THE MOVEMENT OF CHEMICALS THROUGH HAYLE.

Historical Review

The industrial history of 18th and 19th Century Hayle was dominated by mining and engineering but the chemical industries came into prominence in the 20th Century. National Explosives, established in 1888, manufactured a range of explosives whilst Associated Octel, built by British Ethyl Corporation, later Associated Ethyl, produced a key component for the octane improver in aviation fuel. National had a strategic role in the First World War and Associated in the second.

Although the two companies operated at different times they utilised the basic building bricks of the chemical industry in the manufacture of their products, namely sulphuric acid. The importance of sulphur and sulphuric acid is worthy of closer study.

The National Explosives factory started operating on Upton Towans in 1888 but closed down in 1919 after 31 years. It was a unique chemical complex manufacturing nitric and sulphuric acid on- site as well as processing mixed acids. Sulphuric acid was initially imported in glass carboys by rail to Gwinear Road Station sidings for onward movement by horse drawn transport. This was quite a hazardous operation when compared to the imports of glycerine from Crosfield's of Warrington, also by rail, but in metal drums.

A lead-chamber plant for the production of sulphuric acid was built in 1905-6 but ultimately proved to be uneconomic and closed in 1913. There is no available information about the use of rail tankers for subsequent imports of acid so it is assumed that the use of carboys carried in rail wagons was resumed.

For up to 7 years iron pyrites had to be imported to provide the necessary sulphur and it was probably shipped into North Quay and moved by horse drawn transport along the northern shore of Copperhouse Pool. No information about quantities is available.

Sulphuric acid was required for the on-site production of nitric acid, the most convenient means of obtaining an essential material for explosives manufacture. The reaction between sulphuric acid and saltpetre (sodium nitrate) is quite straight forward but the sodium sulphate effluent can be a difficult residue to handle. Saltpetre was imported in sacks through local ports, North Quay being used by National Explosives.

The best information available on the rail link to Upton Towans indicates that it was a wartime project starting in 1914 when Dynamite Bridge was constructed close to present day Broadway. Operation of the railway ceased when production ended in 1919 and it was removed by 1922. Peak use was in 1916, coinciding with the peak of explosives production. It was also likely that full advantage of the link was taken to move saltpetre but no definitive information is available on sulphuric acid movements.

The Associated Octel bromine plant, known locally as "the ICI" was built in 1939-40 by British Ethyl Corp, a joint venture between ICI and Associated Ethyl, It became wholly owned by Associated in 1943, although

operated by ICI until the end of 1947.Import of sulphuric acid took place from the start of production in 1940.

The extraction of bromine from sea water is essentially a three stage process, the release of bromine, the capture and concentration and finally, the recovery and purification stage. In the first phase the sea water is moderately acidified to ph 3.5 and chlorinated to a 10% excess to convert the sodium bromide into bromine and sodium chloride. The second phase collects and concentrates the bromine from 64 parts per million to a 10% solution, alkaline or acidic, depending on the process. There is a different means of recovery for each process. Over the 32 year life of the plant two processes were operated. From 1940 to 1954 the alkali process collected the liberated bromine in an alkaline solution as sodium bromate. The recovery process used sulphuric acid to liberate the bromine from the alkaline solution. From 1956 the acid process collected the bromine in an acidic solution as 10% Hydrobromic Acid. Chlorine was injected into the solution to convert the HBr to bromine and hydrochloric acid. The significant difference between the two processes is that the alkali process had a far greater sulphur/sulphuric acid demand that the acid process, where 50% of the acid required to acidify the sea water was generated in-situ.

Sulphur and Sulphuric Acid

Plant records show that throughout the entire life of the alkali process a total of 172,000 tons of sulphuric acid was used of which 105,000 tons were imported before the sulphuric acid plant was built on site in 1948-9. This equates to an average of 11,750 tons per year, equivalent to a sulphur usage of 3,800 tons per year.

British Ethyl purchased a fleet of 20 rail tankers to import sulphuric acid from National Smelting Corp at Avonmouth and Gibbs-Finch at Plymouth. 87.5% of supplies were received from National Smelting. The size of fleet may be regarded as excessive but the vagaries of wartime transportation had to be considered. There was only one recorded occasion when sulphuric acid “ran out”.

