Cumbria Industrial History Society

BULLETIN

www. Cumbria-industries.org.uk

No. 102 DECEMBER 2018

CONTENTS

EDITORIAL

If you receive the Bulletin by email you should have already received a copy of the latest Cumbrian Industrialist volume 10 or if by post you will find it is in this post. I do have a number of possible papers for the next volume but am always happy to receive offers.

This Bulletin is full of a wide range of papers but I am starting to run out of papers Brian Quayle has provided a series of papers on his work at Marchon. Is there another member of the Society who would be interested in documenting their place of work for the Bulletin?

The committee has arranged a programme for 2019 but has struggled especially with finding speakers for the conferences. If you would like to give a talk on a subject you have been researching or you know of anyone who speaks on an industrial topic we would like to hear from you. We would like to keep the programme of conferences and meetings going in the present format but if we can't find speakers we will have to consider a new format or change of programme.

This is the time of year for most people to renew their membership. We encourage all members to pay their subscriptions by Standing Order - it benefits both members and the Society. It is safe and secure, easy to cancel, saves the hassle of remembering and writing cheques and is CHEAPER for both! Forms can be found on the website, or contact Robin the Membership Secretary and he'll send you one, and should be posted to the him. Thank you.

THE 'CANDLE' WHITEHAVEN. Venue for the autumn conference.

SOCIETY EVENTS 2019

SPRING CONFERENCE SATURDAY 27TH APRIL 9.30AM South Lakes Hotel Penrith. Programme and booking form enclosed.

INNOVIA FILMS WIGTON TUESDAY 14TH MAY. 10.30AM. A tour around part of the plant. Booking will required details will be circulated later.

CANAL HEAD KENDAL WEDNESDAY 19TH JUNE 6.30PM. A walking tour of the area meet outside the Factory Tap pub, 5 Aynam Rd, LA9 7DE.

ACORN BANK CORN MILL SATURDAY 6TH JUNE 10.45AM. Meet at Acorn Bank car park for a demonstration of the mill working.

TARMAC SANDSIDE QUARRY AND ASPHALT PLANT, THURSDAY 12TH SEPTEMBER 2.00 PM. Meet at LA7 7HW road side parking for a tour of the quarry and plant.

AUTUMN CONFERENCE INDUSTRIES OF WHITEHAVEN, WHITEHAVEN GOLF CLUB. 9.30 AM. Programme to announced.

NOVEMBER EVENING TALK GREENODD VILLAGE HALL. Date and topic to be announced.

BOOK REVIEW

YARNS FROM THE ROPEWORKS :A History and a Memoir.
by David Ellwood with Judith M.S. Robinson. Published by the Tools and Trades History Society, 62pp, 24 illustrations. ISBN 978-0-947673-26-0. Price £8

Ellwoods started making rope in Kendal in the mid 1850s and continued for 150 years until the retirement of David, a member of the 4th generation of the ropemaking family. This collection of facts and anecdotes has been assembled from David's notes by Judith Robinson and presented in a very readable way. The wide range of plant fibres which could be used to make twine, rope, or netting are explained and their properties compared with modern synthetic materials.

As parcel string was replaced by sellotape, manilla rope by polypropylene, many ropeworks closed but Ellwoods survived by providing for the needs of the farming community and becoming a specialist supplier. Orders were received for historical reconstructions and sets of films such as Harry Potter.

Outhwaites at Hawes is one ropemaker that still survives and is one of the stockists for this book. You can also get it from Kendal Museum and the Quaker Tapestry Tea-room or from www.taths.org.uk for £9.30 to include p&p. Helen Caldwell.

LIME KILNS – HISTORY AND HERITAGE, By David Johnson. ISBN 978-1-4456-8059-0 soft back 96 pages 100 illustrations. Amberley Publishing £14.99.

As David states the lime kiln is probably the most common monument to rural industry in Britain and can be found in most counties in varying numbers. In this book David has managed to produce an introduction to the both the reason for lime kilns, there change in design through history and distribution. An unusual chapter in the book is a look at the role of the lime kiln in art. It has been represented both by painters as famous as Turner and also appears in a number of novels including those by Dickens and Hardy.
The rest of the chapters look at the development of the kiln through the basic sow kiln design used from the roman period until the middle of the 18th century then the field kilns which had their hay day in the enclosure period and finally the large commercial kilns run by the larger estates and private companies and usually associated with large limestone quarries. He also looks at the coastal trade which occurred in both the transport of limestone to areas were there was no natural limestone such as Cornwall so it could be burned in coastal kilns and also the trade in the product quick lime as occurred from the Cumbrian west coast to the coast of Scotland across the Solway.

Whilst this book looks at lime kilns across the British Isles with David's background in northern England the majority of the examples are from either Cumbria or North Yorkshire and so is of particular interest to those of that area.

As you would expect with David's background and enthusiasm for the subject he writes both knowledgably and in a simple and understanding way on the subject. Unfortunately there is a number of minor faults, the river Tees does not flow through Sunderland and on page 49 completely the wrong photo has been put in. A second photo of Townhead, Kirkland (p52 has the correct picture) instead of Tindale (Bishop Hill) Kiln. Despite these faults the book is a very informative and the quality of the photos is very good.

