PRODUCTIE 1

Vacuum Salt Capacity in Western Europe

A report prepared for
The European Salt Producers Association
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TABLE OF CONTENTS

I INTRODUCTION

The European Salt Producers Association (ESPA) estimated that a substantial over-capacity for the production of vacuum salt existed in Western Europe. That view was, however, based on its own researches and might therefore not be accepted as being truly independent by other parties. Accordingly, early in August 1994 it contracted with Chem Systems for an independent survey of that production capacity together with a brief review of the demand for vacuum salt. Following discussion between ESPA and Chem Systems, the definition of the salt was widened in order to embrace not only vacuum salt but also "salt of like quality". During the course of the study it became clear that no satisfactory single definition of the phrase "like quality" is available and hence the work has set the position of vacuum salt within that of all qualities of so-called crystallised salt.

The study set out to confirm both the nameplate capacities and the effective operating capacities for vacuum salt. Effective capacity is defined as the real production capacity rather than the production capacity for which the plant was designed. A number of factors will influence real capacity. On the positive side these factors include conservatism by the plant designers and/or post-construction debottlenecking such that the plant is actually able to exceed its design capacity. On the negative side unexpected, and unpredictable, geological faults can sometimes limit the volumes of brine that may be extracted from a salt deposit.

Vacuum salt, in common with all salt qualities, is produced at or close to a source of salt. That source may be the sea or natural brines that contain salt; it may be solid deposits that were formed during the distant past of the Earth. In the case of solar salt, that is salt which made by using the sun to evaporate the sea or a natural brine, production on an industrial scale can only occur where the climatic conditions favour it. Thus such production is found in the southern parts of Europe, principally along the shore of the Mediterranean Sea. Huge deposits of salt underlie many countries in Western Europe. The study covered salt production in the following countries:

- Austria and Switzerland
- Belgium
- Germany
- The Netherlands
- United Kingdom
- Denmark
- France
- Italy
- Spain and Portugal

In addition to the comparison of nameplate and effective capacities, recent production levels were reviewed in order to determine the difference between production capacity and actual production, in other words the extent of any over-capacity.

Upon authorisation of the study, Chem Systems executed a Secrecy Agreement with ESPA that provided that any confidential proprietary data that are released to Chem Systems would not be made available to any individual ESPA member. In order to protect the confidentiality of the data it was also agreed that the report would aggregate the findings to describe a West European total.

ESPA required that the study be completed during August. That timescale meant that it was impractical to visit all the salt producers and therefore visits were made solely to the principal producers. The other producers were, however, also contacted and asked to provide the data needed by filling out a questionnaire. All the replies were analysed. Wherever clarification and/or amplification of these was required, the companies were contacted again, generally by telephone.

II MARKET AND TRENDS

A. BACKGROUND

Each salt producer reports its sales to its national producer association and these data are also reported to ESPA. This ensures that ESPA's data series are both comprehensive and internally consistent. For these reasons those data series have been used in setting the scene for salt consumption in Western Europe. There is no production of salt in Finland, Norway and Sweden, which are defined for the purposes of this study as the Northern Countries. ESPA does not therefore have good information available on the markets and their trends in those countries. Some data are available from the national import statistics. They are, however, not especially useful; for example, the figures for salt imports in certain of the last ten years are missing. Thus, in the main, the discussion here of the end-use markets and trends therein relates to the situation in the other countries of Western Europe.

In its statistics ESPA describes the product upon which it is reporting, as being "crystallised salt". That description defines salt that is marketed in solid form. It does not include salt which is obtained and used uniquely as salt-in-brine. Considerable volumes of salt-in-brine are used, primarily by the chemical industry and generally where the brine extraction and the chemical production are in the hands of the same enterprise or one that is affiliated to it. Were such salt to be included in the official statistics, the importance of the chemical industry as a consumer of salt would be even greater that it is shown to be.

