THE STORY OF MURGATROYD'S

INTRODUCTION

In the year 1889 George Lomas Murgatroyd discovered brine at Middlewich and laid the foundations of the Company which still bears his name. During the years which followed, and up to the beginning of the last decade, the destiny of the Company has been essentially in the hands of three men: George L. Murgatroyd, Ivan Levinstein and Herbert Levinstein.

George Lomas Murgatroyd discovered the abundant source of natural brine upon which the whole project still depends, and was responsible for the original conception of the Company.

Ivan Levinstein preserved the name and independence of the Company after Murgatroyd's tragic death in 1894, when it would otherwise have certainly been swallowed up by the Brunner, Mond organization, and he guided its greatly reduced fortunes during the ensuing 20 years until his death in 1916.

Herbert Levinstein maintained and expanded his father's interest in the Company and directed its operations from the period of the First World War until his retirement in 1947. To him we owe the Yew Tree Project from which the present Company has grown.

Murgatroyd's Salt and Chemical Company Limited is today one of the leading firms of the Cheshire Chemical Industry and makes a significant contribution to the country's chemical economy. Its interests are no longer confined to the salt industry in which it was born, but also lie in the chlorine-caustic soda field, where for the last 10 years it has been a major producer. It is therefore desirable that the Company's story should be presented against a background showing the birth, growth and development of the Cheshire heavy chemical industry and the salt field on which it depends.

The story of Murgatroyd's is told in two parts. The first provides an historical background and tells the story of G.L. Murgatroyd and his Middlewich Salt Works up to the establishment of the new works in 1947, while the second part deals with the conception, birth and growth of the integrated chlorine-caustic soda plant at Elworth upon which the present-day fortunes of the Company depend.

I – MURGATROYD'S PAST

Historical Background – (1) Salt

Salt or Sodium Chloride has been known since earliest times and has been called the oldest article of commerce. Its value as a condiment and preservative was certainly known to primitive man, and the rise of the early civilizations of the Middle East stimulated the development of extensive trade channels to the South East and the sea crossing at Dover throughout that area for both salt and salted fish, the latter being an important item of food in those times. There followed the growth of prosperous salt trading communities and it was amongst these that the world's banking system originated. Our present-day 'salary' is a direct reminder of these early times for it was customary for Roman soldiers to receive payment or 'salarium' in the form of salt, while the name 'soldier' itself is derived from an earlier word for one who received payment in the form of salt.

Salt has been produced at Middlewich and its sister Cheshire salt towns, or 'wiches', of Northwich and Nantwich since earliest times. In Pre-Roman Britain there was already an appreciable salt trade with Southern England and Northern Gaul, and a recognized 'way' was taken by the salters' pack trains. London is considered to have grown about the point where these early Cheshire salt traders forded the Thames at Westminster.

Salt occurs naturally as rock salt in beds varying in thickness from a few inches to many feet. These were formed by the solar evaporation of enclosed or intermittently enclosed stretches of sea water which, in the case of the Cheshire saltfield, took place during the Permo-Triassic Age, and gives a positive indication of the tropical climate of this part of the world at that time. The rock salt beds so formed were preserved from dissolution in water by the subsequent deposition of impermeable layers of Keuper marl. This process occurred twice in the Cheshire basin, for there are two rock salt beds separated by an intermediate layer of marl.

The true extent of the Cheshire salt deposits has never been clearly defined, but recent work by the Geological Survey has indicated that the rock salt beds are far more extensive than hitherto thought. At the centre of the salt field around Middlewich the upper bed is at depths of about 200ft, while the lower bed is below 300ft. To the south these beds lie at greater depths and thickness, and recent drilling in the Whitchurch area of Shropshire has revealed the presence of rock salt beds of 1,900ft total thickness, at depths between 2,500 and 5,000 feet.

The area of the upper rock salt bed has been estimated to be about 170 square miles, while that of the lower bed is over 400 square miles. Altogether this represents a deposit of over 400,000 million tons, and there can thus be no anxiety for our future salt supplies.

In the Northwich district the lower rock salt bed is now being exploited, but to the south around Middlewich and Sandbach the production is still from the upper bed with the lower bed still largely untouched.

Natural drainage in the soil has brought water into contact with the rock salt which dissolves, forming underground brine streams. Until comparatively recent times all Cheshire salt was produced from this natural brine which either appeared as springs at the surface or could be found only a few feet below ground level.

In primeval times salt crystals were obtained by pouring natural brine over hot wooden faggots and scraping off the crystals which formed. The Romans introduced the 'open pan' method of brine evaporation and used small square lead pans thought to have been an early Chinese invention. This method persisted essentially unchanged until the sixteenth century when iron pans were first constructed.

In the middle ages the brine for salt making was obtained from communal brine wells which were actually large open pits with boarded sides and supporting wooden cross-beams. The brine was raised by hand from depths of about 20ft and passed to the many salt houses of the community through a system of open wooden channels. The operation of the salt houses was controlled by the Lord of the Manor, or the equivalent local authority, according to the demand for salt and the times when the open pan fires were permitted to burn were marked by the ringing of a bell.

In the year 1670 rock salt was first discovered at Northwich, and during the following decades rock salt mining developed extensively at Northwich and Winsford.

