Derivation of Technologies Employed in Some Pre-1900 Salt Works in Eastern Australia

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While in principle processes for obtaining salt from brines and for purifying crystalline salt are very simple, the application of these principles has resulted in an amazing diversity of technologies. Many salt-making regions throughout the world have given distinctive touches to the processes which they have developed. Salt manufacture and salt use were brought to Australia by the earliest European settlers; the Aboriginal population apparently had neither made salt nor used the natural product. Of some 30 salt manufacturing sites which have been identified in New South Wales, Victoria and Tasmania it is possible to define the precise origin of the technology used in only a handful. The sources identified range from technical encyclopaedias, through personal experience of particular salt works in Britain and Europe, to the specific importation of an experienced salt maker. In most cases the particular technologies were modified to a greater or lesser degree in order to meet the particular conditions which obtained in Australia. The author, who is at the University of Wollongong, attempts to provide an overview of some of the more significant undertakings.

INTRODUCTION

Salt manufacture and even deliberate salt use seem to have been entirely imported activities in Australia. Extensive research both by myself and staff of the Australian Institute of Aboriginal and Torres Strait Islander Studies have found no evidence that salt had any part in Aboriginal culture. This is in marked contrast with indigenous societies in many other parts of the world such as New Guinea, Hawaii, Asia, Africa and the Americas. These societies utilised often quite complex and ingenious processes including leaching ash from salt-rich plants and boiling the resultant solution, leaching salt earth and boiling, and evaporation of sea water.

While the Aboriginal inhabitants of Australia apparently had no use for salt, it was vital to the European colonists. In addition to being a significant direct and preferred element of diet added to foods during cooking it was even more essential as a preservative for meat, hides, and other perishable items, and as an ingredient in a variety of industrial processes such as soap making and glazing earthenware. Almost from the arrival of the First Fleet it was at a premium, to the extent that the salt which capped barrels of meat was saved and issued as rations by the Commissariat. In the early 1800s salt was much sought after for the Tahitian pork-trade, first on government account and subsequently by private venturers. When the sealing trade first began in the early 1800s there was a very strong demand for salt forcing the price up considerably, and this led sealers to exploit natural deposits such as those on Kangaroo Island, South Australia.

The first recorded manufacture of salt in the colony was at Dawes Battery in 1790, only two years after its establishment, but the first site for which a specific location is known dates from 1795, when a salt-boiling house was established on Bennelong Point. These operations almost certainly were pitifully small and makeshift. During the next hundred years numerous salt-making operations were begun in south-eastern Australia, and while the majority were ephemeral, they showed amazing diversity. Before embarking on an account of a sample of these manufactories, it is appropriate to review briefly the range of possible sources of salt, and technologies for producing it in crystalline form.

SOURCES OF SALT

Apart from the rather meagre quantities of salt obtained from leaching ash from salt-rich vegetation or saline soils, as mentioned above, salt production is based on either natural deposits of salt crystals or sea water. Natural deposits range from lake deposits such as those of Lake Eyre or the numerous salt lakes on the Yorke Peninsula in South Australia, to vast deposits of rock salt such as those in Cheshire (England) or at Stassfurt (Germany). These latter deposits, which are the major sources of salt produced in the twentieth century, are often associated with natural springs, which yield brines ranging in strength from a mere one or two per cent to almost saturated solutions of about 25 per cent. Until the late nineteenth century these were major sources of salt in Europe. Sea water, on the other hand, contains on average only about 2.5 per cent sodium chloride, but estimates place the total salt content of the world's seas in excess of 48 000 billion tonnes. This source has been widely used over many centuries, particularly in areas where hot dry climate and extensive flat and low-lying coastal areas combine to facilitate solar evaporation. Even in cooler or moister climates sea water has been boiled to produce salt. Notwithstanding the gathering of small quantities of lake salt, sea water was the principal source of salt production in Australia prior to the 1890s.

