The Life and Times of Alfred Henry Allen, Sheffield's First Public Analyst

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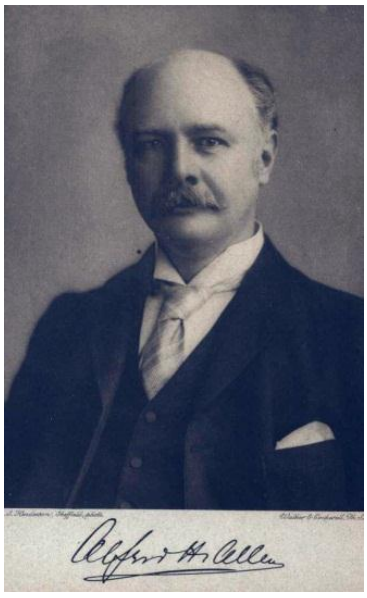
Based on a presentation and an exhibition made at the Annual Conference of the Association of Public Analysts held at the Kenwood Hall Hotel, Sheffield on 28th October 2011.

Summary

Public Analysts are analytical scientists appointed by local authorities in the United Kingdom and who work to ensure the health and safety of the public in relation to food[1], consumer protection, agricultural feeding stuffs and fertilizers and other matters.

Alfred Henry Allen was one of the first Public Analysts in the United Kingdom and the first appointed by the City of Sheffield. He was a founder member of the Society of Public Analysts and served as its President (1887-1889) and was also a founder member of the Institute of Chemistry. Through his work as an analytical scientist he played a major role in the battle against food adulteration and in promoting food and water safety in Victorian Sheffield and Britain. His many achievements were published in scientific papers and books which recorded the results of his and other Public Analysts' work. Tragically, he died at the early age of 58 years.

Introduction



Alfred Henry Allen was born in Southwark on 17th January 1846, the son of an eminent architect. His studies included chemistry at the College of Chemistry and Agriculture in Kennington and the Royal School of Mines and also metallurgy, assaying, geology and mineralogy at University College. This account of his life and times is also an account of the commencement of systematic food analysis and food science and the origin of food legislation which dealt specifically with food adulteration. The account also covers the origin of the Society of Public Analysts. Allen died on 14th July 1904. Obituary notices were given in the Analyst 1904, by Otto Hehner[2] and in the Pharmaceutical Journal of July 1904[3]. Hehner wrote with sympathy and care about his close colleague and fellow public analyst. The obituary in the Pharmaceutical Journal similarly covered his life and works in some detail and left no doubt of Allen's dedication.

He was an extraordinary chemist and published over 150 papers, 13 volumes of his great work *Commercial Organic Analysis* as well as the books *Chemistry of Urine* and *Milk and*

Milk Products, (a list of Allen's papers and publications is given in the Appendix). Such an activity from a consulting practice in Sheffield, South Yorkshire, England merits revisiting.

Allen came to prominence during the second half of the nineteenth century. The events that undoubtedly influenced him include his early work with Dr Arthur Hill Hassall and the comments of the Parliamentary Select Committee which looked at food adulteration in 1874.

Around the time of his birth, the Corn Laws were being repealed by the Conservative administration of Prime Minister Robert Peel[4]. The industrial revolution of the 19th century and earlier resulted in a population shift from the countryside into towns and cities. This and the repeal of the Corn Laws meant that food was more available but manufactured rather than locally sourced and domestically prepared. The population became largely reliant on suppliers (i.e. manufacturers and retailers) and thus, in the main, had lost control of their food supply.

This shift of population also created the need for the supply of large amounts of potable water to towns and cities and consequently reservoirs to supply this water were constructed throughout the reign of Queen Victoria.

The Influence of Hassall, the First Food Analyst

By the mid-19th century the medical profession had become concerned at the quality, contamination and adulteration of food. The secretary and founder of the *Lancet*, Mr Thomas Wakley, commissioned Dr Arthur Hill Hassall[5,6,7] in 1850 to investigate and report on the composition of food. Earlier Frederik Accum, a chemist of German origin who was resident in London, had published his *Treatise on Adulterations of Food and Culinary Poisons* in 1820[8]. Alexander Wynter Blyth in his book *Foods: Their Composition and Analysis*[6] provided an extensive list of general treatises on food adulteration. Hassall was regarded as both the first food analyst and an enthusiastic microscopist[7]. He set about his task in a systematic manner and reported on the analysis of 2063 foods and 324 drugs and presented his evidence of food adulteration. He was a medical doctor with a professional background which included water quality. His findings, which were published in the *Lancet*, were also collected into *Food and its Adulterations, comprising reports of the Analytical Sanitary Commission of the Lancet for the years 1851-54*, this being published in 1855[6].

Hassall's book, titled *Adulterations Detected*, followed in 1857 and with a second edition in 1861[5]. This book contained the analytical methods and microscopic details of his work on samples of food. He advocated a definition of "*adulteration*" and the adulterations and contaminations of foods that he had analysed were chronicled. The analytical scientific work involved microscopy together with extraction procedures using decanting techniques, combustion methods, spot tests and drying operations. The standard of microscopy was surprisingly high; the published diagrams of microscopic findings were of excellent quality being the result of engraving techniques. His findings represented, in many instances, examples of the gross adulteration of different foods.

The following are examples of adulteration that Hassall's reported:

- the presence of strychnine in beer as a bitter
- mineral acids in vinegar
- copper salts being used as food colours

- alum as a whitener in flour and in bread
- infestations
- red lead in cayenne pepper
- potato starch in many foods as a diluent

He defined adulteration as:

The sale of one article in place of another is not an adulteration, but a substitution. Again the presence of substances in articles in consequence of impurities contained in the materials out of which they were prepared as, for example, of arsenic in hydrochloric acid used in the preparation of unfermented bread does not constitute adulteration, they are simply impurities. Lastly, the accidental presence of substances in any commodity does not constitute adulteration, they are simply impurities.

Adulteration consists in the intentional addition to an article for the purpose of gain or deception, of any substance or substances the presence of which is not acknowledged in the name under which the article is sold.

These published findings led to the formation of a Parliamentary Select Committee in 1855, taking evidence which ultimately resulted in 1860 in an act which was entitled "An Act for Preventing the Adulteration of Articles of Food or Drink 1860"[9]. A further act, the Adulteration of Food and Drugs Act 1872[10], included drugs, and the right of boroughs to appoint analysts. Nevertheless there were some serious deficiencies in these acts, one of which was that the appointment of Public Analysts was not mandatory. In addition those appointed as Public Analysts were from a variety of backgrounds including the ranks of the medical profession and academia as well as professional commercial and analytical chemists. Indeed section 3 of the act of 1860 required analysts to possess "*competent medical, chemical, and microscopic knowledge as analysts of all articles of food and drink purchased within the city, metropolitan districts, counties, or boroughs*" for which they were appointed.

Allen joined Hassall at his laboratory in Wimpole Street, London at the age of around 16 years in 1862 as a laboratory assistant and for two years gained invaluable experience of food analysis at a time when Hassall's influence on events was considerable. This experience undoubtedly gave him a head start when he was appointed as public analyst to the City of Sheffield in 1873 when he was 27 years old. The intervening years are dealt with in subsequent sections.