Graham Brooks.

CUMBRIA ARCHIVES RESOURCES

Anyone who has used the search rooms at the Carlisle Archive Centre will have noticed that the walls are covered in bookshelves full of a wide range of books. Some of them are common books but others are quite rare and can be difficult for researchers to find. Until recently you either ask one of the archive room assistants to look and see if they have a copy of the book you require or search the shelves yourself. Now a catalogue of the books is online at

http://www.cumbria.gov.uk/archives/archivecentres/cac.asp then on the right handside of the page is a link to a spreadsheet with the catalogue under related links books and printed material.

DEMOLITION OF THE VM DRESSING MILL (WRIGHT'S BUS GARAGE) NENTHEAD.

The Vielle Montagne Zinc Company of Belgium (VM) came to the lead mining area of Alston moor in 1896 taking over the leases, royalties, mines, mills, works etc. of the Nenthead and Tynedale lead and Zinc Company who sold out after fourteen years due to the collapsing zinc prices and the failure to extend the lease on the zinc spelter at Tindale from the Earl of Carlisle.

The VM immediately instigated new working practices and new technology to both the mining of the ores and the dressing of them. They continued using the old dressing plant until it was destroyed by fire in 1905. A new plant was built at Nenthead in 1908-09 and was the largest and most efficient plant in the country at the time. The building was steel framed and was six storeys high built in the centre of the village. The steel work was produced by Krupps of Germany who did a trial erection in Germany before dismantling it and shipping it to Nenthead. The panels between the steel members were infilled with brick which provided some rigidity but were not structurally load bearing. The new machinery was installed and production started in 1910. At full production the mill could process 200 tons of ore in 12 hours.

The mill although a great success was mostly ideal during the 1920s and 1930s due to the economics of the global metal markets. A floatation plant was installed in the building by the Non Ferrous Minerals development Company Ltd during 1942 to treat the massive waste dumps at Nenthead. The mill between July 1943 and November 1945 produced 20,557 tons of 55% zinc ore concentrate and 1,385 tons of 73% lead concentrate from 564,939 tons of tailings treated.

The zinc processing plant was dismantled in 1946. The higher part of the building at the southern end of the building was at some time demolished and the remaining structure has been the garage for Wrights coaches who still own the site. Because of the type of structure conservation was not possible.

Graham Brooks

THE PARTIALLY DEMOLISHED BUILDING.

PHOSPHORIC ACID PURIFICATION AT MARCHON WORKS, WHITEHAVEN

Some Background

Phosphoric Acid (H_3PO_4) produced by reacting Phosphate rock with Sulphuric Acid (H_2SO_4) in the 'Wet Acid' process contains numerous metallic and other impurities. This impure acid (green in colour and known as such colloquially) was limited in its use due to the unavoidable presence of many of the species present in the rock feedstock. Uses did include fertiliser manufacture such as Triple Superphosphate or processing to Sodium Tripolyphosphate (STPP - $Na_5P_3O_{10}$) for use in synthetic detergent formulations.

The Phosphate rock used almost exclusively at Marchon originated from two rock fields in Morocco (Khouribga and Youssoufia). In comparison with other sources of rock those from Morocco were quite desirable due to their relatively low levels of impurities. Even so the crude 'green' acid produced from these Moroccan feedstocks was limited in its usage. At Whitehaven the production of STPP was possible but required a complex series of steps, as described in a previous paper, during neutralisation with a sodium alkali to produce a product of a quality acceptable to the customers (principally Proctor & Gamble and Unilever).

Other types of product such as phosphates used in food and beverage additives, for water treatment, in metal finishing chemicals required a much purer Phosphoric Acid feedstock and this entailed that 'Thermal' Phosphoric Acid was required. This acid was much purer than those manufactured using the 'Wet Acid' route and was obtained by burning elemental Phosphorus in air. In turn the Phosphorus was obtained by reacting Phosphate rock with coal or coke and silica (sand) in an Electric Furnace. Although these processes produced an acid of high quality the technique of producing the elemental Phosphorus was extremely energy-intensive (requiring large amounts of electricity) with high capital costs and, hence, relatively expensive. Many such plants were located in the USA and Canada where cheap energy was available, including some operated by Marchon's parent company Albright & Wilson (A&W).

The possibility of purifying 'Wet' Phosphoric acid started to receive increased attention, particularly in Europe, which lacked cheap electrical energy and sources of inexpensive low-grade Phosphate rock (such as those from Florida) required for economic Phosphorus production. Several techniques were considered by the industry including Ion Exchange, Crystallisation and Solvent Extraction and it was the last that several phosphate manufacturers were to pursue.

At Marchon some preliminary work in developing a Solvent Extraction purification process was begun in the late 1950s but progress was intermittent and, occasionally, shelved. Impetus was achieved in the late 1960s/early 1970s when more determined efforts to define a suitable process based on this technology were instituted.

What is Solvent extraction?