Time and money were of the essence when the original plant was built for the Air Ministry so on-site production of acid, with the requirement to import sulphur, was deferred until hostilities ceased and Associated Ethyl had full ownership and control of operations. A Simon – Carves “Contact” plant was commissioned in August 1949. A Sulphur Store of 1200 tons capacity was constructed on North Quay at the same time. This remained, in various states of repair and disrepair for 60 years.

Ideally sulphuric acid imports should have ceased and been replaced by sulphur imports but the immediate post war period brought with it a number of problems for the chemical industry. One of these was a sulphur shortage and sulphur rationing. The company was a member of the National Sulphuric Acid Association, an organisation established in 1919 to operate a sulphur pool on behalf of its members. Purchases and shipments of sulphur were arranged by the Association directly with the harbour authority, in this case, with Harvey & Co.

Sulphur rationing was precipitated by the 1951 economic recession, a shortage of foreign exchange and the post war reconstruction of the chemical industry. Associated Ethyl was fortunate in having a fleet of rail tankers available; for approx. 3 years from autumn 1951 over 9600 tons of sulphuric acid were

imported replacing about 25%of normal sulphur demand. The imports were equivalent to 3150 tons of sulphur. The sources of the imported acid were:-

- 1951-2 Gibbs and Finch Plymouth 1180 tons
- 1951-2 Northern Spain 3925 tons
- !953-4 National Smelting 3470 tons
- !954 Associated Octel Amlwch 1000 tons

Annual imports of acid were:-

- 1951 1224 tons
- 1952 2566 tons
- !953 4424 tons
- 1954 1461 tons

Following the commissioning of the Simon Carves Acid plant 67,000tons were used by the" alkali process" 9,600tons being imported. The quantity of sulphur imported during the same period was 18,620 tons. Overall, the "alkali" process consumed an equivalent of 3,800 tons of sulphur per year for a plant designed to recover 2,500 tons of bromine per year.

For reasons given above the acid process consumes less sulphur than the alternative. For a plant whose capacity was doubled to 5,000tons per year the annual sulphur usage fell to 2600 tons. After the acid process settled down alternative uses were found for the sulphuric acid tankers, including conversion to carrying ethylene dibromide.

The first sulphur consignment received in July 1949 was high purity, bright yellow sulphur but this was soon replaced by dark sulphur containing a high ash and tar content. The situation continued until 1954. During the period of rationing storage became a particular problem. Consignments were 500-600 tons in size but the vagaries of transport and availability meant that there were many occasions when sulphur had to be stored outside the north wall of the store or on the acid plant yard. Operating losses increased and impurities were a continuing problem.

Off-loading sulphur was always an issue, especially from vessels alongside the Quay. It was a most unpopular operation with Dockers, employees and local people as evidenced by comments in the recent Hayle oral history project. A handling system was purchased and installed on the western side of the store, comprising hopper, crusher, elevator and conveyor belt. It was always troublesome and required a considerable amount of engineering and maintenance effort before it was finally removed. Subsequently sulphur was loaded into tipper Lorries parked alongside vessels and offloaded directly into the store. Movements from Store to plant was always by Chaseside mechanical shovel, a machine that operated trouble free for 25 years until closure in 1973

Harvey & Co offloaded colliers using crane and grab but this did not apply to sulphur consignments until mid1956. Dockers shovelled the sulphur into buckets which were then lifted by crane and emptied into the hopper. Sulphur dust is an irritant and causes soreness in the eyes. Associated discussed handling

improvements with Harvey & Co in March 1952 but is spite of a measure of agreement to use methods similar to that for coal the project lapsed. In 1954 the Works Manager raised the issue again this time resulting in changes to be introduced when the paint conversion was complete in 1956. It was always difficult to understand Harvey's reluctance to change. It may well have been a concern about the possibility of the grab hitting the side of the vessel, creating a spark and initiating a minor dust explosion or fire. Subsequent experience rendered those fears unfounded.