The Formation of the Society of Public Analysts and a Further Act of Parliament

By 1874 general dissatisfaction with the acts of 1860 and 1872 was put forward, especially from the food trade, which alleged poor analysis was resulting in unfair prosecutions. A second Parliamentary Select Committee sat in 1874 to take further evidence. Allen along with other analysts gave evidence to this committee and he was described[7,13] as "*pugnacious"* in his delivery. The committee expressed concern to the analysts. They deplored their lack of experience and also the lack of a definition of "*adulteration*". Furthermore the committee suggested that the analysts consult amongst themselves on these matters. Most constructively a preliminary meeting was attended by six analysts including Allen in July 1874 at the City Terminus Hotel in London and was followed by the main meeting in the following month

which was attended by 25 analysts, again including Allen. These meetings led to the formation of the Society of Public Analysts and a definition of "*adulteration*" was completed. This was defined by the new Society of Public Analysts[6,7] as:

An article shall be deemed to be adulterated in the case of a Food or Drink:

1) *if it contains any ingredient which may render such article injurious to the health of the consumer*

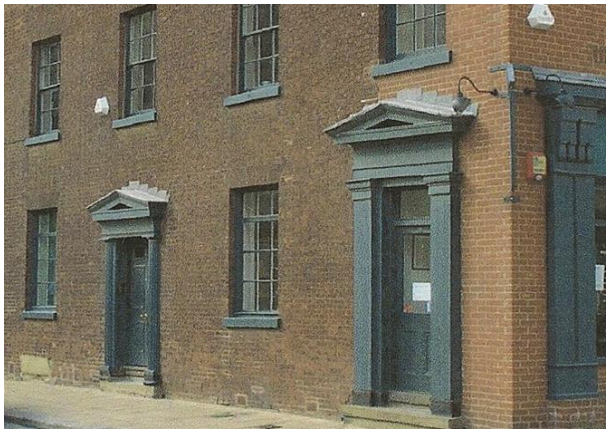
2) *if it contain any substance that sensibly increases its weight, bulk, or strength unless the presence of such substance be due to circumstances necessarily appertaining to its collection or manufacture, or be necessary for its preparation, or be acknowledged at the time of sale*

This definition of adulteration was the basis for the statutory offences contained in the Sale of Food and Drugs Act 1875[11] which expressed adulteration in terms of food being injurious to health, (fine £50 for first offence) and food being not of the nature, substance or quality, (fine £20)[14]. Other provisions related to the adulteration of drugs and milk and other named foods. An amendment in 1879[12] covered some administrative details relating to sampling.

The *Analyst*, the publication of the Society of Public Analysts, followed in 1876. Allen was on the editorial committee of this "*monthly journal devoted to the advancement of analytical chemistry*".

AH Allen's Early and Domestic Life

Allen gained certificates of education in Mineralogy (1863 and 1864), Geology (1863), Inorganic Chemistry (1865) and Applied Mechanics (1865)[15]. These certificates were awarded under the Science and Art Department of the Privy Council on Education. His initial career direction was to join Hassall in his London laboratory in Wimpole Street as a laboratory assistant where he gained experience in food analysis. By 1864 he was keen to move into metallurgy. To achieve this he relocated to join the practice of James Allan, who was not a relative, in the centre of the steel city, Sheffield. This practice was on Surrey Street.



The Surrey Street Premises

James Allan[16] was a consulting commercial chemist and lectured in medicine at Wesley College in Sheffield. This college is still standing and is now called King Edward VII School. His consulting rooms were in Surrey Street in the city centre. In 1866 James Allan was conducting a field trip in the Peak District when he contracted a throat infection which developed into diphtheria. A tracheotomy proved disastrous and he died but not before handing over the business at Surrey Street to the 20 year old Allen. He also took over his lecturing duties. Pasteur is quoted as saying that "*chance favours the prepared mind*"[17], clearly Allen's mind was prepared and certainly he did not lack the necessary confidence for such a development.

Allen's House in Broomfield Place, Sheffield (now part of the Rutland Hotel)

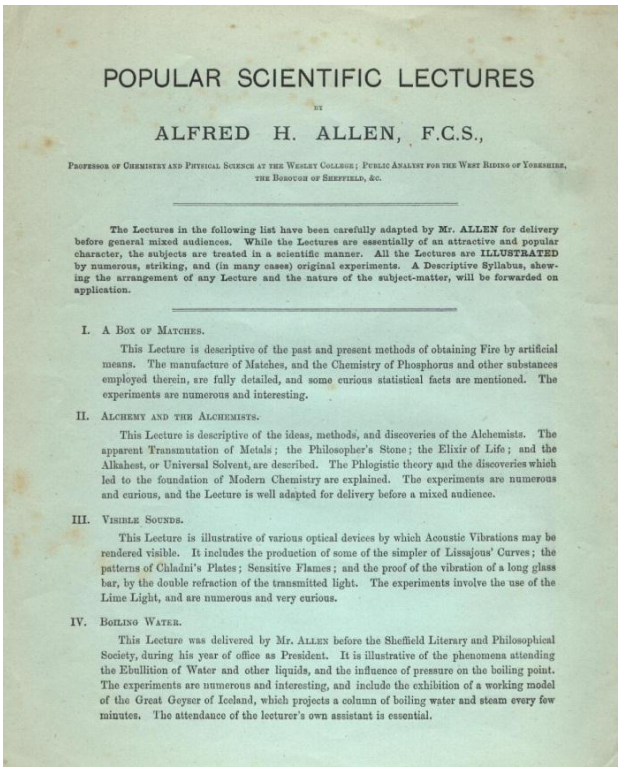
The various national census records[18] during the second part of the nineteenth century give the addresses of the various houses in which Allen lived. His first abode was the second floor flat at the Surrey Street premises. His last house was at 8 Broomfield Place where his household included his wife, Mary, whom he married in 1871 and his three daughters Maude, Emily, and Amy. In addition the household included a cook and a housemaid and Mr. Scott-Smith, who was to marry into Allen's family. This last house is now a part of the Rutland Hotel.

Victorian Times and Some of Allen's Contemporaries

Transport, utilities, education and other aspects of life were completely different to those enjoyed today. Telephones were not available in Allen's domestic and business premises until 1895. Artificial light was gas light. Omnibuses were horse drawn. The railway network was being developed and provided a fast service with top speeds approaching 60 miles per hour by 1895 and 1st class sleeping cars becoming available in 1873[19,4].

People in Victorian times had a thirst for entertainment of a scientific and paranormal nature, this entertainment being in the form of lectures and meetings. Allen was well known for his lectures and regularly gave talks and entertainments. The following were examples of the titles of his lectures[20]:

- A Box of Matches
- Alchemy and the Alchemist
- Visible Sound
- Chemistry of Explosives
- Artificial Light
- Humbug: Ancient and Modern



POPULAR SCIENTIFIC LECTURES

BY

ALFRED H. ALLEN, F.C.S.,

PROFESSOR OF CHEMISTRY AND PHYSICAL SCIENCE AT THE WESLEY COLLEGE; PUBLIC ANALYST FOR THE WEST RIDING OF YORKSHIRE, THE BOROUGH OF SHEFFIELD, &c.