Organic solvents and water may be;
a) completely miscible (ie form only one liquid phase when mixed together)
b) partially miscible (ie form two liquid phases under certain conditions when mixed together)
c) totally immiscible (ie form two liquid phases under all conditions - like oil and water)
Of the above categories processes falling into category (b) were most commonly employed in the industry and it was this type which was developed by A&W for use at Marchon. A suitable organic solvent needed to be chosen to satisfy several criteria for successful operations to occur. While Safety and Cost implications needed to be considered probably the most important criterion was that the solvent chosen needed to have sufficient selectivity - it should dissolve the phosphoric acid preferentially and reject the impurities.

The solvent chosen for use in operations was Methyl Isobutyl Ketone (MIBK) which satisfied the majority of the ideal criteria and was readily available from Shell Chemicals. A Pilot Plant consisting of a series of miniature mixer-settlers was set up in the former Ladysmith colliery powerhouse and, by 1972, a suitable process, the MO Process had been developed. (MO stood for Marchon-Oldbury [near Birmingham] as a means of recognising the supposed new found co-operation between two A&W sites which, historically, had always regarded each other with some suspicion). This process was regarded as so ground-breaking for A&W that those of us required to work on its technical aspects were required to sign the Confidentiality Agreement put under our noses by a company solicitor.

Essentially when the impure 'green' phosphoric acid was mixed with the MIBK under the correct conditions two liquid phases resulted. The majority of the phosphoric acid was dissolved into the upper organic (MIBK) phase whilst the rest of the acid remained in the lower aqueous phase containing the majority of the metallic impurities originally present in the acid feed to the process. This type of process was known as a 'split' process since the phosphoric acid content was split between the two phases. In the MO process some 65% of the feed acid was extracted into the purer organic phase and the remaining 35% constituted a low-grade raffinate acid (known colloquially as 'underflow' acid).
The economics of this type of process depended upon there being a suitable outlet such as fertiliser manufacture for this impure stream. Fortunately A&W owned such a factory at Barton-on-Humber and the underflow acid was shipped there by rail. This trade continued for a time even after A&W sold this business to ICI in 1983; other external sales proved to be difficult and often little more than the nominal cost price of the underflow acid could be achieved. This situation could not be tolerated indefinitely leading to the development of a 'Total exhaustion' type of process in which 95+% of the input phosphate (P_2O_5) could be recovered as a pure form of product - of which more later.

After mixing the feed acid with MIBK the two liquid phases were separated from each other. As described above the underflow acid was sold into fertiliser manufacture at first. The purified acid could be recovered from the organic solvent phase by the addition of water. However if this were to be done directly the resulting acid would still be of unacceptable quality. Although the phosphoric acid dissolved in the MIBK was much purer than initially some metallic and other impurities remained. To remove most of these a 'scrubbing' process using water was required to yield a much purified product - 'Technical' grade acid.

The Processes

After finalisation of the MO Process on the pilot plant authorisation was given by the A&W board for the investment in a full-scale plant which was commissioned in 1976. At this time 'green' phosphoric acid was produced on the F3 and F4 plants at a concentration of some 29% P_2O_5. If acid of this strength were to be mixed with MIBK none would be extracted since its concentration was too low. An acid strength of some 56% P_2O_5 was required and so a concentration step was required. Furthermore acid produced from uncalcined phosphate rock contained soluble and insoluble organic matter which could give rise to downstream processing difficulties (poor separation during solvent extraction and unsatisfactory STPP colour).

Carbon-Treatment and Concentration

Prior to concentration the green acid was treated with Actibon C active carbon to adsorb organic matter present. Treatment took place for 6-8 hours at 60^{o}C in a series of four agitated tanks; the carbon was filtered out of the treated acid using a plate filter press. This process was unnecessary if the acid had been produced from calcined phosphate rock. Thus when uncalcined Khouribga rock was replaced as the feedstock by calcined Youssoufia rock in the early 1980s this carbon-treatment plant became something of a white elephant.

Carbon-treated (or not as the case may be) green acid was fed to the 'New' Concentrator which was a forced circulation vacuum evaporator operating at 80-82^{o}C and at a vacuum of 2-2.5" Mercury absolute. This plant was commissioned in early 1976 with the commissioning team (of which the author was a member) operating out of an unheated wooden garden shed pressed into service as a laboratory.

Concentrated acid flowed down a barometric leg out of the concentrator and into a product cooler tank. Cooling down took place in two stages in order to encourage the optimum growth of crystals of some of the impurities which precipitated out of solution due to the increase in acid concentration. Any such crystals were removed using four Sharples centrifuges acting in parallel.

The 'Old' Concentrator which used the vessels of the original F4 pilot plant was used to increase the concentration of the underflow acid from 42-44% P_2O_5 to 51% P_2O_5 prior to sale and operated in a manner very similar to the New concentrator.