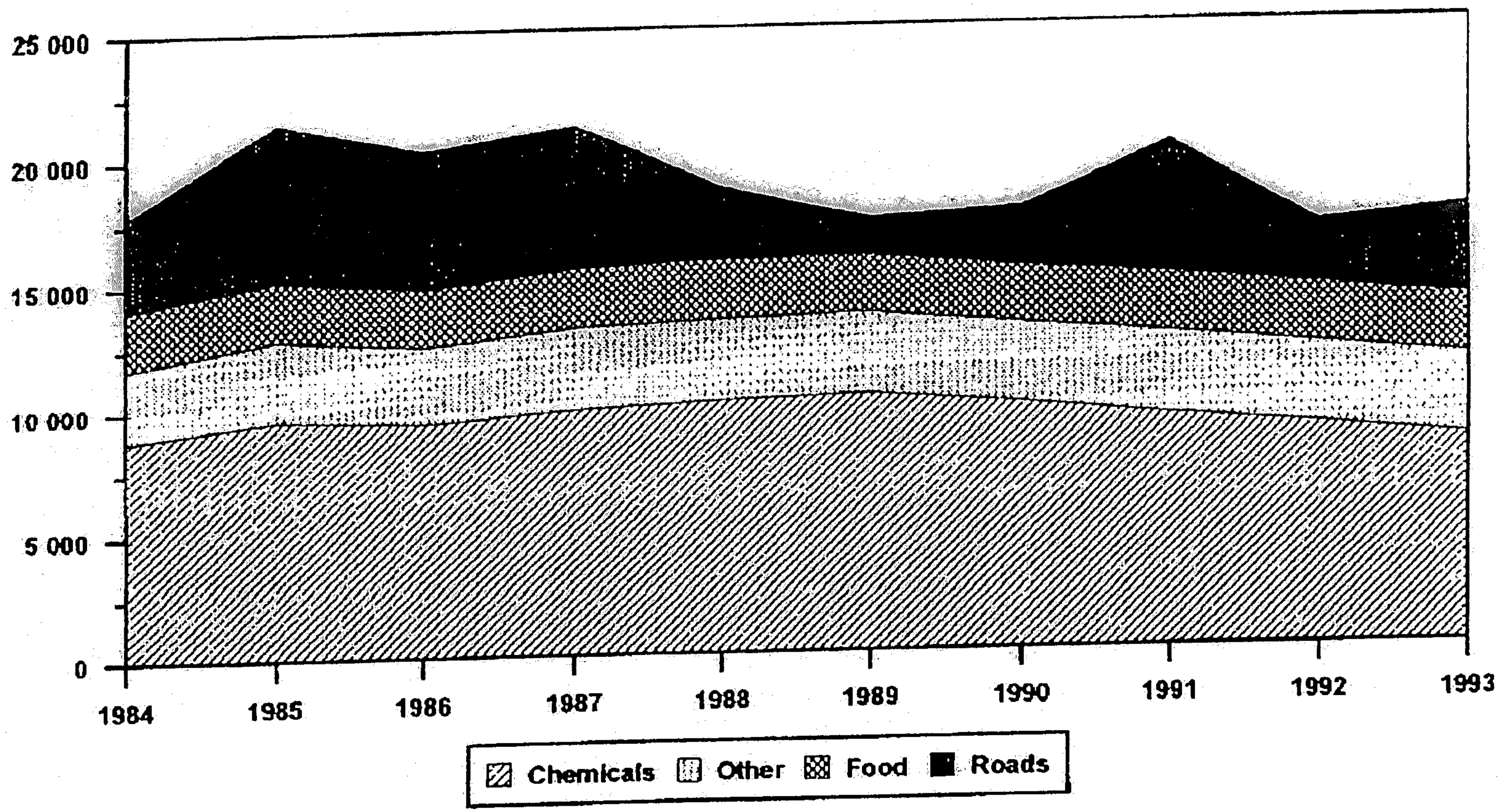
The description "crystallised salt" embraces all qualities of solid salt, ESPA makes no attempt to distinguish between the various qualities and/or sources that are used. Thus the definition includes, for example, salt that is recovered as a co-product in potash mining. It also covers rock, solar and vacuum salts.

ESPA reports salt consumption under four headings:

- chemical industry
- food industry
- other industrial uses
- roads

The balance of consumption between these end-uses is illustrated in Figure II.A.1. Although the "Western Europe" that is shown, excludes the Northern Countries, there are good reasons to consider that the balance of consumption there is broadly similar.

FIGURE II.A.1
WEST EUROPEAN CONSUMPTION OF SOLID SALT
(thousand tons per year)



Inspection of Figure II.A.1 shows that crystallised salt consumption in the three industrial markets has declined from its peak in 1989 of 15.8 million tons to 13.8 million in 1993. From the incomplete statistics that are available, consumption of salt in the Northern Countries is considered to have been in the range of 1.8 to 2.5 million tons per year during the last ten years.

As will be shown in the following discussion of the individual markets, there are no grounds for believing that this slow decline will be reversed in the coming years; at best demand is likely to do little better than remain stagnant.

Use on roads, which is limited to de-icing highways during the winter, depends exclusively upon national weather conditions and is therefore unpredictable and irregular.

B. CHEMICAL INDUSTRY

1. Introduction

Salt has been a basic raw material for the chemical industry since its development in the latter years of the eighteenth century. In those early days its use was associated with the manufacture of sodium carbonate (soda ash) and of sodium sulphate. Soda ash was itself a raw material for a number of chemical products including sodium hydroxide (caustic soda). The development of electro-chemistry in the nineteenth century led to the birth of the chlor-alkali industry which used salt to co-produce chlorine and caustic soda. And today it is the chlor-alkali industry that represents the major chemical end-use for salt across the world.