The Lectures in the following list have been carefully adapted by Mr. ALLEN for delivery before general mixed audiences. While the Lectures are essentially of an attractive and popular character, the subjects are treated in a scientific manner. All the Lectures are ILLUSTRATED by numerous, striking, and (in many cases) original experiments. A Descriptive Syllabus, shewing the arrangement of any Lecture and the nature of the subject-matter, will be forwarded on application.

I. A BOX OF MATCHES.

This Lecture is descriptive of the past and present methods of obtaining Fire by artificial means. The manufacture of Matches, and the Chemistry of Phosphorus and other substances employed therein, are fully detailed, and some curious statistical facts are mentioned. The experiments are numerous and interesting.

II. ALCHEMY AND THE ALCHEMISTS.

This Lecture is descriptive of the ideas, methods, and discoveries of the Alchemists. The apparent Transmutation of Metals; the Philosopher's Stone; the Elixir of Life; and the Alkahest, or Universal Solvent, are described. The Phlogistic theory and the discoveries which led to the foundation of Modern Chemistry are explained. The experiments are numerous and curious, and the Lecture is well adapted for delivery before a mixed audience.

III. VISIBLE SOUNDS.

This Lecture is illustrative of various optical devices by which Acoustic Vibrations may be rendered visible. It includes the production of some of the simpler of Lissajous' Curves; the patterns of Chladni's Plates; Sensitive Flames; and the proof of the vibration of a long glass bar, by the double refraction of the transmitted light. The experiments involve the use of the Lime Light, and are numerous and very curious.

IV. BOILING WATER.

This Lecture was delivered by Mr. ALLEN before the Sheffield Literary and Philosophical Society, during his year of office as President. It is illustrative of the phenomena attending the Ebullition of Water and other liquids, and the influence of pressure on the boiling point. The experiments are numerous and interesting, and include the exhibition of a working model of the Great Geyser of Iceland, which projects a column of boiling water and steam every few minutes. The attendance of the lecturer's own assistant is essential.

Some of Allens Popular Lectures

Only fifty two years before Allen was born, the French chemist Lavoisier[21,22] was guillotined on the orders of Marat. In 1883 Johan Kjeldahl[23,24,25,26], a chemist at the Carlsberg brewery in Copenhagen, produced his method for the determination of nitrogen in organic substances. Noteworthy Public Analysts[7,13] of this era included Dr. Theophilus Redwood, the first President of the Society of Public Analysts who was also professor of chemistry at the Pharmaceutical Society and Hehner who initially worked with Hassall after Allen. Dr. Augustus Voelcker was the advisor to the Royal Agricultural Society. Winter Blyth, Public Analyst for the county of Devon was

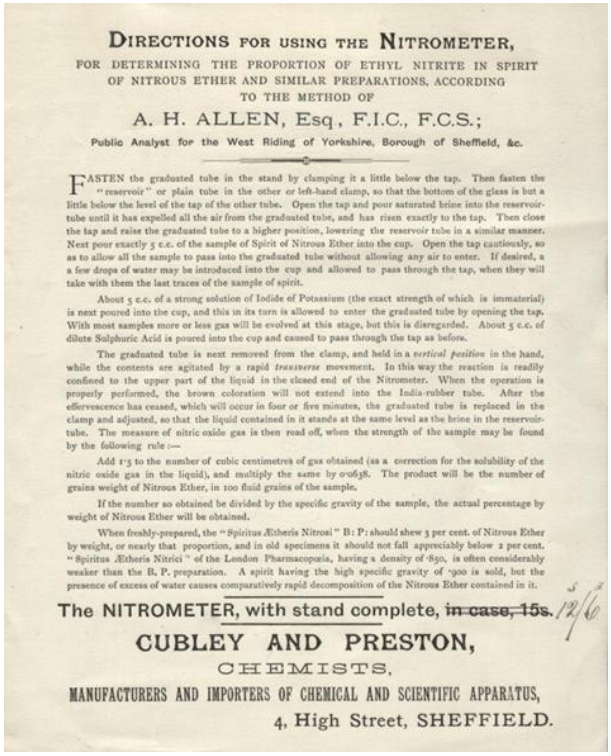
also a Barrister and a Medical Officer of Health[27].

Dr. Bernard Dyer, who earlier had worked under Voelcker, had the presence of mind to record much of the early life of the Public Analysts' world[13]. Noteworthy also was E. Reichert[28,29] who found fame with his butter fat analysis method.

Hassall[30,31] and Wakley[32,33] were both giants of their time. Hassall was a successful medical doctor who succumbed to tuberculosis and spent much time on the Isle of Wight at a sanitorium he founded. A memorial to him is to be found there. Wakley founded the *Lancet* and was a reforming Member of Parliament as well as being a qualified surgeon.

Some Illustrations of the Science of Allen

The Nitrometer



DIRECTIONS FOR USING THE NITROMETER,

FOR DETERMINING THE PROPORTION OF ETHYL NITRITE IN SPIRIT OF NITROUS ETHER AND SIMILAR PREPARATIONS, ACCORDING TO THE METHOD OF

A. H. ALLEN, Esq., F.I.C., F.C.S.;

Public Analyst for the West Riding of Yorkshire, Borough of Sheffield, &c.

FASTEN the graduated tube in the stand by clamping it a little below the tap. Then fasten the "reservoir" or plain tube in the other or left-hand clamp, so that the bottom of the glass is but a little below the level of the tap of the other tube. Open the tap and pour saturated brine into the reservoir-tube until it has expelled all the air from the graduated tube, and has risen exactly to the tap. Then close the tap and raise the graduated tube to a higher position, lowering the reservoir tube in a similar manner. Next pour exactly 5 c.c. of the sample of Spirit of Nitrous Ether into the cup. Open the tap cautiously, so as to allow all the sample to pass into the graduated tube without allowing any air to enter. If desired, a few drops of water may be introduced into the cup and allowed to pass through the tap, when they will take with them the last traces of the sample of spirit.

About 5 c.c. of a strong solution of Iodide of Potassium (the exact strength of which is immaterial) is next poured into the cup, and this in its turn is allowed to enter the graduated tube by opening the tap. With most samples more or less gas will be evolved at this stage, but this is disregarded. About 5 c.c. of dilute Sulphuric Acid is poured into the cup and caused to pass through the tap as before.

The graduated tube is next removed from the clamp, and held in a *vertical position* in the hand, while the contents are agitated by a rapid *transverse* movement. In this way the reaction is readily confined to the upper part of the liquid in the closed end of the Nitrometer. When the operation is properly performed, the brown coloration will not extend into the India-rubber tube. After the effervescence has ceased, which will occur in four or five minutes, the graduated tube is replaced in the clamp and adjusted, so that the liquid contained in it stands at the same level as the brine in the reservoir-tube. The measure of nitric oxide gas is then read off, when the strength of the sample may be found by the following rule :—

Add 1·5 to the number of cubic centimetres of gas obtained (as a correction for the solubility of the nitric oxide gas in the liquid), and multiply the same by 0·0538. The product will be the number of grains weight of Nitrous Ether, in 100 fluid grains of the sample.