The brown rock salt was refined by conversion to brine and evaporation by the normal open pan method. Impurities in the brine were removed by a 'froth flotation' technique in which small quantities of blood and egg white were added to each batch of bring. Each salt maker had his own recipe for this process.

The increasing demand for salt during the 18th century was almost entirely met by the rock salt mines of Northwich and Winsford, and the other salt towns which remained dependent upon natural brine obtained a disproportionately small share of the new prosperity. Middlewich made steady progress, but this was much less than for the industry as a whole, while Nantwich with its poor means of communication steadily declined and by the year 1860 salt production at this centre had ceased altogether.

The table below clearly illustrates the changing fortunes of the Cheshire salt towns during the last three centuries.

Annual Salt Production (tons)*

	1675	*1785*	*1878*	*1951*
Middlewich	5,600	9,500	14,000	150,000
Northwich	16,000	100,000	880,000	2,528,000
Nantwich	5,000	3,000	NIL	NIL
Winsford	250	3,000	1,036,000	250,000
Sandbach	NIL	100	78,000	150,000
Lawton	NIL	100	100,000	NIL

*This includes the salt used directly as brine for chemical production.

During the Middle Ages and before the exploitation of the coal fields, open pans were heated over wooden fires, and this resulted in the gradual depletion of the forests of Mid-Cheshire and correspondingly high fuel costs. Throughout this whole early period the recognition of salt as a form of currency and its restricted yet very essential domestic use as a condiment and preservative led to strict government control of production and the imposition of salt taxes. Such conditions did not encourage the salt makers to seek improved methods of production.

The Industrial Revolution, which found its birth in the textile industry, brought new demands and led rapidly to the development of the coal fields, a canal system, and a chemical industry dependent upon salt as its basic raw material.

These new and increased demands for salt gave manufacturers the necessary incentive to raise their output and seek more efficient methods of production. Pan size gradually increased, coal was used for the fires and attention was paid to flue and grate design in order to achieve the maximum yield of white salt for each ton of coal consumed.

Further impetus was given to this expansion by the abolition of the crippling Salt Duty in 1825, the coming of the railways and the opening of the East Indian markets to English salt.

The continued expansion during the nineteenth century led to fierce competition in the salt industry; prices fell and conditions deteriorated. After numerous unsuccessful attempts to stabilize the position, 64 salt makers finally agreed to form an association which would maintain uniform high prices. In October 1888 the Salt Union Ltd was formed with a virtual monopoly of the industry.

It immediately became desirable for the larger salt users to obtain alternative sources of supply which were free from the price control of the Salt Union, and a widespread search for rock salt and brine began.

The search was primarily for natural brine, for during the latter half of the nineteenth century rock salt mining was being gradually replaced by the more economic method of brine pumping from shafts sunk down to the underground brine streams.

For reasons already given, Middlewich had become a backwater of the salt industry, yet it was blessed with good road, rail and water connections with Merseyside and the export markets, so extensive search for brine was made in the area. Nantwich was less favoured by this new development and there was no serious attempt to revive its salt industry; this was probably due more than anything else to the continued failure to extend the Weaver Navigation above Winsford and thereby provide Nantwich with a vital outlet to the Mersey.

The search for underground brine at Middlewich was made more difficult by the fact that geological faults had produced irregularities in the rock salt strata so that the brine streams followed a complex course. It was this search for brine which brought George Lomas Murgatroyd to Middlewich.

Historical Background – (2) The Chemical Industry

The development of the British Chemical Industry was a major outcome of the Industrial Revolution of the latter half of the eighteenth century, and was largely guided by new and increased demands for textile chemicals which followed the expansion of the textile industry. At the forefront of this chemical revolution was the manufacture of chemicals from salt with demands for chlorine for fabrics bleaching and alkalis for cotton treatment and soap and glass manufacture.

Strange though it now seems, these two sections of the chemical industry developed independently and over half a century was to pass before the chlorine and alkali processes joined together; by this time the heavy chemical industry was firmly established.

The bleaching action of chlorine was first used in 1785 by the Frenchman Berthollet. Four years later he superseded the initial use of chlorine water with a more stable potassium hypochlorite solution which became known as 'Eau de Javel'. The use of these early chlorine bleach solutions spread rapidly throughout Europe and they were manufactured in Scotland from 1787 onwards.

In 1798 Charles Tennant, a Scottish bleach maker, discovered 'liquid chlorine of lime', and in the following year dry 'bleaching powder'. Tennant's two products with their improved stability and ease of transport revolutionized the chlorine bleach industry. In 1799 he erected the St Rollox works near Glasgow, which for over 50 years was to remain the world's largest chlorine producing centre. In these early days chlorine was produced from salt by reaction with sulphuric acid and manganese dioxide in lead stills.

The introduction of chemical bleaching removed the need for the slow and costly crofting or grassing operations, in which the textiles were bleached by sunlight, and permitted the vast expansion of the cotton and linen industries at the beginning of the nineteenth century. This increased use of textiles brought new demands for washing soda and caustic soda, and an economic method for producing these from salt was sought to supplement the limited and costly supplies of natural soda on which the industry had hitherto depended.