2. Soda Ash

Soda ash is obtained either by chemical synthesis or by working up natural minerals. Western Europe has no deposits of suitable natural minerals and therefore all its manufacture of soda ash is synthetic, using a technology called the ammonia-soda or Solvay process. The raw materials for that process are salt and limestone. The process stoichiometry requires approximately one unit of both salt and limestone for each unit of soda ash that is made. This heavy dependence on low cost raw materials has led to the establishment of production plants near to a source of at least one of these raw materials. The process actually uses salt in aqueous solution; it does not require solid salt. Thus, where available, salt-in-brine is an ideal raw material, requiring fairly simple purification before being consumed.

The annual capacity for soda ash in Western Europe now is of the order of six million tons. Thus, if it were run near to that capacity, it would consume somewhat more than six million tons per year of salt. The major part of that salt is consumed as salt-in-brine. While some solid salt continues to be used, the quantities involved are relatively small. In addition the demand for soda ash is relatively static and it is improbable that any new synthetic soda ash plants will be built in Western Europe in the future.

3. Sodium Sulphate

Sodium sulphate is made in a number of ways in Western Europe:

- extraction from natural minerals
- co-production with hydrochloric acid
- by-production of chemical and textile manufactures
- recovery from waste streams

Only the co-production process uses salt. In that process salt is reacted in a furnace with sulphuric acid to yield hydrochloric acid and sodium sulphate; the salt used is high quality dried vacuum salt. The economic viability of that process is influenced very strongly by the market conditions for both the products, hydrochloric acid and sodium sulphate. The market demand for the latter has been declining for many years now. And, as there is a number of other methods whereby hydrochloric acid may be made, the situation can become very complex. The result is that the production of sodium sulphate by this route, and hence its demand for high quality salt, has declined in recent years. Further, there are no reasons to consider that this decline will be reversed in the coming years.

4. Chlor-Alkali Industry

The basis of this industry is the electrolysis of a chloride to yield chlorine and a co-product. By far the most important chloride, accounting for at least 95 percent of all chlorine production, is sodium chloride, salt. The other chlorides in commercial use are potassium, magnesium and hydrogen. Where salt is used, the co-product is nearly always caustic soda; the exception is sodium metal. In terms of the whole picture, sodium metal production is extremely small and will not be discussed further here.

West European production capacity for chlorine from salt is of the order of 10.25 million tons per year; this includes the capacity in the Northern Countries. As a general rule this manufacture uses 1.7 tons salt per ton chlorine. Thus, if operated at capacity, it would consume over 17 million tons per year of salt. That salt need not however be solid salt; many chlorine producers have own salt deposits from which they extract salt-in-brine for use in their electrolysis cells.

Chlorine is consumed by many manufactures and industries, these include:

- the plastic PVC (polyvinyl chloride)
- chlorinated solvents
- chlorinated fluorocarbons (CFCs)
- manufacture of propylene oxide and other chemicals
- bleaching of paper pulp
- disinfection of water.

This list of end-uses is intended to be indicative rather than comprehensive, although it does include the major applications for chlorine in Western Europe. During the last years there has been increasing public concern about the use of chlorine, generally on environmental and/or ecological grounds.

This study is certainly not the place to argue the merits and demerits of the cases that have been made against chlorine and its compounds. It is sufficient to note that this concern has resulted in a marked reduction in certain uses for chlorine. On occasion this reduction has been accompanied by regulatory action; these reductions include:

- switch away from the use of chlorinated solvents
- the phase-out of the manufacture and use of CFCs in many countries
- use of elemental chlorine as a paper pulp bleach has disappeared in many, if not all, West European countries.

The effect of these, and similar actions, may be seen from the changes in the production index that is set out below (Table II.B.1)