If the number so obtained be divided by the specific gravity of the sample, the actual percentage by weight of Nitrous Ether will be obtained.

When freshly-prepared, the "Spiritus Ætheris Nitrosi" B: P: should shew 3 per cent. of Nitrous Ether by weight, or nearly that proportion, and in old specimens it should not fall appreciably below 2 per cent. "Spiritus Ætheris Nitrici" of the London Pharmacopœia, having a density of ·850, is often considerably weaker than the B. P. preparation. A spirit having the high specific gravity of ·900 is sold, but the presence of excess of water causes comparatively rapid decomposition of the Nitrous Ether contained in it.

The NITROMETER, with stand complete, ~~in case, 15s.~~ 12/6

CUBLEY AND PRESTON,

CHEMISTS,

MANUFACTURERS AND IMPORTERS OF CHEMICAL AND SCIENTIFIC APPARATUS,

4, High Street, SHEFFIELD.

Details of Allen's Nitrometer

Allen devised and marketed a glassware apparatus called the "*Nitrometer*", which was used for the determination of the strength of the medicinal preparation Spirit of Nitrous Ether. In this apparatus the chemicals potassium iodide and sulphuric acid were used to liberate nitrous oxide from the preparation as a measure of its strength[34]. This nitrous oxide was in the enclosed environment of his nitrometer. In 1885 he read to the British Pharmaceutical Conference his paper on "*The Determination of Ethyl Nitrite and the Change Undergone by the Spirit of Nitrous Ether on Keeping*", which subsequently appeared in the Pharmaceutical Journal in February 1885[34]. His new method was adopted by the editors of the British Pharmacopoeia and it appeared in the next edition in 1885[35].

Whisky[36,37]

The higher alcohols of butyl and amyl alcohol comprise what was traditionally termed fusel oils, the thick and viscous residue left after ethyl alcohol and similarly volatile components had evaporated from whisky and other spirit drinks. Quantification of these was approached in the laboratory of Allen's era by dilution of the whisky with water, extraction of the fusel oil into chloroform and subsequent oxidation of the alcohols to acids such as valeric using chromic acid. Allen's contribution to the procedure was to use carbon tetrachloride as the extracting solvent rather than chloroform because it had a higher boiling point, making it more suitable for the oxidative step, and was lower in impurities which produced mineral acids during oxidation. The proportions of acids so produced were determined either by a

gravimetric procedure using barium carbonate or by titration.

In a footnote on the matter in the third edition of Commercial Organic Analysis[38] Allen relates the following:

"*Early in last summer I was led to look carefully into the published statements respecting the proportion of fusel oil and amyl alcohol in whisky, and it was then that I discovered the paucity of information on the subject. A well-known firm of Irish distillers supplied a cask of whisky to a customer. When he had drunk the greater part of the whisky the customer refused to pay for it, alleging that it had made him ill and when sued for the amount due brought a counter action for the injury to health, owing to his having been supplied with whisky containing a large percentage of fusel oil. This statement was hardly borne out by his analyst, who had found 0.22 per cent of amylic alcohol, while I, (Allen), who had analysed the spirit on behalf of the distillers, had found but 0.07 per cent. In consequence of this discrepancy, the judge, at my suggestion, instructed us to make a joint analysis, the result of which was that we agreed that 0.07 was the correct figure*.

As the amyl alcohol in spirits rarely exceeds 0.1 per cent, 70 grains per proof gallon, it seems highly improbable that it can produce the local effects sometimes attributed to it. Its effect on the general system has been probably greatly exaggerated. A pupil of mine informs me that some years ago he took a teaspoon of fusel oil, mixed with water, without any ill effect. Recently, for three weeks I took every evening, with a few exceptions, a wine glass full of whisky to which crude fusel oil had been added to the extent ½, 1 and ultimately 2 per cent. The spirit was extremely nauseous, but produced no headache or other ill effects."

The Action of Water on Lead

In 1888, when he was president of the Society of Public Analysts, Allen read his paper[39] "*The Action of Sheffield Water on Lead, and its probable Cause and Cure*" to the Sheffield Literary and Philosophical Society. Allen was a supporter of this society and indeed served as its President during 1881.

Earlier in 1882 Allen had explored the influence of sulphuric acid in water on lead and found that lead was dissolved into the water[40]. Concentrations of around 0.5 grains per gallon could result, equivalent to around 7mg of lead per litre.

Sheffield mains water had been found to contain elevated concentrations of lead at around 0.2 grains per gallon, equivalent to 2.8mg per litre and up to 0.7 grains per gallon equivalent to around 10mg per litre. Lead poisoning had been found in many of the population of Sheffield. Lead poisoning shows itself by aching joints, blue lines on the gums and kidney damage.

Indeed Allen had noted that water delivered by the mains supply to Surrey Street, was relatively free from lead whereas water delivered to the Wesley College, where he had teaching duties, was contaminated. These two different locations were supplied from different reservoirs to the west of Sheffield. At the time different theories concerning the origin of the lead in the mains water were around including the action of silica, the presence of waste from lead mines and interactions with sulphate. Allen noted that the water from the Bradfield reservoir, which supplied Surrey Street, was free from lead whereas water from the Redmires reservoir, which supplied Wesley College, was able to dissolve lead from pipework and other fittings. He concluded that the water from Redmires was acidic because of the nature of the

surrounding flora and absence of neutralising matter such as mortar, whereas that from the Bradfield area was surrounded by grass land and passed through mortar lined culverts on its journey to Sheffield. He advocated the use of blocks of limestone and doses of slaked lime to counter the plumbosolvency of the supply.

He also patented a method[41] to remove lead from contaminated water whereby this water was passed through animal charcoal, the phosphorus in the charcoal capturing the lead.

The Glasgow Lecture

Allen travelled to Glasgow in 1876 to read a paper before the Society of Public Analysts on "*The Solution of Difficultly Soluble Substances*"[42]. The significance of this paper was that he was the first to effect the decomposition of minerals, slags etc by heating the finely powdered material at 100^0C with fuming hydrochloric acid in a sealed tube and that it demonstrated his ability in the field of inorganic chemistry in addition to his well-documented expertise in organic analytical chemistry. Hamence and Chirnside referred to this paper in chapter 11 of their book and made reference to Allen as "*one of the society's most distinguished founder members*"[7].

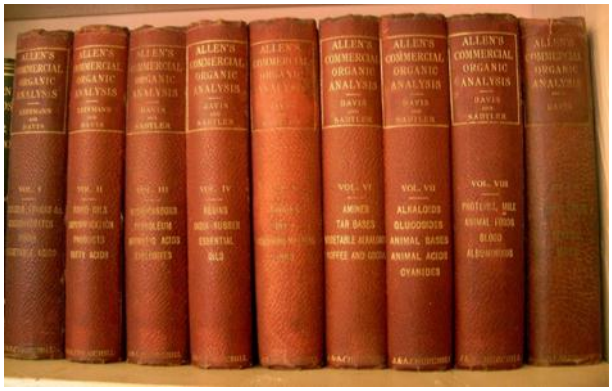
Cider

The quality of drinking water in Victorian times was at best variable[4] and consequently fermented drinks such as beer, cider and wines were considered safer. In a series of letters to the *Times* and other newspapers during the autumn of 1901 aspects of cider, including both the alcohol content and the cleanliness of the drink, were addressed by Allen and others. Allen wrote to the editor of that newspaper in early September and expressed concern about the cleanliness of the production of cider especially where apples had been transported in carts which had previously been used to transport farmyard manure. He wrote, "*unfortunately much of the cider produced in the west of England is made in a slovenly and ignorant manner. The fruit is by no means always sound and the greatest carelessness is shown in many cases as to its condition. Carts which hold manure one day are used for apples the next*".