The problem had been solved in 1783 by a French physician Nicolas LeBlanc. The French Revolution and Napoleonic Wars delayed the establishment of LeBlanc's process in France, but it became firmly established in England, which country was destined to become the centre of the World LeBlanc Soda Industry. This development was encouraged in 1825 by the timely abolition of Salt Duty, which gave a direct incentive to the English producers of chemicals from salt.

The first English LeBlanc operators were the Muspratt's at Liverpool; but public objection to the obnoxious hydrochloric acid chimney fumes, at that time an unavoidable part of the process, prevented further expansion within that city, and the later Muspratt plant was erected at Widnes, a site convenient for Lancashire coal, Cheshire salt and the Merseyside export market.

In time, with many newcomers to the industry, Widnes became the centre of the LeBlanc Soda industry and the birthplace of the Heavy Chemical Industry.

The problem of the acid chimney fumes, which rapidly laid waste the surrounding countryside, was essentially solved in 1836 by William Gossage who devised a water scrubbing tower for removing the offending gases. Many LeBlanc manufacturers were reluctant to adopt the idea since there was little demand for the large quantities of hydrochloric acid so produced. The Alkali Act of 1863 was passed with the specific intention of compelling LeBlanc operators to use the Gossage towers and thereby limit atmospheric pollution to a safe minimum. The situation was eased by the use of hydrochloric acid in the Deacon and Weldon processes in making the chlorine for bleaching powder, and the transfer of the bleaching powder industry to Widnes represented the long overdue merger of the chlorine and alkali industries. A greater evil of the LeBlanc process had by this time developed, which, in spite of the Alkali Act and its amendments, was to be with the LeBlanc industry to the end. Each ton of LeBlanc soda also produced 1½ tons of sulphurous waste which in time choked all available land and presented a pollution problem which was never adequately solved.

The continued expansion of the LeBlanc industry was checked by Ludwig Mond’s successful establishment at Winnington of the Solvay ammonia-soda process, and the phenomenal growth of Brunner, Mond & Co in the decade following its foundation in 1873.

Solvay soda was a purer and cheaper product than that from the LeBlanc process, and sales of the latter declined. As their profits dwindled, the LeBlanc operators merged in 1889 to form the United Alkali Company and turned their interests to other products of the LeBlanc process such as chlorine and bleaching powder. In particular their interest turned to sulphuric acid of which they soon became leading UK producers.

The years following the establishment of Brunner, Mond & Co saw the attempted introduction of variants of the ammonia soda process by those wishing to share the Brunner Mond success. The favourable terms of Ludwig Mond’s agreement with Solvay precluded the establishment of rival Solvay soda producers in the UK and the only attempt, by John Richards at Sandbach, soon failed and was taken over by Brunner, Mond & Co.

Such was the state of the Cheshire Alkali Industry at the time of G.L. Murgatroyd's arrival in Middlewich and the founding of Murgatroyd's Mid-Cheshire Salt Works.

MURGATROYD'S SALT WORKS

George Lomas Murgatroyd belonged to a wealthy and respected Stockport family. His father Joshua Murgatroyd was a Liberal town councillor, an elder of the Tiviot Dale Methodist Community and founder of the large and prosperous engineering firm, Emerson, Murgatroyd & Co. The family received strict Methodist upbringing, the mother's side of the family having become Methodist in the time of John Wesley.

After an education at Stockport Grammar School, young George Murgatroyd entered the family firm, and after a nominal engineering apprenticeship assumed an assistant managerial position.

In 1875, one year after Joshua's death, Emerson, Murgatroyd & Co obtained the contract for the construction of the famous Anderton Boat Lift, near Northwich, by which barges are still lifted 50ft from the Weaver Navigation to the Trent and Mersey Canal. The river and canal at this point carried the bulk of Cheshire's salt exports, while in the meadows across the river the struggling infant empire of Ludwig Mond had been born. Brunner, Mond & Co had been founded in Winnington Park two years earlier.

G.L. Murgatroyd played a considerable part in the construction of the boat lift, and this may well have been his first encounter with the salt and chemical world and a turning point in his life. From the top of the lift he would have gazed down with interest at the first English ammonia-soda plant. We shall never know, but it suits our story well if we imagine that the seeds of his later life were sown at Anderton.

We know little of his activities during the next ten years, or the means whereby he obtained his intimate knowledge of the salt industry and especially the brine runs under Middlewich.

In March 1889, five months after the formation of the Salt Union, he secretly negotiated the purchase of the 42-acre Newton Farm at Middlewich. The transaction was carried out through a certain Abel Grundey, a draper of New Mills, and

Murgatroyd's reluctance to figure in these early negotiations is a clear indication that he was not completely unknown to the salt industry by this time.

The search for brine began soon after the successful purchase of the land on 18th March 1889. We know little of Murgatroyd's reasons for his choice of land or his decision to sink the first brine shaft at the very edge of the property, close beside Sanderson's Brook and the railway. Local legend claims that he was partially guided by the line of the Roman Road which runs across the property, and the surface brine springs were certainly known in Roman times.

The shaft was sunk to a total depth of 330ft; two rock salt beds were discovered separated by a belt of Keuper marl. The upper bed, 50ft in thickness, was at a depth of 200ft and the lower of unknown thickness at a depth of 280ft. The upper portion of the shaft was 8ft square, but below a depth of about 60f it narrowed to about 4ft. The sides of the shaft were lined with thick pitch pine boards, held together with iron dogs. No brine was encountered, and the top of each rock salt bed was completely dry.