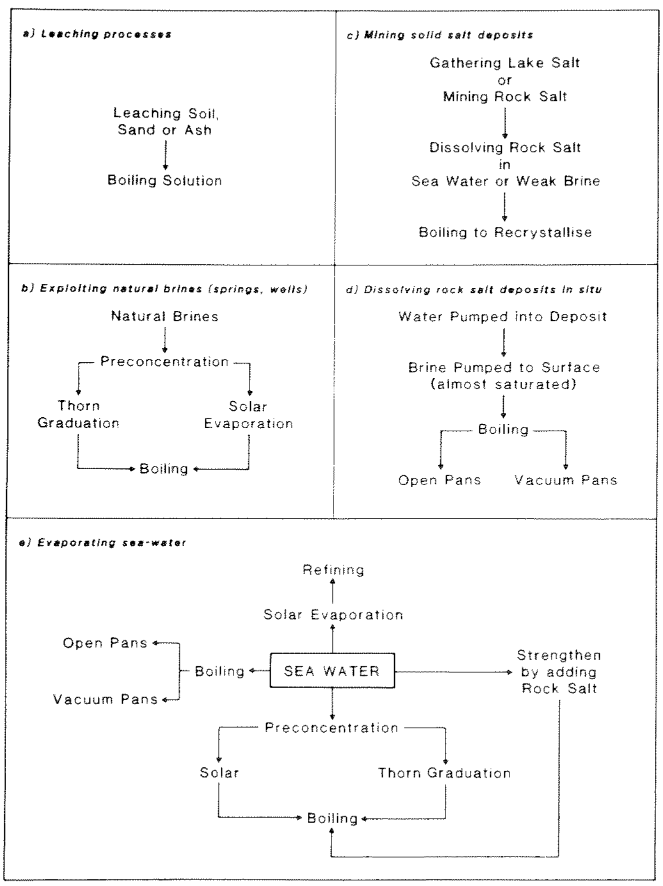
PROCESSES OF SALT PRODUCTION

In principle the production of salt is simple: either naturally occurring solid salt is gathered, or salt in solution is recovered by evaporating the water. Solid salt can be gathered by scraping from dry salt lakes, mining rock salt, or by dissolving rock salt *in situ* by pumping fresh water through the beds, as is done in Cheshire. In the latter instance the resultant brine is treated in the same way as some natural brines, and artificially evaporated either in open pans or multi-effect vacuum pans (similar to those used in the sugar industry). Solar evaporation, which is widely used with sea water, is rarely used for evaporating artificial brines.

These apparently simple processes are complicated by the need to economise on costs, especially fuel costs when boiling weaker brines, and by the need for removing varying types and quantities of impurities present in most sources of salt. To cut fuel costs in boiled salt processes employing weak brines some form of pre-concentration is required. In areas where climate is unsuitable for full solar salt production, brine (including seawater) is (or was) sometimes brought to strengths in excess of 20 per cent by solar evaporation prior to boiling in open pans. At salt springs throughout Europe during the seventeenth to nineteenth centuries a process called 'thorn graduation' was used for pre-concentration. This process involved the use of extensive 'walls' up to 15 metres high, and made of strong wooden frameworks packed with twigs: brine was allowed to drop from tanks at the top, over the twigs, which increased the evaporation surface greatly, and permitted brines as weak as one per cent to be brought up to 18-20 per cent prior to boiling. The fuel savings to be made by pre-concentration can be gauged from the fact that while one hundred tonnes of sea water contains about 2.5 tonnes of salt (of which less than 1.5 tonnes can be recovered) no salt begins to crystallise until over 90 tonnes of water have been evaporated. The interested reader will find a more detailed account of this quite fascinating process in Volume 2 of this *Journal.*[1]

Impurities in salt mined or produced by solar methods include salts of magnesium, calcium and iron, dirt and organic matter. Magnesium salts give salt a better taste and make it deliquescent, while clay, iron and organic matter discolour it. Production of pure salt requires some refining, which might take the form of washing in a saturated solution of pure salt, or of dissolving salt crystals and recrystallising. In practice a variety of combinations of processes are used in the manufacture of salt, some of which are shown in Table 1. Of these, combinations 1b and 1e are most relevant to salt manufacture in eastern Australia.

Table 1: Some common combinations of processes employed in the manufacture of salt.



CHARACTERISTICS OF AUSTRALIAN SALT MANUFACTURE

Some of the more significant generalisations to be made about the production of salt in eastern Australia are as follows.

Salt making technology used in Australia before 1900 derived essentially from British sources, but the application of the technologies produced a variety of adaptations.

Selected technologies were usually more successful when experience was brought to the enterprise along with knowledge of the technology.

Many of the technologies employed were out of date in Britain and Europe by the time they were adopted here. The decision to use them probably reflects capital requirements and limited source of salt (sea water), rather than their absolute efficiency.

Salt making was often associated with another enterprise, such as a coal mine, a cokeworks, or a soap boiling establishment, which could dictate the general process adopted.

Labour shortages and resultant high costs were often the motivation for adaptations.

For boiled salt, fuel cost also created problems, which led some salt makers to adopt pre-concentration technologies not normally associated with British salt works.

Some of these points can be best illustrated by brief reference to specific examples.

THE EARLY NINETEENTH CENTURY

The need for salt in the colony was such that Governor King, who was not known for his willingness to outlay money on public works, ordered two salt pans from England, which arrived in the colony early in 1804. One pan intended for Newcastle, to be operated in conjunction with coal mining, was installed there soon after its arrival.

Table 2: Salt production at government pans, Newcastle, 1805–1808.[2]

Year	Salt	
	Pounds	Tonnes
1805	28,750	13.04
1806	29,738	13.49
1807	32,600	14.79
1808	12,422	5.63
Total	103,510	46.95

It operated from 1805 to 1808 with some success, producing some 47 tonnes of salt during four years of operation (Table 2), but as circumstances in the colony changed, its operation became uneconomic. In a despatch to Lieutenant Menzies, at Newcastle, informing him of the imminent arrival of the pan, and giving orders for its erection, King notes that it was sent there because there was a salt boiler in the settlement. Menzies was quick to respond that the pan would be erected expeditiously, adding that there was no salt boiler at Newcastle. King had intended that the second pan would be erected at Norfolk Island, but before it had arrived in New South Wales the decision to disband the island settlement had been taken. In consequence, the pan was erected at Rose Bay, where it operated for a year or so on government account before being leased out. The pans were apparently sold about 1810, and re-established at Pyrmont, but little information is available concerning the changes. No reference is made to instructions for operating the pans being sent from England, and knowledge of the process of boiling salt was probably derived from descriptions in encyclopaedias. Closure of the government works about 1808–1810 possibly reflected the changed supply situation resulting from an establishment of several private salt boiling operations, and the establishment of a substantial solar salt works at Newington (Silverwater) by John Blaxland.