Later Alban E Bellairs, a resident of Lyme Regis, on 23rd September 1901, commented to the editor of the *Times* that "*purity, delicacy and non-alcoholic properties are important especially with the medical profession, who safely prescribe pure cider to their patients for sundry disorders, in a measure, containing a lower alcoholic strength than other fermented beverages. Such cider comes within the limit (4 per cent) of recognised teetotal drinks permitted by their leaders*". Allen's letter to the editor on 2nd October listed the alcoholic properties of a number of ciders some of which were well above 4% and were strong! His paper, "*A Contribution to a Knowledge of the Chemistry of Cider*"[43], which appeared in the *Analyst* in 1902, included data on the composition of apples, apple and pear musts, and ciders, including alcohol contents.

His information on cider was gathered together at Surrey Street in a scrap book and included letters, papers, and notes on the manufacture of cider from the Western Pomological Association of France and others. This scrap book remains in the possession of the authors.

Commercial Organic Analysis

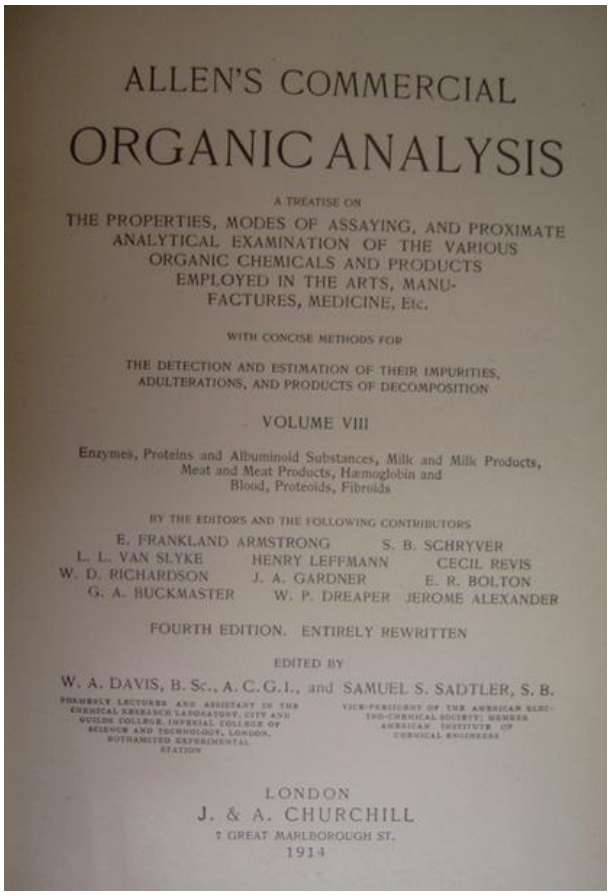


Allen's Commercial Organic Analysis

Allen was a prolific publisher of scientific papers. He also produced his "*magnum opus*", the volumes of "*Commercial Organic Analysis*". As he noted in his first preface of 1879 "*While the libraries of chemists are replete with manuals and treatises on inorganic analysis and the number of these works is being increased almost monthly, books on organic analysis are chiefly conspicuous by their absence*".

He wrote and had published some 150 to 200 papers, articles and notes. These works were of benefit to laboratories and manufacturers. "*Organic analysis emerged from his hands as an orderly and manageable science*" as Hehner wrote in Allen's obituary notice[2]. He also recalled that "*the task of keeping up the continually required new editions overwhelmed him and ruined his health*".

In all, there were thirteen volumes (including revised volumes). Eventually the American academic Dr Leffman, Mr Tankard, his senior laboratory assistant, and others played a role in the further revisions resulting in the third edition, as can be seen in the table of Allen's papers and other publications included in the Appendix to this paper.


ALLEN'S COMMERCIAL
ORGANIC ANALYSIS
A TREATISE ON
THE PROPERTIES, MODES OF ASSAYING, AND PROXIMATE ANALYTICAL EXAMINATION OF THE VARIOUS ORGANIC CHEMICALS AND PRODUCTS EMPLOYED IN THE ARTS, MANUFACTURES, MEDICINE, Etc.
WITH CONCISE METHODS FOR
THE DETECTION AND ESTIMATION OF THEIR IMPURITIES, ADULTERATIONS, AND PRODUCTS OF DECOMPOSITION
VOLUME VIII
Enzymes, Proteins and Albuminoid Substances, Milk and Milk Products, Meat and Meat Products, Hæmoglobin and Blood, Proteoids, Fibroids
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LONDON
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1914

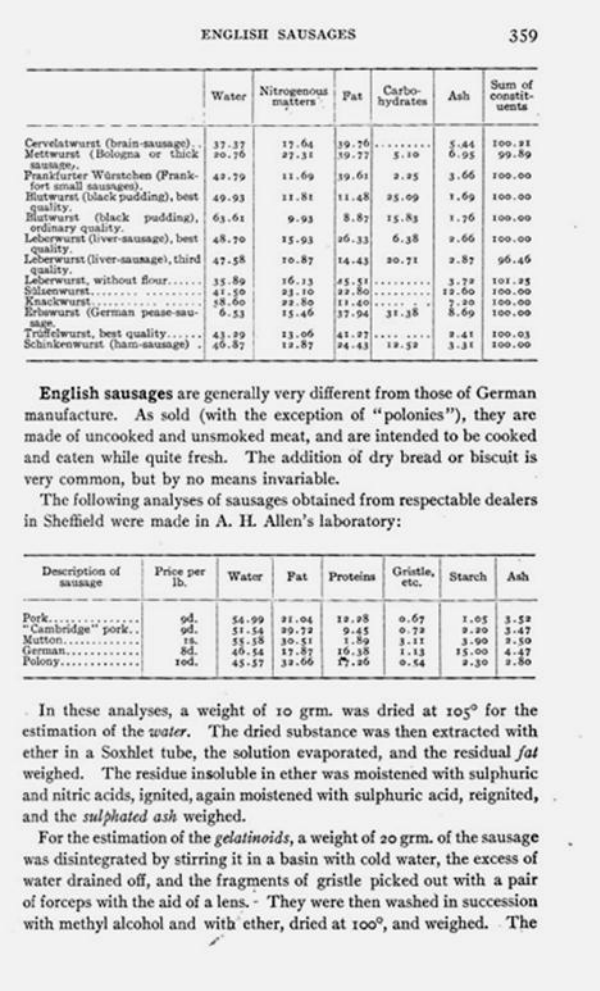
Allen's Commercial Organic Analysis

The subject matter of these volumes was deliberately from a broad spectrum of goods and materials: foods, drugs, oils, tars, dyes, tannins, resins, proteins, to name but a few examples. Both composition and analysis were covered and much of the data was confirmed in his own laboratories. The continual updating of these volumes must have required a major effort, as Hehner recognised in the obituary of Allen.