The next stage was the driving of a tunnel or 'adit' along the upper salt bed in a north-westerly direction beneath the railway. No brine was discovered but the railway company objected to the tunnel under their land, and Murgatroyd was eventually forced to negotiate the mineral rights of the 4½ acres of railway land which divided his estate.

An adit was next driven in the opposite direction, and after some 25yds brine was encountered.

The driving of an adit was a hazardous procedure for the workmen involved, for the discovery of a brine stream could mean a hasty retreat in the face of the incoming and rapidly rising brine. In order to obtain early warning of the presence of the brine, simple stethoscopes were often used. There is no written account of the manner in which Murgatroyd's brine was encountered; some say the shaft was evacuated in great haste, with tools abandoned and the brine coming up above the surface as a fountain; others claim that an orderly withdrawal was made – we may never know the truth.

The Murgatroyd brine shaft was sunk by two brothers named Philips who later did similar work for the United Alkali Co in the Fleetwood salt field. The clay was brought to the surface by winch, in canvas bags. The direction of the adit was considered a matter of secrecy, and the workmen were spun round during descent so that they would lose their sense of direction. The management and railway officials, of course, went down with a compass.

Middlewich was at this time far from prosperous and many were forced to seek employment in the neighbouring salt town of Winsford. Murgatroyd's discovery of brine gave hope of employment and a renewal of the town's prosperity. Flags were flown and the townspeople celebrated their new fortunes in a suitable manner.

The Murgatroyd 'find' was the most remarkable and successful to be made during the extensive search for brine following the formation of the Salt Union, and was moreover the first discovery of rock salt at Middlewich. It was remarkable because of the fact that geological faults have broken the continuity of the salt strata beneath Middlewich and the nearby Amans shaft, although only 50yds from Murgatroyd's and about the same depth, encountered no rock salt at all and negligible brine.

The Murgatroyd Mid-Cheshire Salt Works Company was now formed, and the building of a salt works begun. A railway siding was constructed, while in the nearby field the foundations were laid for an open pan works. Work progressed throughout the autumn of 1889 and the first pan began operation on New Year's Eve. Herbert Smith, a lumpman on that occasion, and later the salt works foreman, has recalled that the first lump of pure salt was placed in the hot house as the church bells welcomed the New Year. As construction work continued, more pans were brought into operation and soon over six were working.

We have no record of the first year's production. The Salt Union was at that time in the middle of a rather shaky start, and Murgatroyd probably found a favourable market for his salt.

By January 1891 the salt works were firmly established and Murgatroyd was making plans for his next enterprise, the erection of an ammonia-soda plant. He was joined in this venture by a German chemist, Hermann Aldendorff, who had previously been employed at the Cheshire Alkali Works in Kinderton Street, Middlewich. This company had been formed in 1887 and had operated a composite LeBlanc ammonia-soda process with indifferent success. In 1891 it was taken over by Brunner Mond who operated the plant for several years before finally closing it down in 1897.

Aldendorff's contract with Murgatroyd, dated 17th June 1891, refers to the construction of an ammonia-soda plant capable of producing 200 tons of soda ash per week at a maximum cost of £3 per ton. In order to provide the necessary capital for this venture, Murgatroyd formed the Murgatroyd Ammonia Soda and Salt Syndicate Limited, with an issued capital of £125,000 in £100 shares. His fellow-directors were mainly Stockport and Manchester traders, while his younger brother Thomas was Company Secretary.

The construction of the chemical works continued to the end of the year and throughout the whole of 1892. The work was completed in January 1893, and on the afternoon shift of the 17th of that month the first batch of soda ash was produced. The start-up took place without a hitch, and the planned production capacity was reached during the second month's operation.

The essential difference between the ammonia-soda process operated by Brunner Mond and that operated by Murgatroyd was at the carbonation stage. In place of Solvay towers, Murgatroyd had a battery of at least three Honigmann-type carbonators in which a batch reaction was carried out. While the process offered some advantages over the Solvay method, it was overall less efficient and moreover did not lend itself to reach scale-up of production without appreciable rebuilding.

After three months' very successful operation of the new plant, Murgatroyd and Aldendorff quarrelled and the latter left the Company to return to Germany where he is said to have risen to an important position in the German chemical industry.

Aldendorff's position was taken by E.B. Harlock of Brunner Mond while Murgatroyd himself began to take a more active part in the running of the chemical plant.

During the summer of 1894 conditions in the soda ash industry began to deteriorate. Prices fell by half during a period of only a few months, and the Murgatroyd Syndicate was faced with fierce competition from Brunner Mond. It is interesting to note that it was only during this period, some 20 years after the foundation of the Winnington Works, that Brunner Mond considered it necessary to convert surplus soda ash into caustic soda.

In addition to declining markets and competition from Brunner Mond, the position of the Murgatroyd Syndicate was further aggravated by low process efficiency and poor product quality.

Murgatroyd became a worried and sick man, and dosed himself increasingly with the homeopathic medicines in which he was a firm believer. He died suddenly on 26th November 1894 from an overdose of belladonna, and at the inquest two days later an open verdict was recorded.