The need for salt for private business ventures, and the response to that need, is reflected by the operations of John Macarthur. Early in 1807 he had three men contracted for one month to catch and salt fish in Botany Bay, using purchased salt. Later in the year he had a larger-scale venture at Broken Bay, in which the fishermen also boiled salt in try pots. In this operation they probably set the pots roughly in a stone and sod casing, as an exposed pot would be too inefficient in the use of fuel. In July the try pots from the Hawkesbury operation were taken to a boiling works at Pyrmont along with four others. This establishment began operating in mid-October and continued until the following July, producing about 20 tonnes (48 689 pounds) of salt in this time. The estimated return on a total outlay of 588 pounds was 20 pounds or about 3.5 per cent. There are no records to indicate that the venture continued beyond July 1808. As the accounts show no expenditure for construction (e.g. a building, or bricking in of pots) it appears that the operation was of a temporary kind, such as that already described in relation to Broken Bay. While Macarthur contracted a 'salt boiler' named Taylor, there is no indication that this person had experience outside the colony. It is of course possible that Macarthur was able to draw on the experience of those men who had operated the government salt pans. His use of try pots for salt boiling was an interesting adaptation of an item of equipment which was not well suited to the task since it constricted top tended to impede the escape of steam, and to slow the boiling process.

JOHN BLAXLAND'S NEWINGTON SALT WORKS

John Blaxland came to New South Wales with a specific intention of establishing a salt works among the variety of farming and other activities he had in mind.[3] The salt enterprise was apparently a suggestion, or more likely a condition, made by the British authorities at the time the Blaxland brothers were negotiating for grants in the colony. Whatever the origin of the idea, John Blaxland arrived in Port Jackson well prepared to implement it. Among the servants he brought with him was a William Rutter, who had been a salt boiler at Lymington in Hampshire. The marshy coastlands of the Solent had maintained an important salt industry based on sea water, which was first mentioned in the fourth century A.D., and had become a major source of salt by the twelfth century. It remained very significant until the end of the eighteenth century, when the impost of a heavy salt tax, together with competition from the rapidly growing rock-salt-based industry in Cheshire initiated a rapid decline. It was perhaps the impact of this decline which prompted Rutter to take the opportunity to migrate. Today there is practically no physical evidence of this once thriving industry remaining near Lymington.

The technology brought from Lymington to New South Wales was a distinctive blend of solar evaporation and boiling of sea water. This combination of processes was necessary in England because on the one hand the climate did not provide a sufficiently long or warm season to crystallise salt in the field, and on the other the cost of fuel was too great to permit direct boiling of sea water. The compromise of concentrating the brine by solar evaporation and then boiling kept fuel costs within bounds. The process has been described in many contemporary accounts. The solar evaporating process, which was possible for only three to four months each year, was carried out in a series of shallow earth pans, established on the marshy coastland and separated from the sea by an earth embankment (Fig.1). These were usually gravity fed from a large storage pond which was filled at high tide. The area required to feed one boiling pan was a function of climate and pan size, and not necessarily applicable in other areas. Where gravity feeding was not possible, windmills were used to pump the brine. Flowing slowly through a series of these earthen pans the brine was brought from about 2.5 per cent salt to over 20 per cent before being pumped to a clearing reservoir. Boiling was originally carried out in lead pans, but these were later replaced by sheet-iron pans, which were in the order of 2.6 m (8.5 feet) square and 25 cm (11 inches) deep. The pans were normally housed in brick buildings with slat roofs, and equipped with large flues and storage facilities, each house accommodating from two to eight pans (Fig. 2). A pan would make between 2.5 and 3 tonnes of salt per week. As the brine evaporated the crystallised salt was shovelled out into wooden troughs to drain.

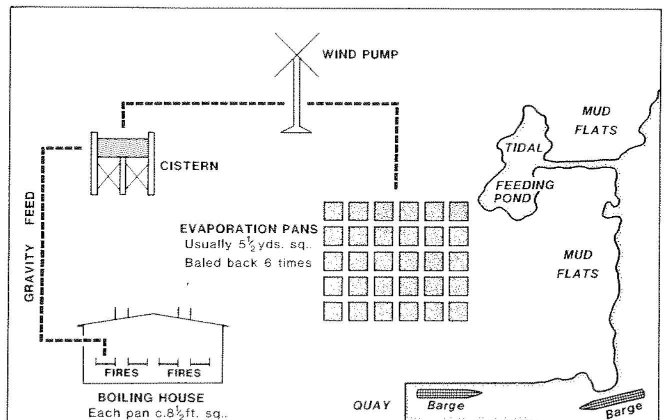


Fig. 1: Diagrammatic representation of the process used at Lymington for the manufacture of salt. This process, which combined solar pre-concentration with boiling of brine in small pans, was very much in decline at the beginning of the nineteenth century when John Blaxland persuaded a salt maker from that district to accompany him to New South Wales. (After Lloyd 1965).