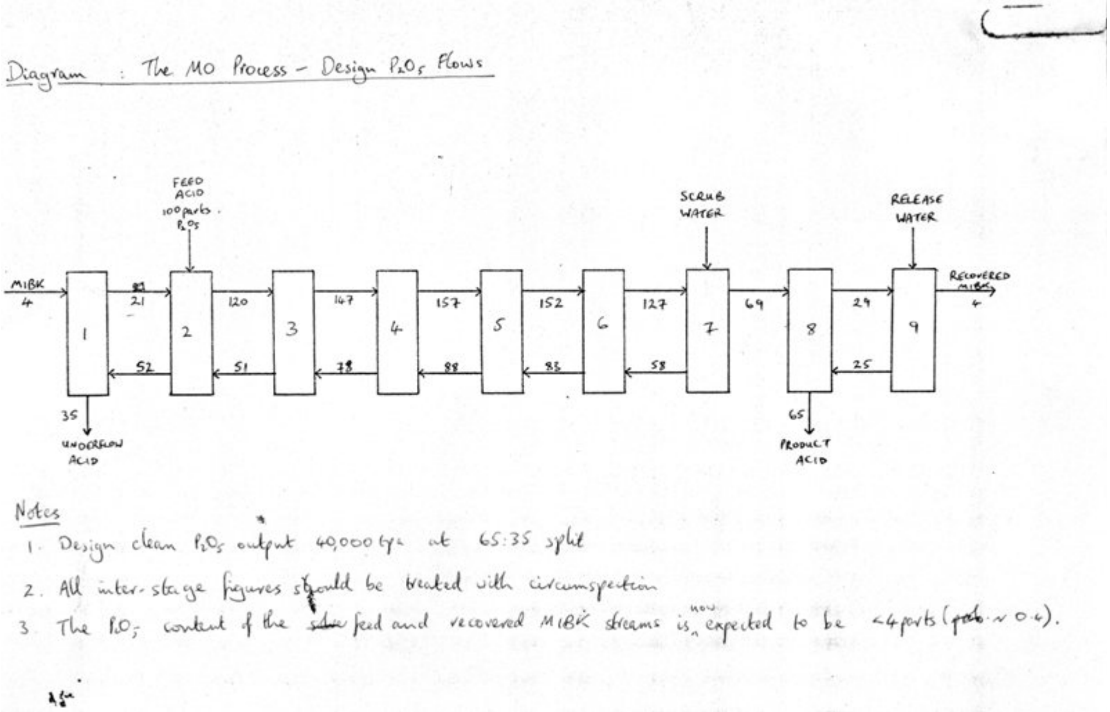
The MO Process

The solvent extraction process on this plant was performed in a series of nine mixer-settlers in a head-to-tail array operating in a countercurrent manner. (A mixer-settler was a vessel consisting of an agitated mixer box in which aqueous and organic phases were contacted together; the aqueous/organic mixture then flowed into the settler section of the vessel where separation (settling) into the two discreet phases occurred).

As noted earlier this plant started operations in 1976 and had the capacity to process 40,000tpa P_2O_5. Feed acid at 56% P_2O_5 was introduced into the mixer-box of mixer-settler No2 where it was contacted with the organic phase from mixer-settler No1. MIBK was fed into mixer-settler No1 and underflow acid was removed from settler No1.

'Scrubbing' in order to achieve an acceptable purified acid quality was accomplished by feeding water into mixer No7. Aqueous and organic phases were contacted with each other in a countercurrent manner in order to 'scrub' metallic impurities from the organic phase containing dissolved phosphoric acid into the impure aqueous stream. Release water was added into mixer No 9 in order to release the phosphoric acid from the organic phase and product acid was taken from settler 8. (This two-stage release yielded a product acid at 42% P_2O_5 rather than the 33% P_2O_5 which would be achieved with a single-stage release thereby saving on energy costs with subsequent concentration).

A simplified block diagram of the process is given below. The reader should not be concerned if all of this takes some time to follow. It took the author some time to 'get his head round it' at first and he was being paid to understand it!



Essentially the organic phase is moving from left to right and gradually becoming ever purer by countercurrent contact with the aqueous phase which is moving from right to left and into which the metallic impurities are flushed. This countercurrent aqueous phase was generated by the addition of 'scrub water' at stage 7 which released some of the P_2O_5

from the solvent phase; the two-stage release section (stages 8 & 9) enabled the purified phosphoric acid to be recovered at a slightly concentration than would be possible using a single stage. After stripping any residual solvent from the product it was concentrated from 42% P_2O_5 to 61% P_2O_5.

The iron content was customarily used as a 'marker' for the efficacy of the purification process. Thus for a feed acid to the MO plant at 56% P_2O_5 the iron content was 0.25% (2500ppm) Fe and the product ex settler No 8 was 32ppm Fe at 42% P_2O_5. This 'Technical' grade of acid was eminently suitable for the manufacture of STPP and other phosphate salts.

MIBK recovered from settler No9 was recycled back to the start of the process. Occasionally it was necessary to distill a fraction of the MIBK to remove organic material which had eluded the carbon-treatment process but the eventual use of calcined phosphate rock even made this process unnecessary.

It is fair to say that the MO Plant was an unqualified success encouraging the A&W board to commit its largest ever investment of some £40m into the construction of the F5 phosphoric acid plant and the MMO (Modified Marchon-Oldbury) solvent extraction plant.