For example Volume 2 deals with oils and fats. The 1st edition of Volume 2[44] contains a section on the identification of butter fat by specific gravity and by water insoluble fatty acid content, the method favoured by Hehner[45]. By the time the 3rd edition of Volume 2[46] appeared Reichert's[47] adaptation of Hehner's method, which utilised the steam volatile water soluble fraction of the fatty acids, was the recognised and the preferred procedure so amendments were necessary.

Incidentally, Reichert acknowledged Hehner's progress and contribution with the chemistry

involved in his approach and whilst the method gave rise to what was universally known as the Reichert method, Reichert himself referred to it as Hehner's method[48]! Allen tried the method of Reichert and gave it a ringing endorsement[49].



ENGLISH SAUSAGES 359

	Water	Nitrogenous matters	Fat	Carbo-hydrates	Ash	Sum of constituents
Cervelatwurst (brain-sausage)	37.37	17.64	39.76	.....	5.44	100.21
Mettwurst (Bologna or thick sausage)	20.76	27.31	19.77	5.10	6.95	99.89
Frankfurter Würstchen (Frankfort small sausages)	42.79	11.69	39.61	2.25	3.66	100.00
Blutwurst (black pudding), best quality	49.93	11.81	11.48	25.09	1.69	100.00
Blutwurst (black pudding), ordinary quality	63.61	9.93	8.87	15.83	1.76	100.00
Leberwurst (liver-sausage), best quality	48.70	15.93	26.33	6.38	2.66	100.00
Leberwurst (liver-sausage), third quality	47.58	10.87	14.43	20.71	2.87	96.46
Leberwurst, without flour	35.89	16.13	45.51	.....	3.72	101.25
Salsenwurst	41.50	23.10	22.80	.....	12.60	100.00
Knackwurst	58.60	22.80	11.40	.....	7.20	100.00
Erbswurst (German pease-sausage	6.53	15.46	37.94	31.38	8.69	100.00
Trüffelwurst, best quality	43.29	13.06	41.27	.....	2.41	100.03
Schinkenwurst (ham-sausage)	46.87	12.87	24.43	12.52	3.31	100.00

English sausages are generally very different from those of German manufacture. As sold (with the exception of "polonies"), they are made of uncooked and unsmoked meat, and are intended to be cooked and eaten while quite fresh. The addition of dry bread or biscuit is very common, but by no means invariable.

The following analyses of sausages obtained from respectable dealers in Sheffield were made in A. H. Allen's laboratory:

Description of sausage	Price per lb.	Water	Fat	Proteins	Gristle, etc.	Starch	Ash
Pork	9d.	54.99	21.04	12.28	0.67	1.05	3.52
"Cambridge" pork	9d.	51.54	29.72	9.45	0.72	2.20	3.47
Mutton	1s.	53.58	30.51	1.89	3.11	3.90	2.50
German	8d.	46.54	17.87	16.38	1.13	15.00	4.47
Polony	10d.	45.57	32.66	17.26	0.54	2.30	2.80

In these analyses, a weight of 10 grm. was dried at 105° for the estimation of the *water*. The dried substance was then extracted with ether in a Soxhlet tube, the solution evaporated, and the residual *fat* weighed. The residue insoluble in ether was moistened with sulphuric and nitric acids, ignited, again moistened with sulphuric acid, reignited, and the *sulphated ash* weighed.

For the estimation of the *gelatinoids*, a weight of 20 grm. of the sausage was disintegrated by stirring it in a basin with cold water, the excess of water drained off, and the fragments of gristle picked out with a pair of forceps with the aid of a lens. They were then washed in succession with methyl alcohol and with ether, dried at 100°, and weighed. The

Analysis of German and English Sausage

Volume 4 of the third edition of *Commercial Organic Analysis* deals with proteids, the term used by Allen for proteins and nitrogenous compounds. Results for the analysis of sausages both of German and Sheffield origin for Proteid/Nitrogenous Matter (Protein), Water, Fat, Carbohydrate and Ash were given[50]. In commenting on the results of analysis, no conclusions were drawn concerning adulteration. This is not surprising as it would be another twenty one years before Stubbs and More[51] published their method of converting such data in terms of meat content.

Milk and Milk Products

A part of Volume 4 of Commercial Organic Analysis dealt with milk and milk products. This Allen decided to also publish as a separate book in 1897[52]. As he explains in the preface "*it occurred to me that the chapters on Milk and Milk Products would be welcomed by magistrates and others concerned with the administration of the Adulteration Acts. I have therefore with the consent of the publishers had a limited number of extra copies of these chapters printed and believe the contained matter will prove of service in affording information as to the difficult – not to say disheartening – conditions under which Public Analysts have hitherto performed their duties. It is to be hoped that some of these difficulties will be removed before long by legislation*".

It is most likely that the difficulties to which he referred were those associated with interpretation of data and the establishment of base data for unadulterated milk and its products. Individual Public Analysts such as Cameron[53] and Wynter Blyth[27] as well as the Society of Public Analysts[13] also studied this topic.

The Chemistry of Urine

In 1895 he produced his book "*Chemistry of Urine, a Practical Guide to the Analytical Examination of Diabetic, Albuminous and Gouty Urine*"[54]. He, himself, suffered from diabetes and it was to end his life. He also published on "*The Examination of Urine for Small Quantities of Sugars*"[55] in the *Analyst* in 1894. The use of hydrometry and chemical analysis for the estimation of sugars in urine and their nature were subjected to his experiments. His contribution to the subject is also recognised in the publication "*Practical Methods of Urine*

Analysis" published by the Offices of the Chemist and Druggist in 1902, which sets out a diagram of the apparatus used by Allen for the determination of sugar in urine, the apparatus permitting the exclusion of air in the redox titration involving a modification of Fehling's method[56].

He died on July 14th 1904.

Conclusion

The life and work of Allen and his contemporaries was unique in that they started with almost no knowledge of the composition of food and equally almost no knowledge of reliable methods of analysis. They responded to the criticism of the second Select Committee on food adulteration in 1874 with the constructive formation of the Society of Public Analysts, the publication of the *Analyst* and a definition of adulteration. Eventually a professional qualification was agreed. All this was necessary to avoid unsafe prosecutions and to provide reliable scientific enforcement of food legislation. Truly todays' practitioners sit on the shoulders of these giants.

Allen, himself, worked tirelessly providing a platform for scientific advances through his "*Commercial Organic Analysis*" and through his papers and lectures. In doing so he shared his knowledge with his colleagues and the public. This was all the more admirable when one considers the facilities available.