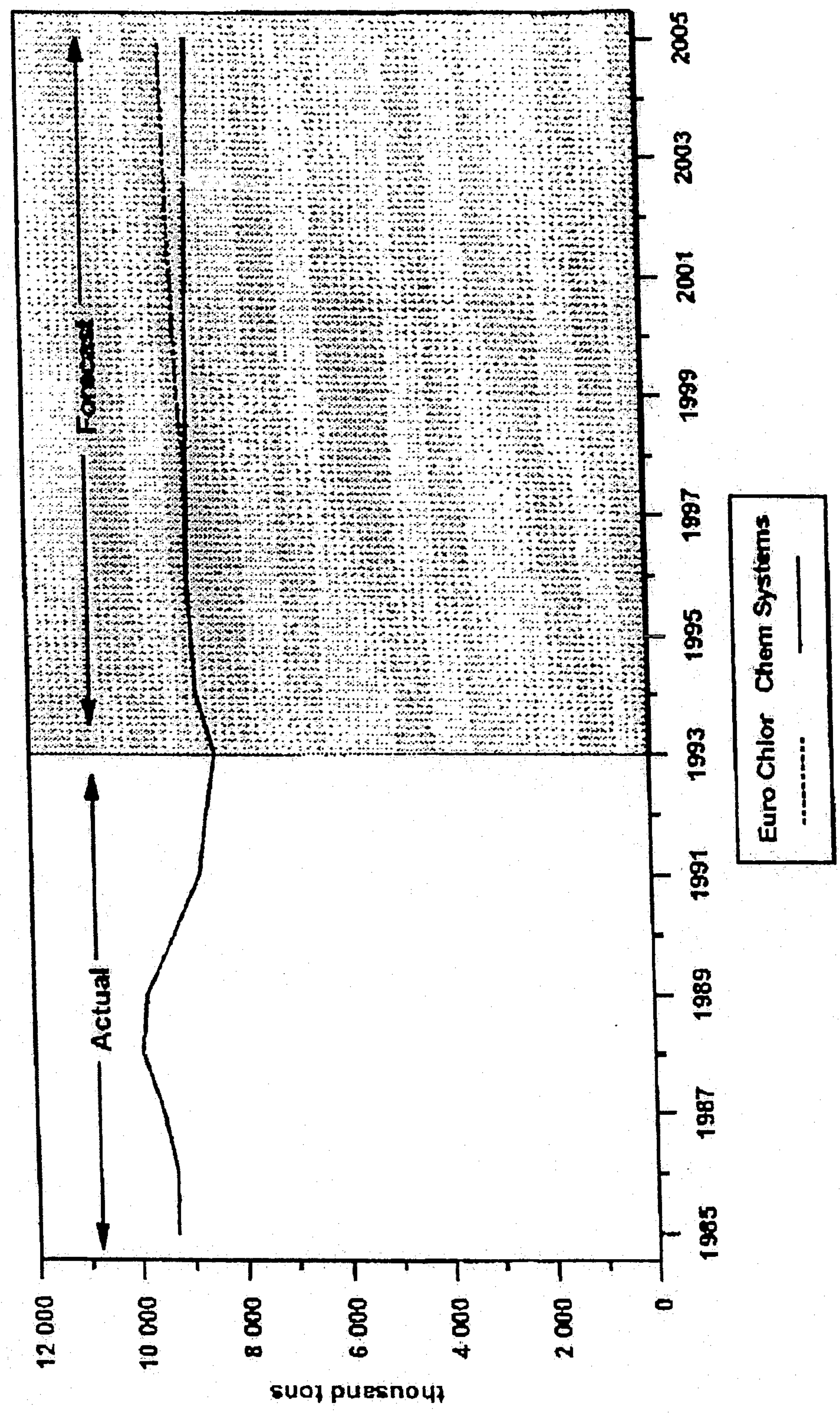
TABLE II.B.1
INDEX OF CHLORINE PRODUCTION IN WESTERN EUROPE
(1986 = 100)

1985	1986	1987	1988	1989	1990	1991	1992	1993
100.2	100.0	102.7	106.7	105.6	99.6	94.3	92.6	90.8

This reduction in chlorine production has been reflected in a reduction in production capacity; thus, if the capacity index in 1986 was 100, by 1993 it had dropped to 93.7.

It is certain that a part of the fall in production index is attributable to the recent Europe-wide business recession. In recognition of this the West European industry is forecasting a very modest increase in demand, and hence production, in the coming years. For a variety of reasons Chem Systems is less optimistic than the chlorine industry is itself. This divergence of opinion is illustrated in Figure II.B.1; it is important to note that even the optimistic case does not expect a return to the output level achieved in 1986 at the end of the forecast period, the year 2005, when the "best case" index figure is forecast to be 99.7.

FIGURE II.B.1
CHLORINE PRODUCTION IN WESTERN EUROPE



There will of course be national differences in the performance of the index. Prediction of them would demand an analysis of the chlor-alkali industry on a site-by-site basis. Such detailed review is outside the scope of this study. There are some pointers, however, which suggest that it is the non-integrated producers that face the greatest challenges in the coming years. One, but certainly not the only, measure of non-integration is reliance on external salt supplies. If the suggestion is correct, it implies that any slight upturn in chlorine production may not be matched in the demand for solid salt.

All chlorine producers, however they are integrated, face issues that relate to the technology they use. These issues may lead to changes in the balance of the salt types that are consumed in electrolysis cells.

There are three electrolysis cell technologies used in chlor-alkali plants for the production of chlorine:

- mercury - has the largest installed base in Western Europe, accounting for approximately 63 percent of installed capacity
- diaphragm - about 24 percent of West European capacity
- membrane - the balance of West European capacity.