The MMO Process

This process operated on much the same principles as its predecessor; it was commissioned in 1979 and utilised 10 enlarged mixer-settlers. Its design throughput was 120,000tpa of P_2O_5 of which some 75% was recovered in two successive purified acid streams. The remaining 25% constituted the raffinate underflow acid which had to be supplied to the fertiliser market. The essentials of the process were very similar to those of the MO process and so are not repeated here.

Until the output of the F5 phosphoric acid plant (whose travails have already been alluded to elsewhere) could be relied upon it was necessary to mothball the MO plant even though phosphoric acid production continued to be supplemented by the ageing F4 plant. Eventually F5 started to come into its own thanks to the diligence of its operators and both solvent extraction plants could be operated in parallel.

In 1980 analysis showed that for an 83% P_2O_5 split with a 58.3% P_2O_5 Feed acid (Fe 1900ppm) the two product acids from the mixer-settlers were 95ppp Fe and 7ppm Fe respectively at 44% P_2O_5.

The Implications

The increased availability of purified acid which could be used in STPP manufacture meant that the laborious, high maintenance and complex 'Wet Salts' process when using 'green' acid feed could be abandoned. The purified acid could be neutralised directly by the sodium alkali without the need for pre-treatment and post-neutralisation filtration.

Furthermore the quality of the product STPP was greatly enhanced to the delight of the principal customers (P&G and Unilever). All in all every-one was much happier and those of us in the Technical Department thought that we might be in for a reasonably relaxed time.

Readers of an astute disposition will probably have discerned that 'resting on one's laurels' turned out to be wishful thinking. The Sales Department continued to have difficulty in realising realistic prices for the underflow acid which was only really suitable for fertiliser manufacture. Something had to be done about it!

And so one fine morning our Technical Manager, T A Williams, came cheerily into the lab and thrust a scrap of paper into my hand. (He had evidently run out of fag packets). Scribbled on this piece of paper were some calculations showing the basis of a new process. 'Here' quoth he 'see if you can make this work'. The principle behind this putative new process was that MIBK extracted phosphoric acid more readily then low value sulphuric acid (of which at Marchon with a production capacity of that acid of 500,000tpa there was no shortage). So, if sulphuric acid were to be introduced into a solvent extraction process with the underflow acid from the MO and MMO processes it might just be possible to recover the latter's P_2O_5 content as purified acid while its metallic impurities would be transferred into the sulphuric acid which could be sacrificed. It is to Alan Williams' eternal credit that the process which he had sketched out on that scrap of paper (how I wish I had kept it) worked more or less as predicted. Given the need to obtain a higher price for the underflow acid's P_2O_5 laboratory work was quickly followed by pilot plant work on a rig attached to the MMO plant. (Unfortunately the lab work was done over the summer while the external pilot plant work coincided with the winter months with all that implies with high winds and driving rain - and that was on a good day!)

Quite crucially an early decision had been taken that any new process would not be carried out in mixer-settlers but in a solvent extraction column. In the intervening years since the commissioning of the MO and MMO plants column technology had advance greatly. Not only were they more reliable but, most importantly, they were much cheaper to build than the equivalent plant using mixer-settlers. A column was a vertical cylindrical vessel separated into sections by perforated plates; the sizes of the perforations varied from section to section. Agitation was provided by a single motor at the top of the column driving a single shaft on which were mounted blades whose sizes again varied from section to section.

The pilot plant work confirmed that the lab process could be successfully translated into a fully operational plant. Since such a process would not only solve the underflow acid 'problem' but also increase the amount of 'Technical' grade acid which would be available for STPP manufacture and at other A&W sites such as Widnes. One can only imagine that the A&W board would have needed little persuasion to authorise the required capital expenditure.

The UFEX Process

Standing for 'Underflow Extraction'. As touched upon above MIBK had a greater affinity for Phosphoric Acid than it had for Sulphuric Acid by dint of differing Distribution Coefficients. MIBK was fed into the bottom of the column. 77% Sulphuric acid was introduced about a quarter of the way up and the Underflow acid was introduced near the top. The aqueous phase continuing the metallic impurities flowed down the column and contacted countercurrently the organic phase containing the 'purified' phosphoric acid which rose up the column. The organic phase was taken off from the top of the column for further purification. This plant was commissioned in 1984.

From the bottom of the column was taken the sulphuric acid raffinate which contained the bulk of the metallic impurities and a small amount of phosphoric acid. No economic use could be found for what was by now a very impure acidic liquor. The immediate disposal route after partial neutralisation was discharge to sea - which eventually attracted the attention of Environmental Pressure Groups such as Greenpeace. Their actions will be addressed in another paper but eventually the waste liquor from the UFEX process was neutralised with quicklime and consigned to land burial.

The success of the UFEX process meant that 95+% of the original 'green' phosphoric acid content could be recovered as a much purer and more valuable 'Technical' grade suitable for STPP manufacture at Whitehaven and phosphate salts at other A&W sites. Doubtless it also caused huge sighs of relief in the sales Department since they no longer had to cajole potential customers to purchase the rather impure 'Underflow' acid.

Time to rest on laurels?