Acknowledgements

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References

1 Food Safety Act 1990, Elizabeth II, Chapter16, The Stationery Office, London
2 Otto Hehner, "Obituary Notice: Alfred Henry Allen", Analyst, 1904, **29**, 233-242
3 "Deaths: Allen", The Pharmaceutical Journal, 1904, **19** 132-133
4 AN Wilson, "The Victorians", 2002, Arrow Books, London
5 Arthur Hill Hassall, "Adulterations Detected", 1861, Edition 2, Longman, Green, Longman and Roberts, London
6 Alexander Wynter Blyth, "Foods: Their Composition and Analysis", 1896, Edition 4, Charles Griffin and Company Limited, London
7 RC Chirnside and JH Hamence, "The Practising Chemists, A History of the Society for Analytical Chemistry 1874-1974", 1974, The Society for Analytical Chemistry
8 F Accum, "Treatise on Adulterations of Food and Culinary Poisons", 1820, Longman, London
9 "An Act for Preventing the Adulteration of Articles of Food or Drink", 1860, Victoria, Chapter 84, The Stationery Office, London
10 "Adulteration of Food and Drugs Act", 1872, Victoria, Chapter 74, The Stationary Office, London
11 "Sale of Food and Drugs Act", 1875, Victoria, Chapter 63, The Stationary Office, London
12 "Sale of Food and Drugs Act Amendment Act", 1879, Victoria, Chapter 30, London, The Stationery Office
13 Bernard Dyer and C Ainsworth Mitchell, "The Society of Public Analysts and other Analytical Chemists: Some Reminiscences of its First Fifty Years and a Review of its Activities", 1932, W Heffer & Sons Ltd, Cambridge
14 A Mansfield Robinson and Cecil H Cribb, "The Law and Chemistry of Food and Drugs", 1895, FJ Rebman, London
15 Information taken from Allen's educational certificates
16 "Historical Notes on Old Sheffield Druggists", lecture presented by John Austen to the Sheffield Pharmaceutical and Chemical Society at the Montgomery Hall, Surrey Street on 2nd April 1903
17 From a speech given by Pasteur on the occasion of his formal inauguration to the Faculty of Letters of Donai and Faculty of Science of Life on December 7th 1854
18 National Archive Census records for 1871, 1881, 1891, 1901
19 Encyclopaedia Britannica, 1989, Edition 15, 768
20 Leaflets detailing these lectures remain in the hands of the authors
21 JR Partington, "A History of Chemistry", 1962, Volume III, 363-495, Macmillan, London
22 H Guerlac, "Antoine-Laurent Lavoisier: Chemist and Revolutionary", 1975, Scribner's, New York
23 J Kjeldahl, "Neue Methode zur Bestimmung des Stickstoffsin Organischen Koerpern", Z Anal Chem, 1883, **22**, 366-382
24 P Morries, "A Century of Kjeldahl: 1883-1983", J Assoc Public Analysts, 1983, **21**, 53-58

25 RS Hatfull, "The Development and Application of the Kjeldahl Process for Legislative Purposes", J Assoc Public Analysts, 1983, **21**, 103-111
26 D Thornburn Burns, "Kjeldahl, the Man, the Method and the Carlsberg Laboratory", Anal Proc, 1984, **21**, 210 - 214
27 D Thorburn Burns, "Alexander Wynter Blyth: A pioneering and Innovative Public Analyst", J Assoc Public Analysts, (Online), 2007, **35**, 17-29
28 E Reichert, "Verein Butterprufung nach Hehner's Princip", Z Anal Chem, 1879, **18**, 68-73
29 Harold Egan, Ronald S Kirk and Ronald Sawyer, "Pearson's Chemical Analysis of Foods", 8th Edition, 1981, Churchill Livinstone, London
30 JH Price, "Arthur Hill Hassall", Oxford Dictionary of National Biography, 2004, Oxford University Press, Oxford
31 EH Grey, "By Candlelight – the Life of Dr Arthur Hill Hassall (1817-1894)", 1983, Robert Hale, London
32 WF Bynum, "Thomas Wakley", Oxford Dictionary of Biography, 2004, Oxford University Press, Oxford
33 SS Sprigge, "The Life and Times of Thomas Wakley", 1897, Longman Green and Co, London
34 Alfred H Allen, "The Determination of Ethyl Nitrite in the Spirit of Nitrous Ether and Kindred Preparations", Pharmaceutical Journal and Transactions, 1884-1885, **15** 673-678
35 British Pharmacopoeia 1885, The Medical Council, London
36 Alfred H Allen and William Chattaway, "On the Examination of Spiritus Liquids for Secondary Constituents", Analyst, 1891, **16**, 102-115
37 SA Vassey, "Analysis of Potable Spirits", 1904, Balliere, Tindall and Cox, London
38 Alfred H Allen, "Commercial Organic Analysis", 1898, **1**, Edition 3, Philadelphia, P. Blakiston's Son & Co
39 Alfred H Allen, "The Action of Sheffield Water on Lead, its Probable Cause and Cure", read to the Sheffield Literary and Philosophical Society, March 6th 1888. See also William Smith Porter, "A Centenary Retrospective 1822–1922", Sheffield Literary and Philosophical Society, 1922, **58**, 87
40 Alfred H Allen, "Notes on the Action of Water on Lead", Analyst, 1882, **7**, 169-172
41 Reference to the patented method is contained in the lecture notes, see reference 38, which are in the hands of the authors.
42 Alfred H Allen, "On the Solution of Difficultly-soluble Substances", Analyst, 1876, **1**, 139-141
43 Alfred H Allen, "A Contribution to the Knowledge of the Chemistry of Cider", Analyst, 1902, **27**, 183-192
44 Alfred H Allen, "Commercial Organic Analysis", 1882, **2**, edition 1, London, J. & A Churchill 229-232
45 Otto Hehner and Arthur Angell, "Butter Its Analysis and Adulterations", 1877, edition 2, J & A Churchill, London
46 Alfred H Allen, "Commercial Organic Analysis", 1898, **2**, part 1,edition 3, 58, Philadelphia, P Blackiston's & Co

47 E. Reichert, "Vereinfacht Butterprufung nach Hehner's Princip", Zeit Anal Chem, 1879, **18**, 68-73

48 Henry Droop Richmond, Dairy Chemistry, 1920, 242, Charles Griffin and Company Limited, London

49 Alfred H Allen, "On Reichert's Method of Examining Butter-Fat", Analyst, 1885, **10**, 103-105

50 Alfred H Allen, "Commercial Organic Analysis", 1898, **4**, edition 2, 280

51 G Stubbs and A More, "The Estimation of the Approximate Quantity of Meat in Sausages and Meat Pies", Analyst, 1919, **44**, 125-127

52 Alfred H Allen, "Milk and Milk Products", 1897, J & A Churchill, London

53 D Thorburn Burns, "Sir Charles Alexander Cameron (1830-1921), Dublin's Medical Superintendent, Executive Officer of Health, Public Analyst and Inspector of Explosives", J Assoc Public Analysts, (Online), 2009, **37**, 14 -39

54 Alfred H Allen, "Chemistry of Urine – A Practical Guide to the Analytical Examination of Diabetic, Albuminous and Gouty Urine", 1895, J & A Churchill, London

55 Alfred H Allen, "The Examination of Urine for Small Quantities of Sugar", Analyst, 1894, **19**, 178-190

56 "Practical Methods of Urine Analysis for Chemists and Druggists", 1902, 46 , The Office of the Chemist and Druggist, London