From 1956 onwards, in spite of its unpopularity, sulphur shipments presented little difficulty. The size of vessel able to use Hayle limited consignments to 500-600tons but uncertainties over arrival and departure demanded prompt responses to any information. Suitable vessels became very scarce in the late 60's. Coastal vessels were in regular traffic from Bayonne, on the Bay of Biscay, to small ports such as Hayle, Watchet and Arklow sometimes back loading granite from Penlee Quarries for a return cargo. I can only recall one occasion when a departing vessel was delayed by neap tides. NSAA and Harvey & Co liaised very well, normally arranging for arrival on spring tides.

Throughout the operation of the acid process sulphur usage averaged 2,600 tons per year, equivalent to about 5 consignments. During the whole life of the plant 61,500 tons of Sulphur were imported by sea and 114,500 tons of sulphuric acid by rail.

By contrast, the sister Bromine plant at Amlwch Anglesey had a design capacity of 30,000 tons when Hayle closed; consuming 15,600 tons of sulphur per year. This was imported via the Port of Mostyn on the Dee Estuary and then rail hauled 70 miles to Amlwch. Handling of the sulphur was always a challenge, with about 7 consignments per year. Each consignment generated a time of peak activity requiring an immediate turn round of rail hoppers.

A liquid sulphur terminal was built at Runcorn in the early 80's to receive liquid sulphur from Poland and Canada for the North West Region. Solid sulphur train load movements were replaced at Amlwch by regular daily road deliveries of liquid sulphur in 1988. This more environmentally friendly supply chain was the result of benefits of scale which would never have been possible at Hayle.

The "Alkali Process"

The selection of North Quay as the site of a strategic, wartime facility for the extraction of bromine from sea water, although not the most ideal, had many advantages not least a rail connection with the main rail network. British Ethyl Corporation had also opted for a 375mile supply line for the transport of major raw materials and finished product to and from North and mid Cheshire.

The economics of the operation, with high power and transport costs combined with the constraints in sea water supply was a continuing issue throughout its life. It was recognised at an early stage that expansion would not be feasible. The design capacity was 2500 tons of bromine per 345 day year using the "alkali process" and requiring, on average, 30 tons of sulphuric acid, 4.5 tons of chlorine and 11 tons of soda ash per day.

This process was used until 1954 when the plant was converted to the more economic "acid process" with sulphuric acid manufactured on site but requiring 16 tons of chlorine per day for a capacity of

5000tons of bromine per year. The significant reduction in raw material transportation and increase in finished product makes it appropriate to consider rail operations for each process separately.

At the outset British Ethyl purchased a fleet of 35 rail tankers; 8 for chlorine movements, 7 for transfer of finished product and 20 for sulphuric acid movements. Common-user rail wagons were transported soda ash. During 1939 / 40 materials of construction were in short supply and costs tightly controlled but having regard to potential delays en-route due to enemy action, irregular transit times and limited storage capacity on the works it was inevitable that many supply and distribution issues would be encountered with such a limited fleet.

The design parameters indicated that a turn round time of 15 days had been assumed for each rail vehicle. Sulphuric acid was sourced from National Smelting at Bristol and from Gibbs & Finch at Plymouth so the size of fleet should have been adequate but in the event it was shortage of acid that caused some shutdowns in 1940.

Soda ash, chlorine, and Ethylene Dibromide (EDB) traffic was routed via Plymouth, Bristol and along the Welsh border (North and West LMS & GWR Joint route) to Shrewsbury and Crewe. Trip working and terminal time accounted for significant delays in addition to the slow speed of freight in wartime conditions. Marshalling delays were often incurred due to enemy action and some cases of misdirection of traffic were reported. Even in the stable, more efficient, post war years transit from North Cheshire could be 6 to 7 days so some problems in the supply chain were inevitable.

Soda ash supplies created many headaches, some of which were alleviated by amending the order/despatch procedures. Non-availability of wagons, irregular transit times and demurrage charges arising from bunching of traffic were additional problems. Limited on-site storage called for imaginative solutions. Storage capacity outside the Works on Harvey & Co premises on North Quay was utilised whilst GWR allowed some standing time in their sidings at Gwinear Road station.

Congestion and management of inwards and outwards traffic within the Works demanded the full attention of the Day Process Foreman and tractor driver but records showed that their ingenuity solved many problems. To minimise short term congestion sulphuric acid and chlorine tankers were also held, temporarily, at Gwinear Road.