What more could be demanded of the Technical department after all of their sterling efforts? The answer transpired after unsuccessful attempts to copy a phosphoric acid purification process outlined in a Japanese Patent. (Patents tend to be cunningly worded so as to give sufficient detail for one to be granted but insufficient for the process contained therein to be copied). By this time I had a pretty good grip of all things Solvent Extraction but try as I might I couldn't get this Japanese process to work.

I had, of course, submitted some samples from my feeble attempts for analysis and the results when they came back were quite startling. The process outlined in the Patent involved introducing a small quantity of Sodium hydroxide (NaOH) into the scrubbing water and its effects on the efficacy of the purification process were very significant. I drafted a short report with a suggestion for extra work to be authorised since there seemed to be potential to obtain food-grade quality from 'green' acid but this was 'rubbished' by our Lords and Masters at Oldbury and the report put to one side.

At this time food-grade phosphates were manufactured using phosphoric acid obtained by burning elemental phosphorus produced in the 'Thermal' process. A&W operated several such furnaces both in this country and in Canada. In 1969, seduced by the promise of the cheap electricity needed, A&W commissioned its largest such furnace in Long Harbour, Newfoundland. It was not an unqualified success; successive production and environmental difficulties made the operators lives far from enjoyable and were a constant drain on resources. (So much so that in 1971 the company's financial difficulties led to a takeover by the American firm Tenneco).

As the years passed Newfoundland's problems were gradually resolved; however from A&W's standpoint the cost of production was still on the high side despite the availability of cheap electricity. If only some way of up-grading green acid to food-grade quality which commanded a high price could be devised...

Fortunately my draft report was still languishing in a drawer; one day Alan Williams was on the phone in an adjacent lab and I was summoned to him carrying said report. It turned out that Alan was in conversation with our Technical Director (Oldbury) and I was handed the phone and asked to read out the recommendation suggesting extra work be undertaken to see if food-grade quality could be achieved. There was a stunned silence from the other end of the phone followed by some choice expletives and a request to hand the phone back to Alan. A programme of lab work commenced the following day; it was every bit as successful as could have been hoped. My final act in was to write up this work as a Technical Development Report before joining the Works Safety Department.

The MOS Process

The introduction of a small quantity of sodium hydroxide into the scrub water of the MO and MMO processes produced the anticipated dramatic effect. Purification judged by the elimination of metallic impurities from the product acid was much as expected and it was a relatively simple matter to modify the existing process plants while an additional solvent extraction column was introduced to allow the concurrent production of food-grade and technical grades of acid. The plant was commissioned in 1987.

Two impurities were immune to the sodium hydroxide scrub. Fluoride which was removed from the product acid by steam-stripping and arsenic which was precipitated as its sulphide by reaction with hydrogen sulphide gas followed by filtration. The precipitate was discharged to sea - of which more in a later paper.

The 'Holy Grail' of up-grading 'green' phosphoric acid to food-grade quality had been achieved. My own prediction that this would mean the end for the smaller Canadian furnaces in either Varennes or Buckingham was way off the mark. It turned out that it was curtains for the millstone that was known as Long Harbour and its closure occurred quickly in 1989.

Food-grade phosphoric acid is used in a wide variety of products including cola drinks. One important customer willing to pay a premium price was Coca-cola but they were a very particular customer. If a tanker of acid was found to be as little 0.001SG unit out of the agreed specification they had no compunction in requiring its return to Whitehaven and a replacement shipment provided. The reader may wish to bear this in mind the next time Coca-cola are trying to burnish their environmental credentials.

The End

A&W was taken over by the French company Rhodia in 2000. It seemed as if they had little interest in A&W per se but merely wished to take a potential competitor out of the marketplace. All of the Whitehaven phosphate operations closed at the end of 2001 followed by demolition of the plants.

Author's Footnote

I joined Marchon as a Graduate Chemist in 1974 as a member of Inorganic Research (later Phosphates Technical Department). I worked an all technical aspects of Marchon's phosphate operations but began to specialise in solvent extraction following the departure of a colleague. In about 1981 I was commissioned to compile a technical description of all Whitehaven phosphate operations so as to provide a ready source of reference. When tidying my garage a while ago I came across a draft copy of this work (I'm not sure if it ever got published completely) and I have based this series of papers upon its contents.
I apologise to the reader if the going got rather too technical at times but regrettably this was unavoidable. (I can assure you that I have simplified things as much as possible). I have spoken to Whitehaven Archive Centre about this document (about 200 pages long); they are keen to take it and it seems more useful to deposit it with them rather than put it back in my garage. So, in the near future, it will be available to all readers as a record of some of what went on in the factory 'at the top of the hill'.

Brian Quayle

FROM LIVERPOOL TO LANCASTER : RAJAH THE ELEPHANT COMES HOME

In the early 1900s Lancaster was a major centre for the manufacture of oilcloth and linoleum. Two rival firms – Williamson's and Storey's – had mills along both the River Lune and the Lancaster Canal. The mills at Halton – 3 miles to the east of the city - became part of the Williamson empire in 1932. At that time they were an enormous complex of buildings stretching for over half a mile along the river. These carried out the whole oilcloth production process from spinning and weaving the cotton backing at Forge Bank to finishing at Low Mill. The mills became barracks and army stores at the outbreak of the Second World War, and when peace came were gradually turned over to a variety of small manufacturing units.