Soon after he arrived in the colony in 1807, John Blaxland deliberately selected land on the southern bank of the Parramatta River, where there were extensive salt marshes similar to those adjoining the Solent. After establishing his household and initiating various farm enterprises, he enclosed about 16 hectares (40 acres) of marshland by building an embankment along the margin of the Parramatta River. While some sources suggest that the area reclaimed was 40.5 hectares (100 acres), the

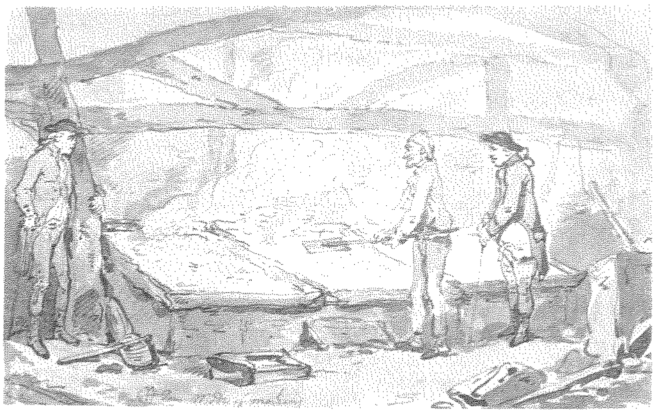


Fig. 2: Sketch of the interior of the boiling house of a Lymington salt works in 1789, showing the small pans viewed from the work.

evidence of an 1893 survey suggests 16 hectares (40 acres) is a more appropriate figure. Within this reclaimed area Blaxland began production of salt in 1808, initially employing 3.24 hectares (8 acres) for the purpose, but the evidence of the 1893 survey suggests that it is likely that by the time the works was fully developed, some 7.28 hectares (18 acres) was being utilised. In 1839, according to Blaxland, his salt works was capable of producing 100 tonnes per year, which lends additional weight to this belief. A brief report in the *Australian* dated 18 March 1829 states that by 1828 this salt works had produced a total of 1000 tonnes of salt of a quality which gave it a ready market, even in the face of competition from English salt. The success which attended Blaxland's venture is further indicated by the fact that the works continued operating in his hands to 1845, and then following his death, under lease to at least the 1860s when Newington College was established, and perhaps to the 1880s. What set this operating apart from numerous others which failed in a short time was that Blaxland not only imported a technology but he also brought labour with the experience to make that technology work.

THE AUSTRALIAN AGRICULTURAL COMPANY

In the 1830s the Agricultural Company attempted to establish a salt works near its Newcastle coal jetty. Almost from the initial suggestion that this company take up coal mining at Newcastle, the idea of an associated salt works was under consideration.[4] The idea was proposed to the company's London directors by Mr Icely, an Australian board member. It had, on the one hand, the purpose of complementing the colliery operation by using otherwise waste coal, and, on the other, that of meeting the need in the colony for good quality salt for culinary purposes and salt provisions. The initial exploration of the possibility was under way in October 1830, and in November of that year the company's secretary, J.S. Brickwood, was asked to investigate the best method of making salt by evaporation of sea water, in conjunction with visits to Liverpool and Scotland where he was to investigate aspects of building a ship for the company. The lengthy report on salt making which he submitted on 30 November 1830 describes in considerable detail the process used in Scotland, and specifically the works of H.F. Cadell at Cockenzie, on the Firth of Forth.[5]

The system he described was very simple. An iron pan 6 m x 3 m x 55 cm (20 feet by 10 feet with a depth of 22 inches) was mounted over a furnace, and by means of a bucket-and-wand system was fed with five tonnes of sea

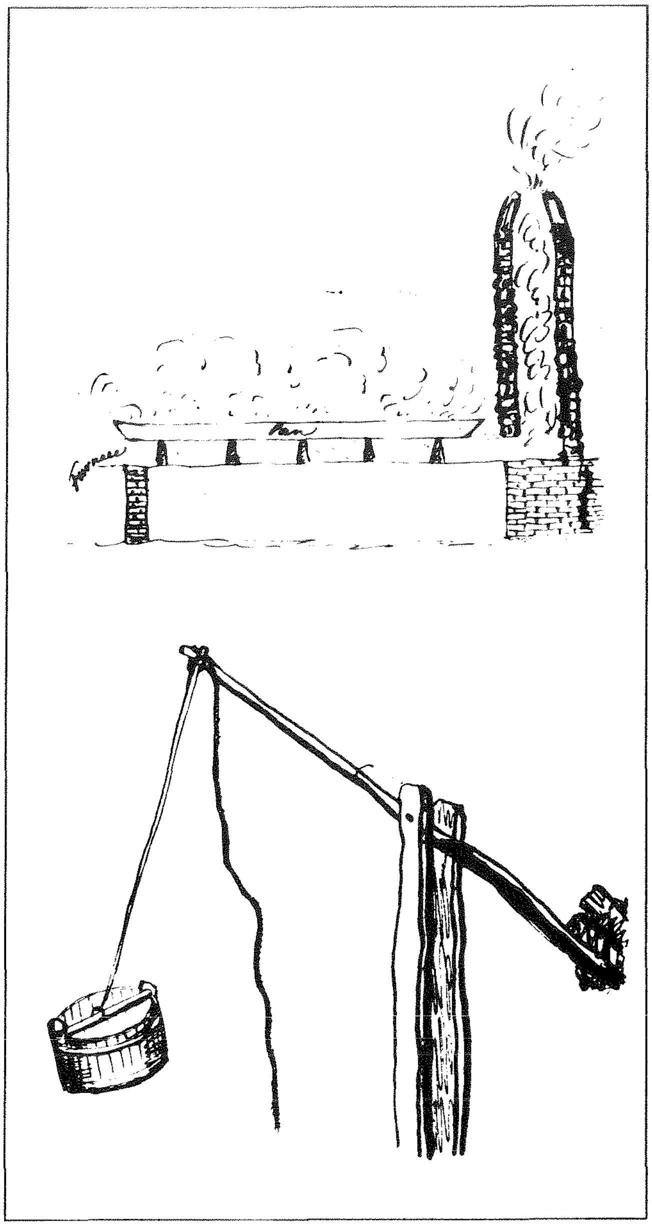


Fig. 3: Sketches included in J.S. Brickwood's report on salt making at the works of H.F. Cadell, at Cockenzie, Scotland, in 1830 show (above) the simple arrangement of the boiling pan and furnace, and (below) the bucket-and-wand apparatus for filling the pan.