In each system the feedstock used is an aqueous solution of salt, a brine. Each system requires that the brine be relatively pure; the degree of that purity will depend upon the type(s) of cells being used, their configuration etc. The extent to which the brine/salt must be purified while depending on these factors, will also be strongly influenced by its provenance.

Salt is a natural mineral, it is not a pure chemical. Each salt deposit or part of the ocean contains its own unique mixture of elements; even within one salt deposit there will be variations in the product analyses that depend upon the precise location from which the sample has been drawn. The variations may be extremely small, but they will exist nonetheless; in the same way the analysis of the water taken from a precise place in the ocean will vary with time.

The purification processes that are required before the salt solution is electrolysed, will be designed to remove all the materials present in the crude salt (or brine) that are undesirable. The extent and nature of the wastes produced thereby will be related to the nature of the contaminants in the crude salt (or brine). These purification processes are technically advanced and well-documented, there is no need to repeat their detail here.

In view of the demonstrable performance of these purification systems, it is certainly not possible to say that one cell technology can use only one type or source of salt. Each cell room operator has, possibly to varying extent, a choice of salt type or source. His decision will be influenced by many factors, not least among them is likely to be cost-in-use. The cost-in-use of a particular salt (or brine) will be affected by factors such as:

- cost of crude salt (or brine) at the factory gate
- purification costs
- waste disposal costs.

As noted earlier, the purification cost will be a function of both cell-room technology (or technologies) and the purity of the salt (or brine) as delivered to the factory. Waste disposal costs will be influenced by the volumes and the types of wastes that arise. This is a subject which has received increased attention in recent years, not only from the regulatory authorities but also from the environmentally-aware public.

Much of the focus of this attention has been on mercury cell technology and the emission of mercury to the environment consequent upon its use. Mercury and its compounds are toxic, hence the discharge of them is strongly regulated. There is indeed a wide-spread perception that the use of mercury cell technology must be discontinued by the year 2010. While a proposal to this effect exists, Chem Systems has not been able to confirm that it has been legislated by the West European governments. The West European chlor-alkali industry is working hard to reduce mercury emissions from their cell-rooms; here emissions are defined to cover:

- losses in the process' products (chlorine, caustic soda, hydrogen etc)
- aqueous discharges
- atmospheric discharges, from process exhausts and cell room ventilation.

According to Euro Chlor, the chlor-alkali industry association of European chlorine producers, mercury cell room emissions averaged 26.6 grammes mercury per metric ton of chlorine produced in 1977. By 1992 that average had been reduced to 3.6 grammes per ton, the technology exists whereby it can be reduced even further.

While mercury cell closure by 2010 has not been mandated by governments, there does exist an agreement, known as the Paris Commission, that requires that gaseous emissions (hydrogen, process exhausts and cell room ventilation) shall be less than 2.0 grammes per ton by 1 January 1996, unless an undertaking has been given that the plant will convert to membrane cells by 2000.

Euro Chlor is confident that the emission rate can be reduced further to no more than 2.0 grammes per ton in total using established, proven technologies. Further, it stated in 1990 that through normal commercial and life-time pressures, approximately half the mercury cell capacity, in place then (1990), will have either converted to membrane cells or closed by 2010. Since then some closures and conversions have already taken place.

Closures will have a direct impact on salt use, regardless of its provenance. How the drive to reduce mercury emissions and cell room conversions will affect the salt business in Europe is far less clear. Some observers consider that the chlor-alkali industry must switch to the use of vacuum salt, pointing to its high purity and reduced potential to generate wastes. Others are less certain. The situation at each chlor-alkali plant is unique; each will therefore find its own way to meet industry and regulatory targets. Chem Systems knows of sites which are achieving zero waste discharge with their cell rooms running on high quality rock salts. Those sites will not change to very high purity salts, such as vacuum salt, unless they are required so to do by legislative action.

While legislation to force that change is rumoured in one or two countries, none has yet been enacted. At this time it appears improbable that regulated change of this sort will be enforced across Europe in the near future. Most, if not all, the West European chlor-alkali industry will therefore continue to choose which salt (or brine) best suits its situation.

C. FOOD INDUSTRY

During the past ten years annual salt consumption in this sector has averaged 2.3 million tons in Western Europe, excluding the Northern Countries.

The sector uses salt defined as "salt of food quality" and this definition requires that the product be relatively pure. Thus, this sector is a market that is essentially a consumer of vacuum and solar salts; rock salts are seldom used. Its consumers often require not only that the salt which is supplied to them meets chemical purity specifications but also that it meets particular granulometric and/or bulk density criteria. The complexity of the sector's requirements are such that switching between salt types (although not necessarily salt suppliers) is a lengthy process.