No matter what were the actual circumstances of Murgatroyd's death, it is probably truthful to say that he died of a broken heart caused by the imminent failure of his chemical works. There is some conjecture as to what extent this failure can be attributed to the type of process operated or to the technical ability of the personnel concerned. Ammonia-soda processes of the type worked by Murgatroyd have been successfully operated on the continent even to the present day.

With the death of George Lomas Murgatroyd the Syndicate lost not only its founder and Managing Director but also the only technically-minded member of the Board of Directors. This situation was remedied by the invitation of Ivan Levinstein to be chairman of the Board.

Thirty years before, in 1864, Ivan Levinstein had founded the Blackley dyeworks which have today become the headquarters of the ICI Dyestuffs division. The Company had prospered, and Ivan Levinstein was a leader of the Manchester commercial world and the chemical industry.

We have no record of a long personal friendship between Levinstein and Murgatroyd but it was probably more than a simple business acquaintance. Ivan Levinstein was one of Murgatroyd's first salt customers and could well have given him moral support in his two ventures. Levinstein's entry into the ammonia-soda industry in later years shows him to have been not completely disinterested in this field.

In the light of such an interpretation it was not out of place for Thomas Murgatroyd and his fellow-directors to seek Levinstein's aid in their hour of need.

Even with Ivan Levinstein as chairman, the fortunes of the Syndicate did not improve, and when, several months later, Brunner, Mond and Co offered to buy the chemical works it was Levinstein who persuaded the other directors to accept the offer. At the same time, in order to safeguard the supply of salt to the Blackley Works, Levinstein purchased for himself the Murgatroyd Salt Works. The conveyances which marked the end of the Syndicate were signed on 8th August 1895. Alone among the directors of the Syndicate, Thomas Murgatroyd remained faithful to his brother by opposing the sale to the end, and always thought that Ivan Levinstein might not have had Murgatroyd's best interests in mind.

Levinstein did at least comply with one of Thomas Murgatroyd's wishes, he agreed to preserve the name 'Murgatroyd' in the title of the salt works. It was apparent however that he showed little interest in the Murgatroyd's Salt Works Company and looked on it merely as a guaranteed source of salt for the dyeworks at Blackley. He retained a 50 per cent interest in the Company, his fellow-partners G.W. Fox and Otto Isler each having a 25 per cent share.

The Murgatroyd's Salt Works followed an undistinguished path during the next 20 years until Ivan Levinstein's death on 15th March 1916 when his interest in the Firm passed to the second son Dr Herbert Levinstein.

Of Ivan Levinstein's three sons, the youngest, Gerald, was killed in Flanders in 1916 and the eldest, Edgar, showed no interest in chemistry and spent the greater part of his life in the USA. It was the remaining son, Herbert, who was destined to follow in his father's footsteps.

Herbert Levinstein was born in Prestwich in 1878 and was educated at Rugby and Owens College, Manchester, where he obtained his MSc in 1898. He then worked for a PhD at Zurich and in 1900 joined Levinstein's Limited.

After a period of research work, he became Works Manager in 1907 and assumed full control of the Company on his father's death in 1916.

The Blackley dyeworks grew considerably under the wartime stimulus caused by the loss of German supplies and pre-war government neglect of the dyestuff industry. This expansion is clearly reflected in the salt dispatches from Murgatroyd's to Blackley which rose from about 145 tons per month in 1913 to about 900 tons per month in 1918.

In 1919 Levinstein's Limited joined British Dyes Limited of Huddersfield to become the British Dyestuffs Corporation with Dr Levinstein as Joint Managing Director. He disapproved of the national dyestuff policy and two years later resigned. By this time he was also in full control of the salt works which in 1922 became Murgatroyd's Salt Works Limited.

The Blackley dyeworks continued to absorb over half the Murgatroyd salt works' production in the post-war years; more open pans were constructed and a brine purification plant was installed to meet the dyework's demands for pure salt.

In 1926, when the British Dyestuffs Corporation joined with Brunner, Mond and Co, the United Alkali Company and Nobel Industries to form Imperial Chemical Industries Limited, Murgatroyd's lost a large proportion of their trade virtually overnight. Such a tonnage was difficult to replace at home, so the firm entered the West African market and has continued to place substantial quantities of salt in that part of the world ever since.

The following years up to about 1937 continued to be difficult for the Murgatroyd salt works because of the cut-throat competition due to declining markets in open pan salt and the development of vacuum evaporation.

With the formation of ICI, Herbert Levinstein ceased to have an active interest in the dyestuffs industry, and for many years played an important part in the establishment of the rayon industry. His remaining links with ICI prevented him from expanding and diversifying the salt works, for this would have been in direct opposition to the Alkali Division, of which Brunner Mond had become part. During the mid 1930’s these links were finally broken and he turned his attention to the establishment of a vacuum salt and alkali plant which would make maximum use of the ample supply of brine which he had inherited.

In 1936 his plans moved a step nearer reality with the purchase of an ideal site for a chemical works near Croxton Hall about one mile north of the salt works at Middlewich. Here he was to build his new works, but with the outbreak of war his plans had to be put in cold storage and the land was, in fact, sold to ICI.

