDC and VCM, is anticipated to be imported. Again, this is simply because of uncompetitive power costs restraining caustic exports. It is that imbalance in demand between caustic and chlorine in the home markets that will require a growing proportion of chlorine to be imported, as PVC resin and its precursors.

Again, and to stress a point, tariffs and surplus installed ethylene or VCM capacity, can modify the balance and the profile of trade.

Broadly the higher the ECU cost, the greater the propensity to import the vinyls. Import tariffs and short term currency fluctuations will of course influence that relationship in the intermediate term which is schematically shown in the next figure. The net trade in chlorine correlates to the cost of the ECU in the region.

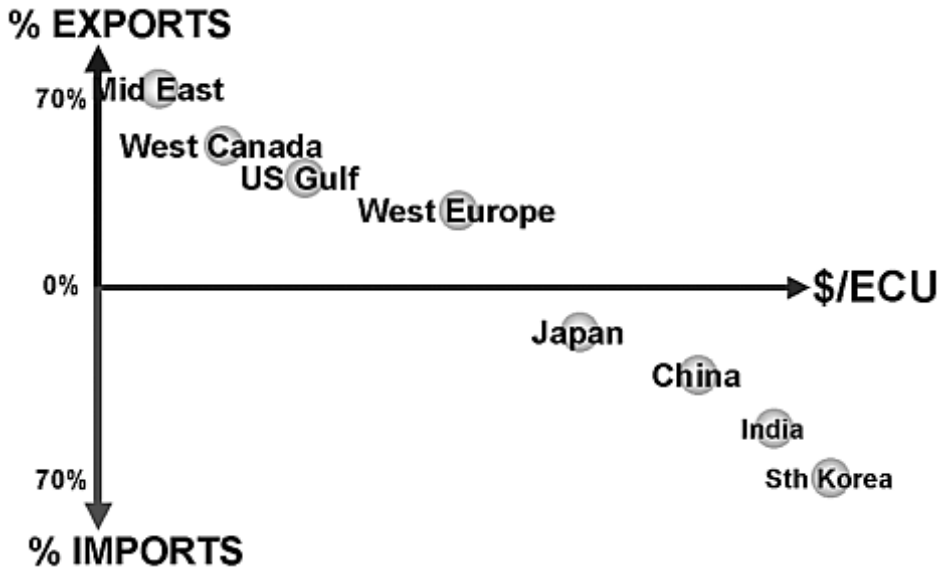

Figure 14 The projected trade in the vinyls, EDC, VCM and PVC and ECU in countries of manufacture. The direction of net trade correlates with the cost of the ECU.

Prices

There are therefore regional movements in the production, demand and trade in chlorine which is superimposed by global movements. These global movements have a cyclical pattern.

The global pattern is well illustrated in the next figure showing ECU values for the last ten years typical of past periods. It suggests short-term two-year cycles superimposed on larger seven-year cycles.

As previously shown, while the effective value of chlorine, as incorporated in chlorine chemicals, generally moves in an opposite direction to caustic, the value is also jointly moved with caustic in major cycles. This cyclical nature is shown anticipating a period of weakness through 1999.