Chlorine tankers were usually berthed on the spur line from the Wharves branch to the old Hayle Railway line, in front of Clidgy Cottages, as a precaution against enemy action; the location, in the shadow of Clifton Terrace, being considered less obvious to enemy aircraft.

From 1949 half the acid fleet was released for alternative use with the rest being retained for alternative use on inter-works transfers between the new facilities at Ellesmere Port and Anglesey two tankers were converted to EDB use in 1947 and a further 8 in 1951.

Demand for EDB and bromine increased steadily during the war years until bromine production reached 3400 tons in 1945 and 4000tons by 1954. When the “alkali” process was closed down chlorine usage had increased to 2400tons in 1945 and 2800 tons in 1954, well in excess of the design requirement of

1700tons. Fortunately, ICI (sellers) tankers were available, at additional cost, to meet any shortfall in supply.

The 7 tankers purchased for EDB proved to be insufficient for moving 3900tons in 1945 and at the rate of 4600 tons per year in 1954. The design output was 2800tons.Two silicate tanks were hired from ICI but whilst they created problems at the Works they enabled supplies to Northwich Works to be maintained. In his final report the Works Manager made the point that in spite of shortage of transport equipment and inadequate storage capacity all problems were overcome.

There were only two mishaps during the war years, in May and November 1943, both in the vicinity of Newton Abbot and involving chlorine tankers. There was no leakage of chlorine in either incident.

It is worthy of note that during the life of the "alkali" process, from 1940 to 1954, 309,500 tons of rail freight was generated in the production of 45,000tons of bromine. This compares with an estimated 123,250 tons for 91,000 tons of bromine during the life of the later "acid" process. Sulphuric acid and soda ash accounted for 241,000 tons. Most significantly the peak year for rail freight in the whole life of the Works was 1945 with 24,500 tons of freight for 3,400 tons of bromine.

The size of the rail fleet was based on a capacity of 2,500 tons of bromine which would have generated 18,500 tons of freight. The data for 1945 illustrates and measures the extent of the issues faced by employees in despatching finished product and receiving supplies during wartime.

The "Acid Process"

Conversion to the "acid" process reduced the amount of rail freight significantly and also improved the economics of the plant. Chlorine and finished product (EDB & bromine) continued to be transported by rail but the estimated tonnage fell to below 8,000 tons per year.

(Detailed records are not available for the acid process but the estimates are based on the knowledge and experience of the writer who was involved in the operations as Works Manager)

A more significant change to traffic patterns occurred when Chlorine Works at Ellesmere Port was commissioned in 1958. ICI had given notice of its intention to cease supplying the Company's heavy chlorine requirements in 1955 so in-house facilities had to be built. An additional fleet of 35 14ton payload tankers were built by Hurst Nelson between July 1957 and Feb 1958. This was the last order for tankers built to the standard Railway Clearing house design. From early 1958 Hayle and its sister bromine plant in Anglesey were supplied from Ellesmere Port instead of Runcorn. The route was Ellesmere Port to Mold Junction (Chester) thence to Shrewsbury instead of via Crewe.

The 1960's was a period of continuous change for the Company in its endeavours to meet market needs. Expansion of the facilities at Amlwch, Anglesey was inevitable given the economics of the Hayle plant. High power costs, variable bromine content of sea water, falling temperatures and limited sea water availability were such significant constraints that in 1962 it was decided to incur no further capital expenditure. The new strategy was based on selling all the bromine produced which meant that EDB

production fell steadily until it ceased in 1968. These changes had a negative impact on rail freight tonnage but improved plant economics.

Whilst there was a dedicated fleet for EDB movements it was never used in the conventional manner due to the seasonal nature of production, being temperature dependent, and variable demand patterns. Stocks were always highest in the autumn and lowest in the spring. The Company's main product had two specifications, Motor Mix and Aviation Mix, the former with 50% of the quantity of EDB contained in the latter. From 1964, when 10.000ton bulk chemical tankers came into use, shipments to international customers caused production planners to use EDB rail tankers as temporary storage. Hayle Works was very happy to use road tankers because of the turn round time of 48-60 hours compared to 10-12 days for rail tanks. Road movements gradually became the norm further impacting on rail traffic.