water from a cistern on the foreshore, which was filled at high tide (Fig. 3). The two operators then fired the pan in six hour shifts, combining to refill the pan at the end of each period. In 24 hours the pan burned some four tonnes of refuse coal to produce half a tonne of salt, provided of course that the sea water was of normal strength. Brickwood claimed to have adhered closely to what he saw at the Cockenzie works, and noted that he did not give any account of salt manufacture in other areas because Cadell assured him that he had at one time travelled extensively to find ways of improving his own process, and that he had returned home convinced that his own method of production required no alteration.

In New South Wales the company's superintendent, Parry, was sufficiently perceptive to realise that the estuarine location of the proposed salt pans was likely to cause problems: the fresh water in the Hunter River would dilute the salt water. Parry indicated this reservation to the Court of Directors, but despite his reservations they did not reject the proposal. Later, he did make it clear that a decision to proceed with the project was the responsibility of the Court of Directors. For their part the directors tried to place responsibility for the decision with Parry, but they were ultimately obliged to make the final decision, which was that the project go ahead. In August 1832 Parry indicated that should they wish to proceed, they should have eight pans built to the dimensions given in Brickwood's 1830 report, together with all ironwork and utensils. In the meantime, he would proceed with buildings based on dimensions given. At the end of October, in the face of a note from London urging financial stringency, he amended the order to two to four pans, and reiterated that any decision to undertake the manufacture of salt rested with the Court of Directors. It was the following March before the London directors made a decision, when they decided to send four pans to Australia, to have Cadell arrange for their construction and despatch, and also that it seemed expedient to send two experienced salt makers to New South Wales with the pans. A week later the number of pans to be sent was reduced to two, in order to keep down expenses, and by the end of April it was deemed inexpedient to send the two salt makers as proposed. So far as the need for expertise was concerned, they wrote to Parry that they had been '... informed that there is a person by the name of Peter Anderson now in the employ of Mr Jones in Sydney, who has a perfect knowledge of the manufacture of salt...'

At Newcastle, progress with the works was barely perceptible because Parry, on the one hand, was unable to secure skilled convict labour, and, on the other, unwilling to meet the expense of non-convict labour. When the first pan arrived in Newcastle in February 1834, the construction of the building to house it had not even begun, but two bricklayers were to be sent from Port Stephens immediately. These skilled workmen were often diverted from the salt works to more urgent construction at the company's mine. Dumaresq, who had taken over from Parry as the company's Superintendent, noted that '... returns are not sufficiently rapid in the country to justify great outlay of capital – and as there is no risk of being forestalled in undertakings of the nature of the one question, it is more prudent, I think, to proceed leisurely in its completion...' It was not until November 1835, a full five years after the project was first proposed, that construction was sufficiently advanced for a trial boiling, and this took place early in December. Three pans of salt water (40 tons) were evaporated for a yield of about one half-ton of salt (40 tons of sea water should contain about one ton – not all recoverable) consuming nine tons of coal in the process. It was noted that nine men would be needed to continue the process, and this, in a time of serious labour scarcity, would certainly have been perceived as a profligate waste of resources.

At the end of February 1836 Dumaresq noted that one of the original assumptions on which the viability of salt making was calculated was that small coal was unsaleable, whereas at the time of the trial of the pans it was selling profitably at nine shillings per ton, and there was no surplus on hand. It seems that at this time Dumaresq had already accepted that the operation was not viable, and he commented in his report to the London directors that the building could readily be converted for a variety of useful purposes. The 1837 report to shareholders stated that in view of the price obtaining for small coal it was inexpedient to proceed with salt making. In June 1838 it was reported that a trial produced good salt at the works. This trial generated some optimism that the plant could be leased, but nothing seems to have come of it, and in 1840 a despatch from London to Superintendent King observed that '... We hardly expect that the salt works will be productive or much advantage, but if you find the buildings useful for general purposes, it will be better to retain than lease them.' Later the same year that building served admirably as a woolstore, and in 1857 it was converted to a workshop. The total expenditure on the salt project, which had reached over 1300 pounds in 1838, remained on the books as an asset for a year or two, and then was quietly written out after 1840.

While the adoption of the salt making project as a complement to mining was logical, and followed the precedent of Scottish and northern English colliery owners who had for some time used salt boiling as a profitable outlet for unsaleable small coal, the basis of adaptation was less obvious. It seems that in describing Cadell's process, Brickwood was not entirely accurate. Modern accounts suggest that Cadell had increased the size of his pans to 5.4 x 2.7 metres (18 x 9 feet), not 6 x 3 metres (20 x 10 feet) as stated by Brickwood, and added the furnace in 1810. Brickwood probably simply rounded these figures to those already mentioned. The same sources also indicate that Cadell had put aside the bucket-and-wand apparatus in favour of a force pump, although it is not indicated whether this was steam-powered.[6] Perhaps Brickwood deliberatly overlooked the use of pumps as a cost-saving measure, in the mistaken belief that cheap and plentiful convict labour could be used to power the bucket and wand. Certainly he expressed the view that the least complicated and cheapest process would be least liable to disappointment. Whatever the reason, he made no mention of Cadell's use of pumps, but in the salt works built in New South Wales a steam-driven pump was installed at the cistern, no doubt to reduce the demand for labour which could be more profitably employed elsewhere.