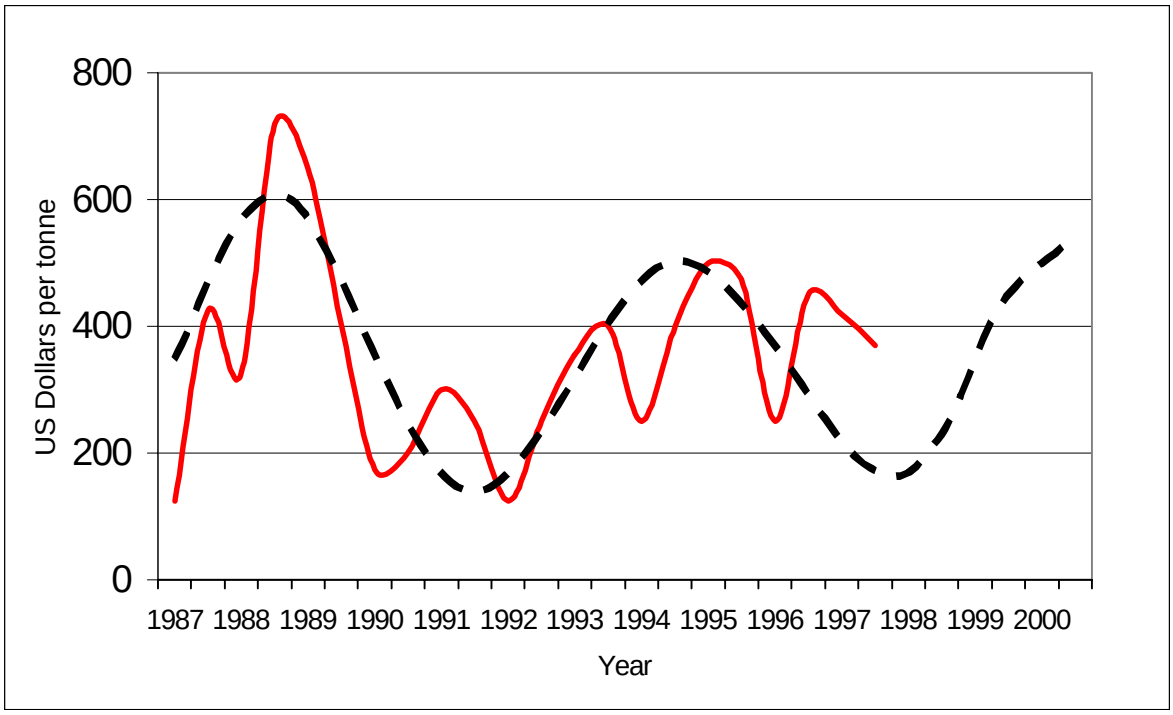

Figure 15 ECU values in Europe (smoothed) with underlying cycle and projection to year 2000. Shows two and seven year cycles about a mean of about $380.

A broad short-term projection is therefore for weak chlorine prices through 1998/99 with a general upturn through year 2002. For any country, regional shifts in production and trade are an important influence for any operator, most notably in the faster growing Asian region.

Considerations for new investors

Australia

As indicated previously, Australia aims to attract a petrochemical venture centred on chloralkali production. With a one million tonne local market for caustic soda, it could competitively produce chlorine chemicals at a substantial negative effective cost. For Asian countries, its establishment would therefore

reinforce the trend to import EDC or VCM placing further pressure on their small high-cost chloralkali businesses.

Protectionism

Import tariffs help protect the home market for many countries. Tariffs do not help selling surplus caustic or chlorine chemicals into world markets - so important for expanding chlorine production. Tariffs have little effect in levelling the chlorine/caustic imbalance.

The World Trade Organisation is promoting tariff reductions that would result in lower home market prices as they approach open market levels. Though leading to some plant closures, lower tariffs is promoting the shift favouring world-scale operation. Of course anti-dumping measures may help offset some of the effect of lowering tariffs reducing the incentive to sell at marginal prices. However it is clear that import tariffs and the enforcement of anti-dumping measures should be closely monitored as these have direct and indirect influences on current and potential industry.

Notwithstanding the fundamental competitiveness issues, new projects can still be promoted in marginally competitive regions. These could include;

- National incentives and facilitation measures aimed at regional employment or industrialisation.
- Synergistic gains from new investment linked to other activities where other indicators would otherwise rule out competitive operation.
- Adoption of new technology that provides intermediate term competitive advantages. EVC in Western Europe has developed new technology to produce EDC direct from ethane. With ethylene prices around four-times that of EDC, there is potential for an one-third reduction in the cost of producing EDC. Being chlorine intensive, the new technology could serve to depress the price of not only EDC, but it could flow on to depress the

price of chlorine. Naturally, lower chlorine prices will place pressure on smaller and less competitive chloralkali producers.

The environment

Chlorine chemicals are under scrutiny in many parts of the world. The paper and pulp industry may be driven to using non-chlorine bleaching agents, and PVC is under close scrutiny.

- Greenpeace have estimated the cost of reducing chlorine use in the US and Canada to one-half at only $4bn per year. A Swedish commission is reviewing a trade ban. The EPA in the US has considered the level of dioxins, by-product of chlorine chemical production, use or destruction, in the human body to be at maximum acceptable levels.
- Plasticisers used with PVC, notably the phthalates, have been identified as being endocrine disruptors (hormone like substances) and a basis for concern and possible trade bans.
- PVC will not be used at the Sydney 2000 Olympic Games where it can be replaced by other plastics.