Until 1960 bromine sales were in glass bottles, 4 per wooden case each case holding 33 Lbs of bromine. Transport was either by road or rail. Bottling and packing was a costly and labour intensive process with many attendant problems. Bromine sales were developed with bulk, high usage customers in UK and Europe using 15ton pay load rail tankers and 7.5ton semi bulk demountable road/rail tanks. Bromine distribution by rail increased steadily throughout the mid and late 60's, increasing total rail freight to 9500tons in the final year of operation. Chlorine traffic, at 8 tankers per week, was routine but bromine shipments required tight management. Available equipment was again limited and on site bulk storage was only 20 tons. The final stages of recovery had to be planned carefully and control over the distribution fleet had to be improved.

The principle customers for bulk bromine were in Holland, Switzerland and North West UK. Customers for bromine in semi bulk, demountable tanks were in the Home Counties and North of England. This business started in the pre TOPS (Total Operating Performance System) days when data on movements was not so freely available.

Commercial negotiations with BR were at Company level and conducted with Liverpool Division of London Midland Region. Hayle Works developed a culture of accepting what services were available, relying on the effective liaison between the Office Controller and Hayle Station Foreman. It was clear that a cultural change was needed and I gave this a high priority following his appointment as Works Manager and lifted the contacts to a higher level. It soon became apparent that the BR Area staff knew little about the business strategy for Hayle Works, neither were works staff familiar with current rail developments. A proactive stance was adopted and with the ready cooperation of the Area Freight Officer significant and speedy progress was made. In Jan 1947 a positive working relationship was also established with the new Area Manager.

In September 1966 the Area Manager advised that a recent Civil Engineering inspection of the viaduct carrying the Wharves Branch line from the main line across the road to the rear of Penpol Terrace was beyond economic repair and that traffic on the branch would cease. An alternative of a road rail interchange service from Drump Road, Redruth was offered. Robust opposition to this impracticable proposal, a review of our business plan and a clear indication that the outcome would be the early closure of the Works left the Area Manager stunned and embarrassed. He was unaware of what was at stake.

Within a short period of time a further visit was made to inform us that after further inspection it was decided that essential maintenance could be carried out economically. There must have been some red faces further up the line!!! Thereafter the Area Freight officer was in frequent contact and quickly grasped that rail freight would grow rather than decline in the medium term.

The challenge was to establish mutual trust and cooperation and jointly work towards optimising the use of the available equipment. It was essential that basic information on journey times and services used by the bulk bromine traffic should be collated by Works and a better form of control established within BR. "Thinking outside the box" on both sides proved effective with the main outcome being improved communication. BR Working Timetables were not issued to freight customers but sufficient information was made available to develop a custom built DIY control system. There was a recognition that delays in transit meant less freight revenue due to sub optimal use of equipment

With BR assistance information on all routes used by Hayle traffic was compiled with expected transit and terminal turn round times calculated as the basis for a Control Chart. Typical traffic flows were:-

- **Bulk to Continent:** Hayle-Tavistock Jct –Acton Town-Temple Mills- Harwich/Hook of Holland-Rotterdam/Basle.
- **Bulk to North West UK:** Hayle-Tavistock Jct-Crewe-Local to Widnes.
- **Bulk North West to Hayle:** Crewe-Bristol-Tavistock Jct-Hayle.
- **Semi Bulk to Home Counties:** Hayle-Tavistock Jct- Acton Town-Watford- Road to St Albans.
- **Semi Bulk to North West:** as above to Crewe-Bamfurlong- Local to Burnley- road to Todmorden.

The chart plotted actual and planned movements over a rolling 42 day period for outward and return journeys. Customers were advised of ETA in order to expedite terminal turn round or to progress late arrivals. ETA for return journeys was used to prepare production and filling schedules as well as to progress late arrivals. Informal relationships with BR staff and within BR organisation raised the profile of this traffic and utilisation gradually improved to our mutual benefit. An apparent" Heath Robinson" device was a very effective substitute whilst TOPS was under development. It provided the basis of communication with BR area staff at Penzance.