It is difficult to know why the project in fact failed. The delay of about five years in bringing it into operation resulted in changed conditions, in that the small coal, originally considered to have no value, had become a marketable and valuable commodity. Brickwood's calculations of salt yield in his report were optimistic, and for some reason the consumption of coal was grossly excessive. Possibly the project might have had more satisfactory results had skilled salt makers been brought out. Although the process is simple in principle, it requires considerable art to operate it efficiently.

THE SALT WORKS OF RICHARD CHEETHAM

In the 1870s Richard Cheetham, a manufacturing chemist by profession, in partnership with others established solar salt works on French Island, in Westernport Bay.[7] This undertaking proved to be unrewarding, and Cheetham withdrew from it under circumstances which are not yet clear. Climatic unsuitability of the site was a factor in the failure of the operation. In 1888 Cheetham began a new undertaking on a swampy area bordering Stingray Bay, on Port Phillip Bay, about four kilometres east of Geelong.

Cheetham had travelled extensively in Europe and modelled his undertaking on the salt works in the south of France, which in principle consisted of a series of shallow ponds through which the sea water is conducted. These ponds are progressively decreased in area to compensate for the loss in volume by evaporation. So far as possible the process is conducted by gravitation, but in any such works some pumping would be necessary. Although windmills and water wheels were the usual apparatus used in Europe at this time, Cheetham installed a steam-powered centrifugal pump. When the brine reaches the final compartments, it is almost saturated, and further evaporation leads to deposition of salt crystals, which

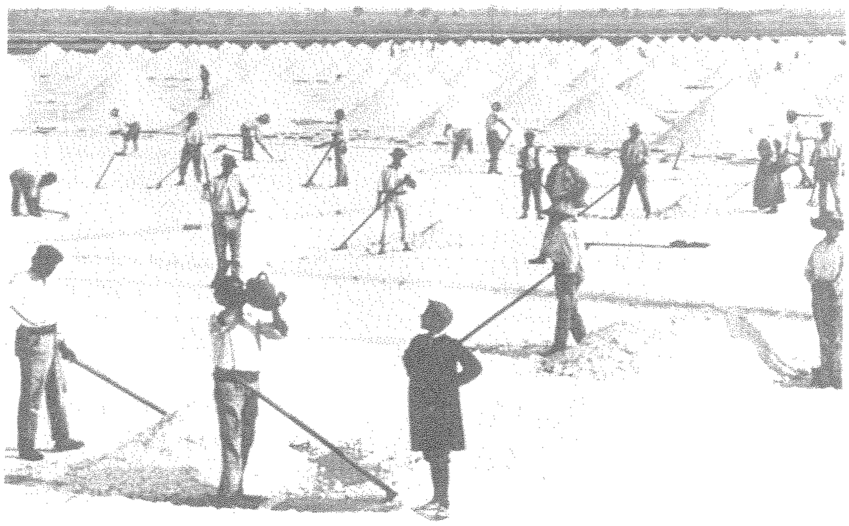


Fig. 4: (at left) Salt harvest in the south of France in the 1890s. This operation required a great deal of labour to lift the salt carefully from the bottom of the crystalliser and place it in small stacks to permit residual mother liquor to drain away. The salt was then barrowed to the sides of the pans and carried in carts to stacks containing hundreds of tonnes. (Photograph from the archives of the Compagnie des Salins du Midi et du Sud-Ouest).

Fig. 5: (below) This view of the salt harvest at the Cheetham works, Geelong, in 1900 is remarkably similar to that in Figure 4. In this photograph the drained heaps of salt are being moved to the larger heaps in the background. (Photograph courtesy of Cheetham Salt).

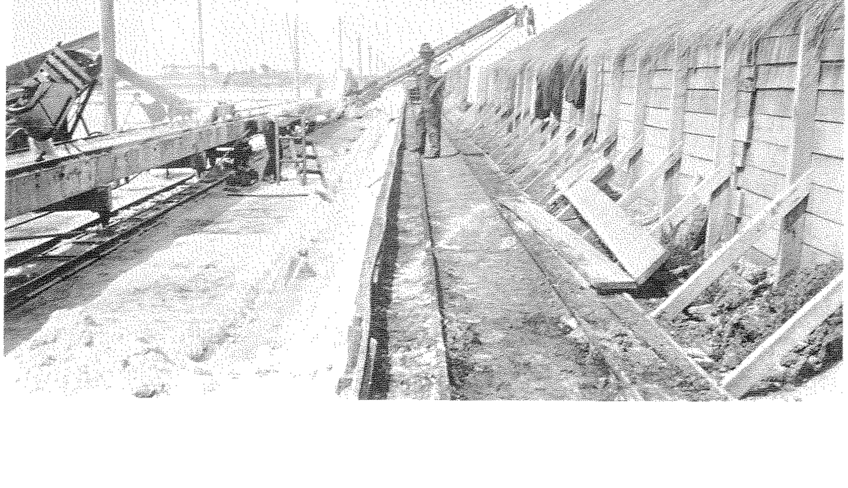


Fig. 6: Salt stack at Cheetham works, Geelong, in the 1920s, showing the reed thatch which protected the stacked salt during storage. This mode of protection was widely used in salt works in the south of France. (Photograph courtesy of Cheetham Salt).

form a bed 5 to 10 cm thick. After draining residual liquor this was harvested by lifting with shovels and gathered into heaps (or cocks), and left to drain for a few days, after which it was removed by wheelbarrow to heaps of several hundred tonnes, and left to drain further for at least a year, this latter process helping to remove impurities.