In 1937, the year in which the old Salt Union was finally absorbed into ICI and became the Salt Division, British Salt Manufacturers again formed a Federation, and conditions in the industry improved during the remaining pre-war years. During the war years the open pan works were given a new lease of life and operated at maximum production, the main problem being manpower. Salt imports, particularly to the fish-curing trade, had been cut off, but while some exports were similarly affected, the firm’s West African trade was able to continue.

While the war prevented any major expansion, it did not prevent Herbert Levinstein from making plans for the post-war years. Moreover, it was obvious that the abnormal war-time working of the open pans would not continue and that the peace-time salt trade would depend more and more upon multi-effect vacuum evaporators which were already in use by the bigger competitors. His main problem was to locate a suitable site with road, rail and water facilities, so vital to a chemical works. Most of the land in the district had been closed to future salt and chemical development by the restrictive covenants inserted during land purchase by Brunner

Mond and others. An untouched oasis was the 200-acre Yew Tree Farm at Elworth which he successfully purchased in 1944.

At the end of the war, together with his friend James Clayton, detailed plans for the new factory were prepared. A case was made for the project in relation to the national economy and the predicted needs of the chemical industry during the immediate post-war years. This included detailed estimates of plant requirements and production costs and a market survey carried out with respect to the intended products.

The fifth draft of this historic document, referred to as the Yew Tree Memorandum and dated 25th June 1945, was submitted to the Capital Issues Committee and the Government-sponsored Finance Corporation for Industry. On the strength of this, the FCI agreed to provide the necessary capital.

On 25th May 1947 Murgatroyd's Vacuum Salt Co Ltd was formed and, a few months later, work on a narrow 18-acre site between the road and the railway began. Construction continued for over two years and production commenced in 1950. A conspicuous feature of the new factory was the cooling tower which became a notable landmark on the Cheshire plain, only recently rivalled by the Jodrell Bank telescope.

In 1949 the name of the Company was changed to Murgatroyd's Salt and Chemical Co Ltd in view of its entry into the chlor-alkali field.

As the new Company became firmly established, the FCI relaxed its control and in 1954 the Company was bought on an equal basis by Fisons Limited and the Distillers Company Limited. The main products of the factory are Vacuum Salt, Chlorine, Caustic Soda, Hydrogen, Hydrochloric Acid and Sodium Hypochlorite.

The increasing demand for these products, especially chlorine for the growing PVC plastic and chlorinated organic chemical industries, has resulted in a continuous expansion of capacity. A mercury cell installation giving high grade caustic soda was completed in 1956 and the chlorine capacity of the factory was doubled overnight. At the present time a second mercury cell installation, which will increase chlorine production by a further 50 per cent, is under construction.

The Elworth factory stands as a memorial to the man who conceived it, and who encouraged its growth into the form we know today. Dr Herbert Levinstein died at the age of 78 on 3rd August 1956, two weeks after a visit which remains a cherished memory to all at Murgatroyd's who knew and worked with him.

The story of the original Middlewich open pan works during the post-war years is a sad one, especially for those who worked there or who are at all sentimental. One by one the pans have fallen into disuse with the declining trade in open pan salt, and today only five remain in operation. Of the 650 employees of the Company, less than 40 remain at the old works, and of those who work at Elworth, many have never visited or even seen the open pan works less than three miles away from where the brine, on which the whole enterprise depends, still flows, most of it from the very shaft G.L. Murgatroyd sank some 70 years ago.

II – MURGATROYD'S PRESENT

FOREWORD

Murgatroyd's post-war developments have centred around the new chemical plant at Elworth where vacuum salt is produced in modern multi-effect evaporators, and where chemicals are manufactured from salt in an electrolytic chlor-alkali installation.

The electrolysis of brine requires large quantities of electrical power which only became available during the 1880's following the invention of the dynamo; the process was therefore very much in its infancy when Murgatroyd founded his salt works in 1889.

Once the problem of electrical power had been overcome, rapid progress was made in Europe and also in the US, and the two main types of electrolytic cell, the mercury cell and the diaphragm cell, were conceived and developed from about the year 1894 onwards.

Of particular interest is the story of the Hargreaves-Bird diaphragm cell, the successful outcome of work by James Hargreaves – a Widnes chemical consultant, and Thomas Bird – a young Liverpool electrical engineer. This cell was operated successfully in the works of the Electrolytic Alkali Company at Middlewich and also in the US, where it was the precursor of the 1903 Townsend Cell from which the present-day Hooker Cell has developed.

Herbert Levinstein had always been interested in the Hargreaves-Bird chlor-alkali installation at Middlewich, and this may well have stimulated his own ideas for a chemical work based on the source of brine he had inherited.

Since the electrolysis process must of necessity produce chlorine and caustic soda in equivalent amounts, it is essential to have a balanced demand for both of these products. While caustic soda in the anhydrous form may be stockpiled to meet the needs of a fluctuating market, chlorine presents a costly storage problem, and progress during the early years was retarded by the restricted use of chlorine for the production of bleaching powder and bleach solution, although demands for these two products did increase.

From about 1914 onwards the increasing use of liquid chlorine, firstly as a war gas and then for chlorinated organic chemicals, has lead to a steady expansion of the electrolytic method. This expansion has been particularly marked since 1945. By 1939 the USA had become the centre of diaphragm cell design and operation, while Germany was leader in the mercury cell field.