The environment is an important issue for chlorine and chlorine-using industries. Restrictions would directly impact on the caustic industry and caustic-using industries by increased prices. It goes without saying that these environmentally motivated initiatives should be closely monitored.

Regional commentary

Asia in perspective

About 14 per cent of demand for all chlorine is represented by imports of the chlorine chemicals EDC, VCM and PVC.

The demand for chlorine in Asia is growing at double the world rate at around 4 per cent per year to represent around 40 per cent of new capacity by year 2000.

Increasing from 12 million tons per year in 1996 to 13.5 million tons in 2000. At this rate of growth it will overtake the USA by year 2005 presently producing around 14 million tonnes of chlorine per year.

However more significantly, of the 14 million tonnes of chlorine, about 40 per cent of demand will be imported as EDC/VCM or PVC resin. By year 2003, Asia will be the destination of two-thirds of world trade in chlorine chemicals!

China

China is a growing market for caustic and chlorine with some unique aspects and most notable being that only some 23 per cent of the 5 million tonnes of chlorine produced is for PVC - which is well below the world average of 35 per cent. A contributing factor is the large proportion of chlorine used for water treatment to represent around 20 per cent, some ten-times greater than in the USA and Europe. Other applications include for the manufacture of pesticides and other organic derivatives, each representing around 10 per cent of chlorine use. This pattern is therefore consistent with the high proportion of small-scale production centres dedicated to produce chlorine for water and waste treatment and smaller scale chemical manufacture. The scale-related operating cost penalty being offset by the high cost or impracticality of transporting the chlorine.

China like other Asian countries is a high cost producer of chloralkali chemicals and PVC (two-thirds produced from acetylene in small scale production units). China is projected to import one million tonnes of PVC representing one-third of its PVC resin by year 2000.

It is worth noting how quickly import balances can change. In 1989, China was a net exporter of PVC but with economic growth, in just three years, imports grew to represent 25 per cent of the market by 1992. The continued growth of the Chinese economy at around 8 per cent per year and using less than one-half

the world's per capita average of PVC, will underpin demand for chlorine for some decades. By year 2000, China will have capacity to produce 2 million tonnes per year of PVC, requiring 1 million tonnes per year of chlorine. While production capacities will therefore continue to increase at double the world average. And becoming increasingly competitive with increasing scales of production, intrinsically high costs will continue to restrain caustic exports. China will increasingly import chlorine chemicals notwithstanding industry rationalisation and investment.

As with other countries in the region, the growth for chlorine chemicals, largely PVC, will outstrip growth in demand for caustic soda. Growth at 1.5 to 2 times the rate of growth of GDP, around 13 per cent, can be anticipated for chlorine. Caustic soda will grow more slowly at around 8 per cent. This imbalance will ensure that China remains a major importer of chlorine.

South Korea

South Korea has a chlorine market of 1.2 million tonnes per year of which 60 per cent or 0.7 million tonnes per year is represented by PVC resin. Chlorine demand is growing at some 10 to 12 per cent per year - twice the growth of GDP while caustic is slowing to around 8 per cent per year. The limited and slower growing market for caustic means that some 40 per cent of chlorine is imported (85 per cent represented by VCM and PVC - the balance represented by chlorine-derived chemicals).

Thus there is not only a major shortage of chlorine and caustic soda, the imbalance will see Korea remain an importer of chlorine from some 200 000 tonnes in 1990 doubling to around 370 000 tonnes today.

Conclusion

Clearly the issue for chlorine producers are the markets for caustic. The trade relationship for vinyls is very sensitive to the cost of power and the limitations

imposed by the size of the home market for caustic. Reducing tariffs will promote increasing imports of vinyls from low cost ECU regions, which includes Western Australia.

Within Western Europe itself, leading producers are reluctant to invest in cost-efficient plants few have world-scale plants.

There will be a growing number of EDC exporters, especially in like the Middle East, but fewer large EDC importer customers. Qatar and Brazil are likely to emerge by 2000 as major new players in the deep-sea EDC exporting market, while Saudi Arabia will be doubling its export capacity.

Chlorine is an important chemical whose outlook is consequently very sensitive to economic and environmental influences. Environmental trends should therefore be closely monitored for PVC.

In the shorter term, producers should watch the ECU cycle and an announcement of an investor in the Australian chloralkali industry. The trend in chlorine production and trade is complex.