Salt is used in the food sector for a number of reasons. One of the most significant is the preservative property that salt brings. In recent years several new techniques have been developed and introduced which replace or reduce the use of salt as a preservative. Some sources consider that these developments have already resulted in a decline in salt consumption by the sector. It is however difficult to discern the trend when reviewing the indices of salt consumption shown below (Table II.C.1).

TABLE II.C.1
INDEX OF SALT CONSUMPTION BY THE FOOD INDUSTRY
(1986 = 100)

1985	1986	1987	1988	1989	1990	1991	1992	1993
102.0	100.0	101.9	103.7	98.2	98.2	102.3	100.6	99.7

Industry observers claim that purchases of salt by the food industry in severe winters for de-icing purposes mask the real decline in use. This observation has not been investigated during this study. Whatever such an investigation might show, salt consumption in this sector is stagnating, it should also be noted that there are no reasons whatsoever to expect growth in demand Western Europe in the coming years.

D. OTHER INDUSTRIAL SECTORS

This market segment is a "catch-all" for all the other industrial uses. These will include water treatment, leather processing, textile manufacture, domestic dishwashers etc. Consumption of salt by these sectors has remained virtually static during the last ten years. The total consumption in Western Europe, excluding the Northern Countries, averaged 3.2 million tons per year over the ten years, 1984-1986. The indices of this consumption are shown in Table II.D.1.

TABLE II.D.1
INDEX OF SALT CONSUMPTION BY OTHER INDUSTRIES
(1986 = 100)

1985	1986	1987	1988	1989	1990	1991	1992	1993
104.9	100.0	106.2	104.8	104.3	103.0	106.8	104.4	104.9

Reviewing these indices it is difficult to discern any reasons to expect significant growth in demand by this sector in the future.

E. ROADS

Salt is used to prevent and control the formation of ice on highways. The use occurs during the winter months and highway authorities generally build up their stocks before winter arrives. The demand for de-icing is impossible to predict with accuracy. The authorities will therefore purchase their salt requirements based upon past experience and the budgets available to them.

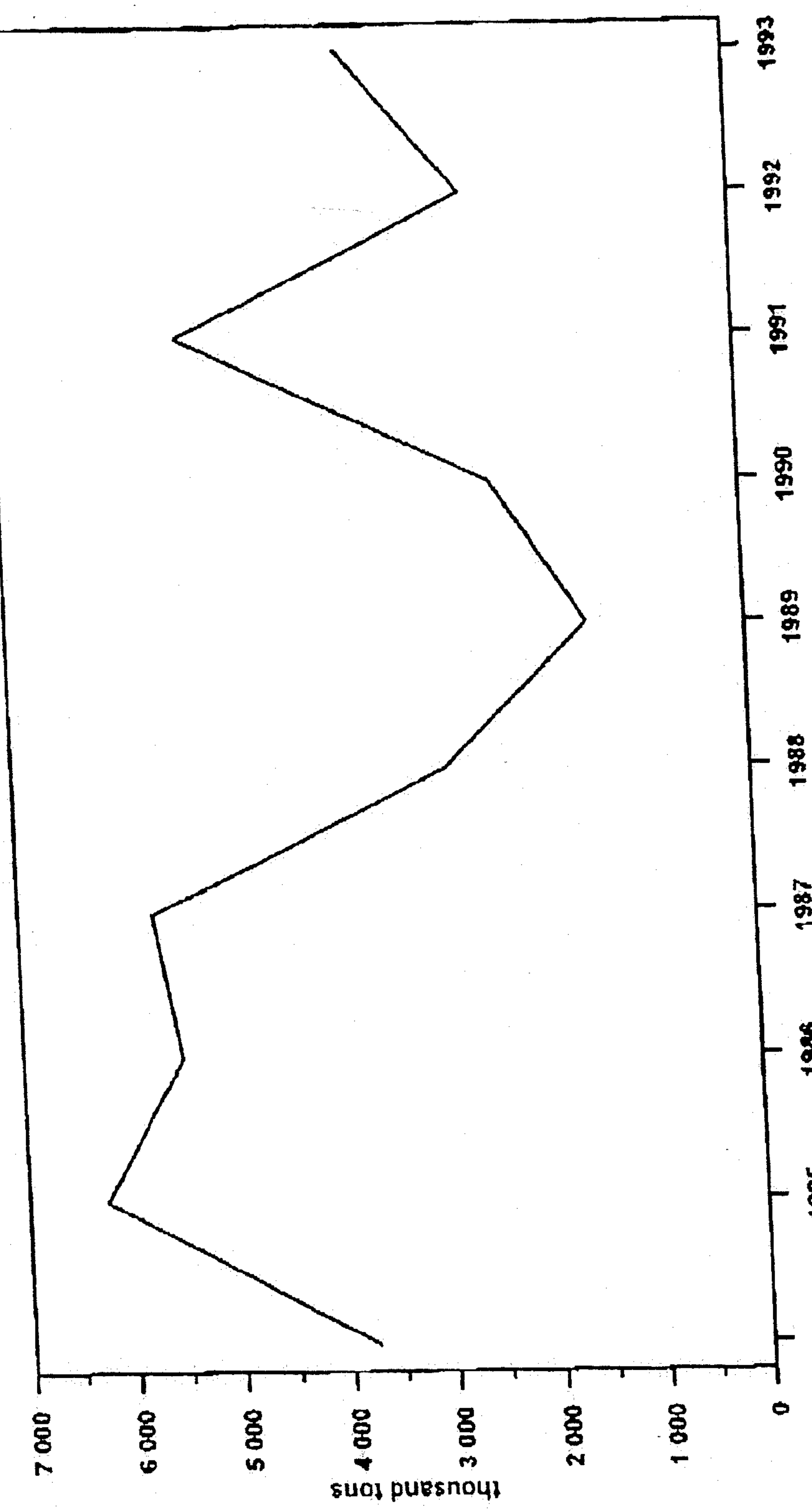
It might seem entirely logical to expect this market to use only the salts which have the lowest cost delivered to the authorities' depots. Such logic would lead to the view that the market would use only unpurified salts such as rock and low-cost solar salts. That view would however be incorrect as quantities of vacuum salt are used in several parts of Western Europe every year. The reasons for this use are various; they include:

- an immediate urgent need for salt regardless of cost
- official policy in some countries

The recent history of salt use on roads illustrated in Figure II.E.1. For the reasons already mentioned, the definition of Western Europe excludes the Northern Countries. This consumption includes all types of crystallised salt, within it vacuum salt consumption has ranged between 250-750 000 tons.

The outlook for salt use in this sector can not be predicted. History suggests that it will vary between 1.5 and 6.3 million tons. The trend towards the reduction of market barriers will reduce the protection afforded to vacuum salt in this sector. It is therefore likely that use of vacuum salt will decline in the coming years.

FIGURE II.E.1
SALT USE ON ROADS IN WESTERN EUROPE



F. SUMMARY

During the last ten year period, 1984-1993, the annual consumption of salt in all the countries of Western Europe has varied between 18.7 and 24.0 million tons. The most significant single element in the variation of consumption has been road de-icing. The largest market sector for salt is the chemical industry, this is also the most important market for crystallised salts of all types.

Within the chemical industry, production of chlorine and caustic soda from salt is the dominant use for crystallised salt. The demand for chlorine and products made from it has always been sensitive to the economic climate. It was therefore not surprising that the recent recession reduced chlorine demand. This effect has been compounded by the impact in recent times of widespread public concerns about the use of chlorine and compounds containing chlorine. The result was that the actual demand for, and hence output of, chlorine has fallen further than can be explained solely by economic effects. These concerns mean that it is improbable that chlorine production in Western Europe will ever recover to the levels achieved in the late 1980s. Consequently, demand for salt and salt-in-brine for use by the chemical industry is not forecast to return to those levels either.

Turning briefly to the consideration of which salt types will satisfy that demand, it should be noted that no clear trend across Western Europe has yet to emerge. Some observers point to chlorine producers that have switched from one salt type to another, generally a purer type and claim that those actions mark the start of an irreversible trend. This study has not examined the reasons for those changes in salt type and is therefore not in a position to confirm or deny the claims being made. It is certain that the changes are significant at a national level; on the basis of Chem Systems' current information and experience of the chlorine industry it is far from clear that they have significance on a regional, West European level.

The outlook for salt demand in the other market sectors, food and miscellaneous industries, is unexciting. There are no positive signs of growth in demand; indeed there may even be some pointers that lead to the expectation that demand will decline in the next years. The balance of consumption between the salt types has been established and there is scant evidence that it will change.

The road sector has varied widely in its consumption during the last ten years. At its zenith it has consumed as much as 6.3 million tons, at its nadir as little as 1.5 million tons. Within that consumption there has been some use of vacuum salt. While the outlook for total future demand is unpredictable, it is probable that the use of vacuum salt will represent a smaller proportion of the total figure than it has in the recent past.

III SUPPLY

A. DEFINITION

Salt is not a rare commodity. Huge deposits of salt underlie many of the countries in Western Europe; the only countries that have none are Finland, Norway and Sweden. These deposits feed natural brine springs in some places in Europe. In addition there are limitless reserves of salt in the seas that surround Europe.

Salt is obtained from these reserves on an industrial scale by three means:

- conventional underground mining including co-production with potash (potassium chloride)
- solar evaporation of sea water and natural brines
- solution mining of underground deposits.