Colonel T Benirski was the chief training officer at the Polish Resettlement Centre established after the war at what was RAF Millom and is now HMP Haverigg. Concerned at the lack of opportunities for skilled Polish workers he decided to do something about it himself and, with a group of Polish comrades, leased part of the Halton Mills complex and started up Luneside Engineering. The firm grew into a successful manufacturer of precision machined parts for the aircraft, shipbuilding and nuclear industries until it closed in 2008.

So how does an elephant fit into this story? Well, at first, the firm took any business opportunities it could find including the unusual job of making six foot high mechanical elephants! These were solidly built on a steel frame, plastered and painted, and powered by a 250cc petrol engine. Their speed and direction were controlled by an assistant walking alongside. The elephants were a popular seaside attraction, giving rides to children at resorts around the country including nearby Morecambe. They all returned to Halton in the winter time for maintenance.

Rajah is one that has been preserved, not quite in her original state but doing the same job. Owned by Crosby Lions she visits events to give rides and raise money for charity. One such event was during the Heritage Open Days in September as part of the celebrations to mark the 70th anniversary of the founding of Luneside Engineering. This was held in the mill building that the firm had occupied and which still stands, now used as workspaces for the adjoining co-housing development. Only this event was special, because Rajah was back home where she was made!

Roger Baker

SOME QUESTIONS AND ANSWERS 2018

Our website, www.cumbria-industries.org.uk, has again attracted queries from researchers, most of which are circulated to all members who are part of our 'mail group' in the hope that somebody will have the necessary local or industrial knowledge to provide answers.

If you are not receiving this kind of email from me, plus notices and newsletters etc , but would like to do so, please contact me at lowludderburn@btinternet.com.

Bill Allan from Silloth wrote: “We are renovating an old farm machine with the name W. Head (or Herd?) & Sons Egremont on it. The machine is a Blackstone hay turner & swath turner (invented 1906, in production till 1920, this is one of the first)”. Confusingly there was both a W. Head, Agricultural Engineer, and a Henry Herd, Blacksmith, in Egremont, but following contributions from a number of members we concluded that it was the former who made this piece of machinery.

Alasdair Roberts sent this picture of his grandmother on an unknown packhorse bridge, which our members were able to identify as Stanegarth, near Bampton.

Mark Brennand had been shown some images of wooden water pipes that had been retrieved from a (stone-lined) well on a farm near to Penrith. They were large, circular but unlike any Roman or medieval timber pipes that he had come across, and he felt that they were quite late, possibly nineteenth century. Why would one use timber rather than cast iron or lead?

Chester Foster drew attention to an article by Denis Perriam in the Cumberland News about household wells and the associated pipes made from larch trunks which were in use until mains water came to Carlisle in the mid 19th century, and later in outlying areas.

We were contacted by two T.V. producers, one making an archaeology programme about the Solway Firth and seeking information about Port Carlisle which was provided by Gavin Watson. The other was making a drama programme set in the 1980s and sought advice about the suitability of the farm buildings they proposed to use. Graham Brooks responded.

This interesting photo is of an iron artefact which was found on a river bank. Members came up with various uses to which it might have been put, including turning a spoked wheel associated with a sluice gate, but further suggestions will be welcomed.

Phil Reay was trying to track down the marble mill where William Armstrong, on a fishing holiday in 1835, got the inspiration for his invention of the hydraulic crane which made his fortune, by watching an overshot mill wheel. Members directed him to

Stonehouse, Dentdale where both the High Mill and the Low Mill were involved in marble cutting and polishing using water power from the Artengill Beck . Unfortunately the mill buildings and waterwheel have been demolished.

We have previously heard of Cumbrian rails found in Canada, but now this message from down under:
I recently found a piece of 80lb. rail at Kalannie, Western Australia which is marked –
WA – BS 80R – B.A.M.M. – WORKINGTON – 8/50
This was obviously made at a steel mill in Workington, England but I don't know what the 'B.A.M.M.' stands for. Are you able to help? The railways in Western Australia used a lot of 'Barrow Steel' rails and I have found dates from 1879-1907, while the only 'Workington Iron & Steel (Moss Bay)' rail I have found is dated 1911.
The answer kindly provided by John Lawson was:
WA. Western Australia
BS 80R. British Standard 80lb / yard. Infrequently used rail
B A. Bessemer Acid Steel Process
M M. Medium Manganese Steel Type. A very tough / hard steel
Rail rolled Aug 1950

Several students have written to ask for help with their researches into

- Sellafield's history;
- south-east Lakeland's connections with Atlantic slavery;
- Duddon Iron Furnace and workers' housing;
- the industrial history of Whitehaven and working class identities.

We were able to offer help and advice to varying extents on all of these topics.

Helen Caldwell

BELOW LAKELAND FELLS, THE FINAL INSTALMENT.

The years went by and the mine was gradually working out – after over 200 years. The staff below ground was much reduced and things were not so rosy.