The most significant advance in the salt industry during the first half of the present century was the gradual introduction of multi-effect brine evaporators and the corresponding decline in open-pan operation. The change-over has never been completed, for although vacuum evaporation gives the most economical fuel-salt conversion ratio, it has been unable to achieve the versatility of the open-pan method with regard to the size and shape of the salt crystals produced. With today's high fuel costs, the special grades of open-pan salt must be highly priced, and although appreciable quantities of low-density salt are still exported to West Africa, open-pan operation must be looked on as a dying art that will eventually disappear.

The Yew Tree Project

Herbert Levinstein's early plans for a vacuum salt and chlor-alkali plant, already described in the first part of this story, were shelved on the outbreak of war; but, as the fighting in Europe drew to a close, detailed planning commenced for a chlorine-alkali plant to be constructed as soon as post-war conditions would allow. In 1944 the 200-acre Yew Tree Farm at Elworth had been successfully purchased and this contained suitable sites for the new factory with the necessary rail and road connections and also a canal for cooling water.

By June 1945 the plans were completed, and in the form of the "Yew Tree Memorandum", were submitted to the Capital Issues Committee and the newly formed Finance Corporation for Industry. Approval was obtained and the FCI agreed to finance the venture. With the necessary capital available, negotiations for the development of the land were opened with the various planning bodies. Within the Yew Tree estate itself there were several possible sites for the proposed works, in which ideally the various production units would be arranged symmetrically about a central boiler and power house. The most suitable land for such a scheme was to the south of Yew Tree Farm itself, but permission to develop this was officially opposed, even though it was within the area rescheduled for industrial use. In fact, the only land for which permission could be obtained was the 20-acre strip between the road and the railway, and the present plant layout was therefore revised to suit the allocated site.

Negotiations were now concluded with the railway company for the installation of sidings and the laying of a pipeline alongside the railway to bring brine from the old works in Middlewich, and with the canal authorities for the abstraction of water for cooling, and for permission to discharge treated effluent.

By the spring of 1947 most of the preliminary planning had been carried out, and on 21st May 1947 Murgatroyd's Vacuum Salt Co Ltd was formed to translate, into a working reality, the scheme described in the Yew Tree Memorandum.

The basic aim of the project was to produce vacuum salt, caustic soda and chlorine in such balanced quantities that would achieve the most economical usage of steam and electrical power. In addition, so that production should not completely depend upon the demand for chlorine, and to give the factory a necessary flexibility of operation, the scheme was to include plants for the conversion of surplus chlorine into hydrochloric acid and sodium hypochlorite, both being products with a ready sale.

The placing of orders for the many items of plant and building material required, in a world of permits, shortages and the various other restrictions of the immediate post-war years, was no mean task; often the choice of equipment was decided more by availability than suitability for the particular task.

A major decision which had to be taken at this point was the choice between diaphragm and mercury cells. No British cells of either type were available, and economic recovery in Europe had not advanced sufficiently for any German-built mercury cells to be a possibility. The obvious choice was therefore diaphragm cells of American design, and the Hooker-S-cell was chosen from the types available. This had been well tried in the USA, and was the most recent member of a long line of diaphragm cells dating back to the Townsend cell of 1903.

Since in diaphragm cells only a portion of the feed brine is electrolysed, the resulting cell liquor contains a caustic soda-salt mixture, and an evaporation and filtration plant is necessary for producing 50 per cent caustic soda liquor. This latter plant was constructed by John Thompson Limited to the design of Walter L. Badger.

The compression of chlorine gas to 100 psi presented a particularly difficult problem. No compressors capable of reaching this pressure and also specifically designed for chlorine were available in this country at that time, and dollars could not be obtained for the purchase of suitable American equipment. It was therefore decided to adapt two-stage double-acting non-lubricated compressors, of British manufacture; and originally designed for the compression of air.

The hub of the new factory was the power house in which two John Thompson water tube boilers raised steam for driving a 6.5 megawatt Parsons DC generator which produced the electrical power for the electrolysis process, while the general factory AC needs were supplied with a 1.5 megawatt turbo alternator. The low pressure "pass out" steam from the generators was then passed to the brine and caustic liquor evaporation plants, thereby achieving the balance between electrical power and steam for process work upon which the basic economy of the new works depended.

After a construction period lasting over two years, the various sections of the new plant came on load during the autumn of 1950. Twelve months earlier, a pilot plant with two Hooker cells had been constructed in order to gain valuable operating experience in readiness for the full scale start-up. The chlorine produced by this pilot plant was absorbed in purchased caustic soda liquor, and the sodium hypochlorite so produced was the first saleable product of the new works; (the first dispatch was made to Deosan Limited on 25th November 1949). Electrical power for the pilot plant was obtained from the public electricity supply and rectified on the site.

The first section of the new factory to begin production was the brine evaporation plant in September 1950, and this was followed a few weeks later by a full-scale trial of the 50 per cent caustic liquor evaporation plant using the cell liquor stored up during the 12-month operation of the pilot plant.

Full-scale chemical production commenced on 19th December 1950 when the inter-related plants, starting from the Hooker cells, were commissioned. Naturally, some teething troubles were experienced and, in such a highly integrated plant, they affected the whole chain of operation. By the late summer of 1951 most of these headaches had been overcome and, before the end of that year, the chemical plants were operating at their design rating.