The purity of salt deposits varies widely. This is perhaps not as important an issue when the salt is extracted by solution mining as it is when it is obtained by conventional methods, because any undesirable insoluble materials in the deposit can be left behind when the salt solution is taken out. Nonetheless conventional mining can and does produce salt of relatively high purity with some mines able to offer product containing 99 percent sodium chloride (salt) expressed on a dry basis, from run-of-the-mine production. Other mines have developed beneficiation techniques which can yield a product containing over 99.5 percent sodium chloride (dry basis). Such qualities are not required in end-uses such as road de-icing, they are however desirable in the chemical industry.

Solar evaporation technology may be low cost in terms of energy, but it is certainly not low technology. Nowadays precise control of solar pond systems coupled with sophisticated monitoring of the precise physical chemistry involved, yields products with salt contents better than 99.6 percent sodium chloride.

Solution mining will by the nature of the technology involved, yield a brine which contains little, if any, insoluble matter. This does not, however, mean that it is pure sodium chloride. The brine can, and more than often does, contain a number of elements and compounds (ions) other than sodium and chloride. Accordingly the brine is purified before use either as a chemical feedstock or as the raw material for the manufacture of vacuum salt. It is therefore not surprising to find that vacuum salt is often offered with a minimum sodium chloride content of 99.9 percent (dry basis).

It is clearly possible to define the capacity for vacuum salt by applying two tests:

- production technology used
- product analysis.

These tests have been employed in reaching the findings that are discussed below. These tests are however unsatisfactory as a technique whereby over-capacity of supply is assessed. There are several reasons of which one will suffice: they do not include this test:

- fitness for intended use.

When that test is applied, the over-capacity for salt supply in Western Europe changes markedly and for the worse.

B. FINDINGS

The research on which this report is based, was carried out during August 1994. It used a mixture of face-to-face interviews and telephone/facsimile contacts with most of the producers of vacuum-quality salt in Western Europe. These producers were asked to advise their production capacity on the basis of full-shift working and also to confirm their output during each of the last three years (1991, 1992 and 1993).

1. Total Crystallised Salt

ESPA itself maintains a database on producer capacities. This database is updated on an irregular basis using information from the producers themselves, their national associations and published comment. Total production capacity for crystallised salt is recorded in that database at over 35 million tons; it will be recalled that the demand maximum achieved in the last ten years was some 24 million tons. Thus the total overcapacity for crystallised salt is at least 11 million tons.

2. Rock Salt

Over half of that capacity total is recorded as being for rock salt, ESPA holds no reliable data on the qualities that are produced however. Some volumes of certain qualities of this rock salt are being used currently as raw material for chlorine production. And, as discussed, the chlorine producers concerned appear confident that they will be able to continue to use such salt.

3. Solar Salt

Approximately five million tons of ESPA's recorded capacity are related to the production of solar salts; again no quality data are recorded. Chem Systems believes that a substantial proportion of that capacity can be employed to produce salts of high quality (over 99.0 percent NaCl on a dry basis). High quality solar salts are used for chlorine production; the salt producers report that there is no evidence that such use will be threatened in the future.

4. Salt-in-Brine

Neither ESPA nor Chem Systems has good data on the capacities in place for the extraction of salt-in-brine. Such salt represents a significant proportion of the salt used in chemical manufacture (chlorine/caustic soda and soda ash). It is almost always owned by the chemical manufacturer who may often evaporate it for his own use; this salt is likely to remain "in-house" whatever the future pressures on salt qualities may be.

5. Vacuum Salt

Before presenting the findings on vacuum salt, it is useful to recall the outlook for the major end-use sectors:

- Chemicals - uses all salt types including salt-in-brine, primarily concerned with chlorine production which may see some very slow growth in the coming years. Unless the change is regulated across Europe, the sector offers limited potential for increased sales of vacuum salt.

- Food - uses high quality salt types (vacuum and solar), demand is stagnant or possibly declining.

- Other industries - uses all types of crystallised salt, no expectation of demand growth.

- Roads - uses all types of salt, demand is unpredictable as it is driven by the weather. Very likely that use of vacuum salt will decline in the future.

From the standpoint of vacuum salt the coming years may see some growth in demand as a raw material for chlorine production; they will also see a reduction in use on highways. The net effect is likely to be small, possible several hundred thousand tons, net increase in the consumption of vacuum salt.

The study has confirmed that the nominal installed capacity for vacuum salt was 12.5 million tons in Western Europe last year (1993) and effective capacity was 500 000 tons lower at 12.0 million tons. The study has also confirmed that the average output of that salt was 9.85 million tons in the period 1991-1993 inclusive. The average effective over-capacity, as shown by these findings, is therefore 2.15 million tons per year, a figure that is substantially greater than any foreseeable growth in consumption in Western Europe.