The Atomic Weapons Research Department took over the mine in order to make certain tests. What they wished to do was to make a non atomic explosion and make tests by seismograph at certain points. They would then, knowing how much explosive had been used, be able to compute how much atomic explosive had been used by a foreign power if they had an underground explosion. So they decided to use the south end of 175 fathom as the ground above was pretty solid. Here an egg shaped chamber was made with a small drift running at or off to the left. In the big chamber a platform was erected to put a 500lb charge of TNT and one of 250lbs in the small drift. It was to be fired electrically from surface. The big charge immediately after. However when the big charge went off it

severed the wires intended to fire the smaller charge and it had to be fired later – with disastrous results.
In preparing the chamber and in order to make it safe or to stop the blast going up to north end fire dams were to be built with brick walls and steel doors – like bulk head doors in a shaft.

A good deal of work was done and eventually the charge was made ready and fired. The rescue team assisted by others from other mines went in to open up the mine. We expected terrific chaos when we got to 175 fathoms level we found the railway lines air and water pipes, bulk head doors, brick walls, sandbags had been either blown to dust or blown not only a considerable distance down the level but round a bend and right up another level – which saved us a lot of work incidentally. However the second charge had to be wired and prepared for firing, also the mine also had to be tested for gas from the 318 level right up to the Glencoyne Level in the old mine. We walked the whole way up wearing our moto sets – no mean feat believe me. The inspector of mines declared the mine clear of gas and so it was except one place where it was never expected anyone would go – but two did and died.

The technicians made the TNT ready wired up again and the fire dams were being rebuilt, track relaid and as the AWRE people wished to get the job finished. Men were brought in from the outside workers. Amongst these was Alex Santamena and William Sinkinson. Sinkinson had worked in the mine before, was married a few months and only a young man. Santamena was middle aged, also married with a family. He was curious about the mine and at break time asked the foreman for permission to have a look round. Permission was granted and they were warned not to go any futher than the North shaft. They set off and that was the last time they were seen alive. We had "bait" then set off to work building the sandbag fire dams. I was building with Fred Dawes after about two hours I said to him I had not seen "Santa" as we called him or his mate. Fred said maybe they're working elsewhere or gone home which they could have done as they were on overtime. However we asked the loco driver if he had seen them – he said no and on phoning to the shaft top found that they had not gone up. We told the foreman and he immediately got a search party out. Fred Dawes went in his old stope and returned to me and said "I'ved seen Santa lying at the bottom of a ladder in my old stope" So he and I went in with the first aid bag. As soon as we had got up the ladder and into the stope we saw Santamena lying at the foot of a ladder some distance away. We both then realised the place was full of gas. Sinkinson had climbed up the ladder and we could see his light – we did not know both of them were dead or perhaps we would not have attempted to rescue them. I said "what shall we do Fred?" He replied you're the first aid man – so I said lets try to get them or him to the top of the ladderway. We ran in grabbed Santamena by the feet and dragged him to the gateway or ladderway in the hope we might get him to fresh air and be able to revive him – and we were fighting for our own lives. We got back. I don't know how we did get back but we stopped anyone else going in. Told the foreman to get the doctor and rescue brigade. I went out like a light and when I came round the doctor was flashing a light in my eyes and I heard him say he's coming round! Shortly after this we were sent for in the office and commended by the manager and the mines inspector. Later we both received the Queens Commendation which was awarded

by the Hon Richard Wood at Lancaster House, London in October 1961. I had by then left Greenside Mine for good and the mine was closed down not long afterwards.
I saw the old mine workings not so long ago – I would not even tell where we went into the Lucy Level, so well had it been covered and I thought of those men I worked with, most are growing old and soon even we will be a memory. That is the reason why I put these notes on paper for those who may wonder what work in a lead mine was like. There is much more I could write and perhaps I will some day tell of some of the experiences I had at Greenside.

Arnold Lewis, Burneside 1978.

COMMITTEE MEMBERS DETAILS

Roger Baker,
3 Sun St
Ulverston
Cumbria
LA12 7BX
mbarb@freenetname.co.uk

Bill Myers
20 Lord St.
Millom
Cumbria
LA18 4BL
w.myers708@btinternet.com

Geoff Brambles, Chairman
21 Derwent Drive
Kendal
LA9 7PB

Graham Brooks, Bulletin Editor
Fairhurst
Aglionby
Carlisle CA4 8AQ
solwaypast@yahoo.com

Helen Caldwell, Secretary
Low Ludderburn
Cartmel Fell
Windermere LA23 3PD
lowludderburn@btinternet.com

Hilary Corton Trearurer.
27 Fountain St
Ulverston
LA12 7EQ
hilarycorton@aol.com

Dan Elsworth, Publicity Officer
6 Town Street
Ulverston
LA12 7EQ
dwelsworth@cooptel.net

Peter Hearn
2 Beckside Court
Kirkby-in-Furness
LA12 7TQ
biarmicus@live.co.uk

Robin Yates Membership Secretary
Glenrae
Brigsteer Rd
Kendal
LA9 5DX
robin@phonecoop.com

David Beale, Minutes Secretary,
Low Row
Hesket Newmarket
Wigton
CA7 8JU
beales.lowrow@virgin.net