The similarity of Cheetham's salt works to those in the south of France can be seen from Figures 4 and 5. One shows the harvesting operations at Cheetham's salt works in 1900, and the other depicts the same operation at a saltern in the south of France at about the same time. One particularly French touch to Cheetham's process was the application of a protective reed thatch to the large stacks of salt (Fig. 6). Use of thatch continued into the 1930s despite the cost of labour required to gather reeds and lay them out. It is interesting to note that at one time the firm was persuaded to try a thatching machine, but had little success with it, and reverted to traditional methods.

'Bay salt' produced at Geelong, like that of other solar operations, often contained residual dirt and sand, as well as a proportion of other salts which discoloured it and reduced its quality. During the 1890s the works operated a refinery to remove these impurities and to produce very pure fine-grained salt for domestic and dairy purposes. Such a refinery involved redissolving salt crystals and boiling the brine to produce fine salt. In the process, suspended solids were filtered out and the small quantities of other salts still present were carried off in the residual bittern. This process was a-typical of French salines, and it represents a significant adaptation. The structure of the shed and pan indicates that the refinery was patterned to British technology. Because it used as much as two to three tonnes of coal to produce one tonne of salt and was labour-intensive, the refinery was costly to operate, and in about 1900 this process was superseded by one which involved grinding the bay salt, washing it in concentrated brine, and drying it using a combination of hydro-extractors and a rotary kiln.

Cheetham's salt works is the only nineteenth-century salt works in the eastern colonies to survive beyond Federation. It is still operating today, having been expanded from 120 to about 500 hectares, plus additional works at Lara and Laverton. Success depended in part upon existence of a large market, but no less on Cheetham's active approach to marketing, his technical knowledge, and first-hand experience of the European model for his operation.

THE ILLAWARRA CONNECTION [8]

In the early 1890s a small cluster of salt manufactories appeared along the short stretch of coastline between Wollongong and Austinmer. These salt works had in common their application of the process of 'thorn graduation', which was normally associated with brine springs, to production of salt from sea water. As an account of these undertakings has already been published,[9] a few comments will suffice here.

Bulli Coke Company

Althought the Bulli Coke Company was not the first of the group salt works to be announced, this company was the first to begin its operations. In 1893 it began to establish an experimental salt-making plant which was to utilise waste heat from the cokeworks, and to embody a graduation works of the kind already described to pre-concentrate the brine prior to boiling. Whereas in Europe graduation works would be as much as 9 to 15 metres high, and extend over two kilometres in total length, in a single salt works, the experimental structure of the Bulli Coke Company, built on the headland behind its jetty, was a mere six metres high and 45 metres long. The experiments in adapting the process at Bulli were reported to have been based on the description of German graduation works in *Ure's Dictionary*,[10] but the boiling pans were based on English patterns. For this experiment the company allocated the considerable sum of 1000 pounds. The tests of efficacy of graduation combined with the waste-heat process were showing promise, as was the quality of salt obtained, but before the experiments could be concluded the economic plight of the whole coal and coke industry forced the Bulli Coke Company into liquidation, and in consequence this attempt at salt making never reached a commercial stage.

The Illawarra Salt Company

This firm was established by a group of petty capitalists, mainly mine managers and engineers, who had subscribed an initial capital fund of 500 pounds. Their works, established on a small site on the southern end of Austinmer beach, were intended to have an initial output of 200-300 tonnes of salt annually, using cheap slack coal from nearby mines. A coil constructed within the chimney to preheat sea water by means of flue gases was an interesting and unusual attempt to reduce fuel costs, but on the other hand lack of any provision for pre-concentration of brine gave the local press cause to castigate the proprietors for lack of enterprise. Eventually an attempt was made to make such provision. Following the collapse of the Bulli Coke Company the Illawarra Company purchased its graduation works and re-erected it at its Austinmer site. Although announced late in 1892, the company's plant was not operational until some two years later. Beset by lack of capital funds, the firm was further handicapped by a series of mishaps when eventually it began production, and operated only intermittently during late 1894 and 1895 before going into liquidation in 1896.

The Sydney Salt Company

Late in 1893 the formation of the Sydney Salt Company was announced, but it was not registered for another year. When finally registered it had the substantial capital of 2500 pounds which was later increased by a further 1000 pounds. The company planned to build its works at Austinmer, on Hicks Point (Long Point) near the Austinmer jetty. The promoter and manager of the company was A.A. Lycett, who had been involved in management of salt works in Cheshire. Lycett had apparently been involved in the Bulli Coke Company and had access to data gathered during its experiments.