The graph of freight revenue from the Octel account began to grow steadily and so did the interest of BR officers in Plymouth and Bristol. They wanted to know more about our business prospects and arranged visits and meetings to achieve this. A visit to Tavistock Junction marshalling yard to meet the Yardmaster was quite notable. It was a meeting of the human faces of the business where mutual problems were discussed and most importantly solutions quickly found. There were often problems marshalling Octel chlorine traffic going north because the tankers were not fitted with vacuum of air brakes. They had to be marshalled next to the brake van at the rear of the train and on a number of occasions this could not be achieved ready for an "on-time" departure, a 24hour delay being incurred. It was agree that we would despatch chlorine tankers in pairs and so reduce the frequency of any delays. The reasons for moving bromine traffic through the yard as quickly as possible was also fully discussed and understood. Such contacts are invaluable because contact with operational staff are just as important as with sales staff. Yardmasters were a vital link in the supply chain.

An occasional but politically important traffic was the 100ton consignments of bromine for export to India or China under the Government sponsored “Kipping Loan “scheme. The exports were by rail to Vittoria Dock Birkenhead. It is an understatement to describe them as an interesting experience. There was a 400 mile journey to the Docks and the full consignment had to be alongside the vessel on the stated “lay days” but not before. The packing and delivery schedule had to be coordinated with delivery of 7,000cases, 28,000 bottles and vermiculite packing and availability of sufficient rail vans to meet the dockside target. Such orders were received with trepidation rather than enthusiasm but targets were somehow achieved.

I was familiar with this traffic as Process Manager Chlorine Works at Ellesmere Port through providing a safety service and disposing of or replacing defective bottles and cases. During the long rail journey some ground glass bottle stoppers became loose, allowing bromine fumes to stain the wooden cases. It was often suspected that Dockers would drop the odd case to create an emission and then negotiate a special payment for handling the cargo.

Space on the Works for storage and loading was always at a premium and every available space was usually crammed with cases prior to the arrival of rail vans. On taking over as Works Manager a consignment was due for export so the usual procedure was adopted pending a critical examination after despatch. It was an experience not to be repeated but the areas for improvement and change were readily apparent. The principle change was to arrange for a steady flow of packaging materials and to pack bromine into cases as soon as practicable. The ideal was to load the cases in the rail vans at a similar rate but the cooperation of BR was needed. The Area Freight Officer was very enthusiastic and with some lateral thinking and a willingness and ability to stretch the rules to the limit he arranged for “shoc vans” to be delivered to site at regular intervals and hold the loaded vans in BR sidings until the consignment was complete. Signals would then be sent up the line when arranging final despatch advising that the whole consignment had to be alongside Vittoria Dock on specific dates. The Day Process Foreman was so thrilled with his new experience that he reminded me of it at every subsequent reunion.

This is not only a case study for “just in time “applications but a first class example of what was possible when BR and customer joined forces in mutual interest.

Railway Company Operations

Chemicals traffic relating to Hayle Works was consigned to and from Gwinear Road Station from 1940 until freight services were withdrawn in 1964 at the same time as Helston Branch and Hayle Exchange sidings closed. Movements to Hayle Exchange sidings were by a trip working with the subsequent transfer to North Quay and Works via the Wharves branch, at least once per day.

From 1964 all freight was via Ponsandane and continued until the works closed in 1973, during which time deliveries to Works and movements along the branch were under the watchful eye of the Hayle station foreman who fulfilled his role admirably over a long period of time.

Motive power in the steam era was usually a 0-6-0 Pannier tank of Class 97xx or a 2-6-2 T Class 45xx. Following the withdrawal of steam and the transfer of Class 22 1100HP diesels to Cornwall for freight duties the daily services in early afternoon were powered by these locos. By 1968 Class 42 Warships had

taken over the duties only to be succeeded in time by the ubiquitous Class 25's until the line closed in 1983.

Chemicals traffic shared the services with Oil traffic for the nearby Esso Distribution Depot and whilst the peak volume for traffic was in 1945 it did steadily increase through the 60's to reach 10,000tons in the final year of Hayle Works operation.

Throughout the whole life of the works 433,000tons of freight was moved along the Hayle Wharves Branch. Ingenuity and imaginative solutions were frequently required to overcome operational problems but that was part of the "Hayle Experience".

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