In January 1952 a Dowtherm heated high concentrator for the production of anhydrous caustic soda, the first in Europe, began operation, and this marked the successful completion of the original Yew Tree Project.

Expansion

With the country's expanding chemical economy, demands for chlorine increased but the production of the Hooker cells was limited by the capacity for generating direct current. Further generating capacity would have given increased quantities of low pressure steam for which there was no foreseeable future demand, and extra power was therefore purchased from the Electricity Authority and rectified in a mercury arc rectifier installation. This new capacity came on load at the end of 1954 and enabled the chemical plant to operate at a substantial margin above its design rating.

In the meantime, plans were also made for a major expansion of chemical production. It was decided that this should be based upon a mercury cell installation to enable the Company to offer high-purity "Rayon-Grade" caustic soda, which is produced directly from such cells. An advanced design of mercury cell perfected by Farbwerke Hoechst and available from Friedrich Uhde GmbH of Dortmund, was chosen, and it was decided that the additional power requirements should be purchased and rectified in mechanical contact rectifiers.

The decision to put these plans into effect was made when the Company obtained the contract for the supply of chlorine to British Geon Ltd for the manufacture of PVC. Construction of the mercury cell plant commenced in April 1954 and it was commissioned at the end of March 1956. Within this period (actually in October 1954) Murgatroyd's was taken over jointly by DCL and Fisons Ltd.

During the past five years, chlorine demands have continued to increase, so that early in 1960 it became obvious that a further expansion of cell capacity would be needed to cope with the demand for the ethylene dichloride plant of British Hydrocarbon Chemicals at Grangemouth. A further battery of mercury cells is now under construction, together with the necessary expansion of related parts of the chemical plants. Once again, the additional electrical power is to be purchased, but the direct current will be produced in the latest type of silicon semi-conductor rectifiers. When this new equipment is commissioned, Murgatroyd's chlorine capacity will have been more than trebled in seven years.

Up to the present date there has been no compelling need to extend the company's range of products, and progress during the first 10 years at Elworth has taken the form of expansion of existing processes rather than diversification. Thus the general pattern remains unchanged with Caustic Soda, Chlorine and Hydrogen as the primary electrolysis products, and Hydrochloric Acid and Sodium Hypochlorite as the secondary chlorine-consuming products. In addition, there is a considerable trade in unstoved and stoved vacuum salt, both of which are distributed widely throughout the food processing, chemical and plastics industries. Only a very small proportion of the vacuum salt production finds its way to the domestic market.

Caustic Soda is marketed as Caustic Liquor (the solution in water) or in the anhydrous fused and flake forms. It is used widely throughout industry and there is an appreciable export trade in the anhydrous material. Caustic Liquor sales are restricted to the home market where the comparatively short haulage distances make its use economical.

Chlorine is dispatched in liquid form in pressurised road and rail tankers, and drums and small cylinders. Much of Murgatroyd's chlorine is used for the production of PVC, but a considerable proportion is also used for the manufacture of chlorinated organic chemicals.

Of the products of electrolysis, the use of hydrogen was not adequately provided for in the original plant. Apart from the small quantities burnt with chlorine to produce hydrochloric acid, most of it was vented to the atmosphere. Very soon provision was made for burning unwanted hydrogen in the boilers, and this produced a 5 per cent saving on the fuel bill. In 1957 a hydrogen compression plant began operation, which has since been considerably expanded to meet with the increasing market for bulk hydrogen for edible fats production and other miscellaneous hydrogenation processes.

The compressed hydrogen is dispatched in the large trailer-mounted cylinders shown in an accompanying photograph. Each vehicle carries a load of 50,000 cubic feet hydrogen compressed to 3,000 psig.

The present production capacity of the Sodium Hypochlorite plant represents a considerable increase on the original installation. The bulk of Murgatroyd's sodium hypochlorite now comes from the modern continuous plant, which came on stream in

1959. Previously only the original batchwise process was carried out. The essential feature with both processes is the reaction of chlorine with caustic soda liquor at a controlled temperature until the desired strength of sodium hypochlorite is obtained.

The original hydrochloric acid plant, installed when the factory was built, was constructed to the design of the Hooker Electrochemical Company. This was supplemented in 1956 by a second unit obtained from Siemens-Plania and designed primarily to use dilute chlorine arising in the process. Both plants operate on the same principle; chlorine is burned in excess hydrogen to form hydrogen chloride which is then absorbed in water to give the required acid.

Sodium Hypochlorite is the essential constituent of many domestic and industrial bleaches and disinfectants, and is also used as an oxidising agent in certain chemical processes. Hydrochloric acid is used widely throughout the chemical and metallurgical industries.

The accompanying photographs show various sections of the present Elworth factory. The undernoted references to detailed accounts in the technical press are given for those readers wishing to obtain more technical details of the plant and its operation.

G.D. TWIGG

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1. *Industrial Chemist;* 1951, vol. 27, p.115.
2. *Industrial Chemist;* 1952, vol. 28, p.451.
3. *Industrial Chemist;* 1956, vol. 32, p.535.
4. *Power & Works Engineering,* Feb. 1957, p.49.

(Typed by Jan Hutson – Feb 2020)