The extensive plant included a large boiler and steam-driven pumps, a graduation works nine metres high by 45 metres long, two boiling pans, a large finishing pan, a drying shed over the furnace flues, and a 10-metre high stack. Unlike the Illawarra Company's equipment, this was protected from the weather by large sheds. When the company began salt production late in 1895 analysis indicated that the quality of salt was very high, but no sooner had production begun than the graduation works was demolished by a storm. This structure was rebuilt, but it appears the shareholders were not happy with the way things were proceeding, for in December 1895 Lycett began to operate the plant on lease rather than as manager. He was energetic in promoting his salt, but could not sell enough to cover costs and his own assets were sold to pay wages. The Sydney Salt Company sold the plant soon after; the buildings and brickwork were demolished and the materials sold. With this liquidation ended not only the Sydney Salt Company but the salt industry in New South Wales.

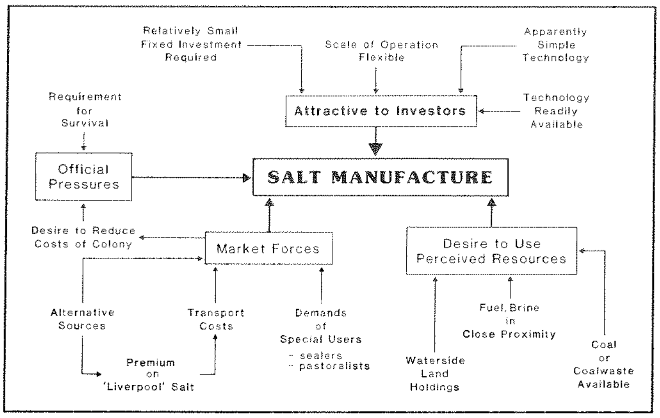


Fig. 7: Influences on investment decisions in the salt industry in eastern Australia before 1900.

CONCLUSION

The foregoing examples have been presented in an attempt to show the range of motivations for establishing salt works, the sources of technology employed, and the extent of adaptation. The principal factors which led to investment in the salt industry, summarised in Figure 7, included the need to overcome chronic salt shortage, the desire on the part of property owners to utilise otherwise unemployed resources, and the requirement for relatively small amounts of fixed capital. Derivation of technology appears to have been mostly fortuitous. It depended in large measure on where the proprietor had travelled, or what reference books were on hand. There is little to suggest that any proprietor actively studied a range of technologies before selecting the one which offered most advantage on the site. The obvious exceptions were of course Blaxland and Cheetham who took the realistic approach of looking for a site which would suit the technology they had chosen to employ, and no doubt this matching was the factor which made their enterprises the most successful salt manufactories in the eastern colonies. It is interesting to note that in these two successful cases the technology was complemented by direct experience in its working, and, perhaps more significantly, that there was little attempt to adapt it by adding elements of other technologies. It seems that these factors were the key to success.

The adaptation of salt making processes to colonial conditions of necessity took many forms, because of the variety of processes attempted, changes in the availability of materials in the colonies, and the impact of changing economic conditions. Macarthur's utilisation of try pots as a substitute for more orthodox pans reflected the relative availability of such pots on the one hand, and the scarcity of iron and labour for making open pans on the other. Blaxland's salt maker seems to have replaced the tiny solar concentrating pans traditionally used at Lymington with a field pattern similar to that of a normal solar salt works. At the Australian Agricultural Company's works substitution of a steam-driven pump for the bucket-and-wand apparatus, described by Brickwood in the report sent to Newcastle for the guidance of the Superintendent, reflected the relative scarcity of even unskilled labour (and the high cost of using it) compared to the plentiful cheap labour available in Scotland. Cheetham replaced the wind pumps and water wheels traditionally used in French salt works for raising water with steam-driven centrifugal pumps, and in response to a demand for refined salt successfully adapted British salt-boiling processes to add a refinery to the typically Mediterranean solar salt works he had established. The several attempts in the Illawarra district to marry European thorn graduation technology with British boiling processes as a means of reducing cost of fuel used to fire the pans, and the substitution of the readily available tea-tree for European blackthorn represented significant adaptations, as did the coil installed in the flue of the Illawarra Salt Company's works to preheat sea water prior to boiling. No comparable adaptations are mentioned in the literature dealing with the British salt industry. From all accounts these attempts to adopt and adapt various salt making technologies worked, at least to the extent that good quality salt was produced. But generally a strong market preference for Liverpool salt prevented a concomitant commercial success.

NOTES

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2. TURNER, J.W. (ed.) 1973. *Newcastle as a convict settlement: the evidence before J.T. Bigge in 1819–21.* Newcastle Public Library and the Council of the City of Newcastle, p.278.
3. The following outline of the Lymington salt-making process is based mainly on LLOYD, A.T. 1965, *The Salterns of Lymington, Milford and Hordle*, Lymington; information concerning Blaxland's operation has been obtained from the Blaxland papers in the Mitchell Library [A1322] and from items in the *Sydney Gazette*, 1808–1828.
4. Australian Agricultural Company papers, *Archives of Business and Labour*, Australian National University.
5. ADAMS, I.H. 1965. 'The salt industry of the Forth Basin'. *Scottish Geographical Magazine* 81:153-62.
6. Adams 1965.
7. SWINTON, E.A. 1962. 'The early Australian chemical industry: 3 Cheetham Salt Limited', *Proceedings of the Royal Australian Chemical Institute*, 29:365-370.
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10. HUNT, R. (ed.) 1860. *Ure's dictionary of arts manufactures and mines*, 3 vols., London.