Appendix 1

List of Papers and Other Publications Written by AH Allen

a) Papers read before the British Association for the Advancement of Science

1 On the detection of the Adulteration of Tea, 1873
2 On a method of effecting the Solution of Difficultly Soluble Substances, 1875
3 Reports (Three) of the Committee on the Methods employed in the Estimation of Potash and Phosphoric Acid and on the Mode of stating the Results (AH Allen, secretary), 1875, 1876, and 1877
4 Illustration of the Hollway Process of Smelting Sulphide Ores, 1879
5 On the Presence of Nitrogen in Steel, 1879
6 On Petroleum Spirit or "Benzoline", 1879
7 On the Specific Rotatory Power of Cane and Invert Sugar, 1880
8 Further Notes on Petroleum Spirit and Analogous Liquids, 1880
9 On the So-called "Normal" Solutions of Volumetric Analysis, 1880
10 On the Separation of Hydrocarbon Oil from Fat Oil, 1881
11 An Apparatus for determining the Viscosity of Oils, 1885
12 On the Action of Water on Lead, 1885
13 On the Utilization of Blast-furnace Creosote, 1887
14 On the Reaction of Glycerides with Alcoholic Alkalies, 1891

b) Papers read before the Sections of the Society of Chemical Industry

1 On the Chemistry and Analytical Examination of Fixed Oils 1883, **2**, 49
2 Note on the Stability of Hypobromite, and its use for the Titration of Oils etc, 1884, **3**, 65
3 New and Little-known Applications of the Nitrometer, 1885, **4**, 178
4 Further Notes on the Methods of Examining and Chemistry of Fixed Oils, 1886, **5**, 65
5 Supplementary Notes on the Methods of Examining Fixed Oils, 1886, **5**, 795
6 On the Treatment of Soap-makers' Leys for Recovery of Glycerin, 1887, **6**, 87
7 Crude Carbolic Acid and its Substitutes, 1887, **6**, 671
8 The Analytical Examination of Water for Technical Purposes, 1888, **7**, 795
9 Notes on Commercial Cresylic Acid and Allied Products, 1890, **9**, 141
10 The Chemistry of Whisky and Allied Products, 1891, **10**, 305
11 Supplementary Notes on the Chemistry of Whisky, 1891, **10**, 519

These presentations were subsequently published in the Journal of the Society of Chemical Industry.

c) Papers read at Meetings of the Iron and Steel Institute

1 Preliminary Experiments to Determine the Existence of Nitrogen in Steel, 1879, 480
2 Further Experiments on the Existence of Nitrogen in Iron and Steel, 1880, **1**, 181

These presentations were subsequently published in the Journal of the Iron and Steel Institute.

d) Papers read before the Society of Public Analysts, (The Analyst)

1 On the Adulteration and Impurities of Tartaric Acid and Citric Acids, Proceedings of the Society of Public Analysts, 1876, **1**, 151
2 On the Determination of Quinine, 1876, **1**, 17
3 The Solution of Difficultly Soluble Substances, 1876, **1**, 139
4 On the Analysis of Plating and Gilding Solutions, 1876, **1**, 178
5 Some Points in the Analysis of Water and the Interpretation of the Results, 1877, **2**, 61
6 Note on the Determination of Alcohol in Ether and Chloroform, 1877, **2**, 97
7 Note on the Detection of Strychnine, 1877, **2**, 111
8 The Assay of Carbolic Acid Powders, 1878, **3**, 285
9 A Curious Case of Poisoning by Mouldy Bread, 1878, **3**, 355
10 On the Distinctive Tests for Carbolic Acid, Cresylic Acid, and Creosote, 1878, **3**, 319
11 Experiments on the Determination of Free Acids of Vinegar, (with R Bodmer), 1878, **3**, 268
12 Notes on the Analytical Examination of Tinctures, 1879, **4**, 101
13 Note on the Quality of the Paper employed by the Daily Press, 1879, **4**, 161
14 A Suggestion respecting the Expression of the Results of Butter Assays by Dr. Koettstorfer's Method, 1879, **4**, 162
15 Note on the Examination of Coffee, 1880, **5**, 1
16 An Improvement in the Mode of Estimating Nitrates by Crum's Method, 1880, **5**, 181
17 Notes on the Analysis of Cream of Tartar, 1880, **5**, 114
18 Relative Proportions of Olefines in Shale and Petroleum Products, 1881, **6**, 177
19 On Maumene's Test for Oils, 1881, **5**, 114
20 Note on the Isolation of Strychnine, 1881, **6**, 141
21 Notes on the Action of Water on Lead, 1882, **7**, 169
22 Notes on Commercial Albumen, 1882, **7**, 209
23 A Critical examination of Dr. Voelcker's Published Statements on the Composition of Milk, 1883, **8**, 256
24 Notes on the Estimation of Lead in Aerated Waters, 1884, **9**,194
25 Reichert's Method for Examining Butter Fat, 1885, **10**, 103
26 Note on the Optical Estimation of Milk Sugar, 1885, **10**, 72
27 The Assay of Carbolic Soap, 1886, **11**, 103
28 Saponification of Fixed Oils, 1886, **11**, 145
29 Commercial Shark Oil, 1886, **11**, 122

30 On the Determination of Glycerin produced by the Saponification of Fatty Oils, 1886, **11**, 52
31 Suggestions for the more ready employment of Adam's Method of determining Fat in Milk (with W Chattaway), 1886, **11**, 71
32 Note on the Fat of Porpoise Milk, 1886, **11**, 190
33 Specific Gravity and other Properties of Waxes and Allied Bodies, 1886, **11**, 223
34 Preservation of Milk Samples for Reference, 1886, **11**, 203

35 An Improved Method of Detecting Quassia and certain other Hop Substitutes in Beer, 1887, **12**, 107
36 Note on Reichert's Distillation Process, 1887, **12**, 11
37 Note on the Composition of some Preparations sold as Hop Substitutes (with W Chattaway), 1887, **12**, 112
38 Laboratory Notes: Alumina in Wheat, etc; Detection of Sulphur in Oils; Precipitation of Hop-bitter by Lead Acetate, 1888, **13**, 41
39 On the Detection of Cotton Seed Oil in Lard, 1888, **13**, 161
40 Use of the Word "Normal" in Volumetric Analysis, 1888, **13**, 181
41 Adulteration of Lard with Coconut Oil, 1888, **13**, 189
42 Presidential Addresses to the Society of Public Analysts, 1888-1889, **13**, 14
43 The Detection of Saccharin in Beer, 1888, **13**, 105
44 On some Abnormal Samples of Butter, 1889, **14**, 5
45 Abnormal Danish Butters, (a reply to Mr Estcourt), 1889, **14**, 79
46 Possible Future Extension of the Duties of Public Analysts, 1890, **15**, 2
47 Detection of Hop Substitutes in Beer (with W Chattaway), 1890, **15**, 181
48 Suggestions for the Assay of Aconite and its Preparations, 1891, **16**, 185
49 On the Constitution of Butter-fat, 1891, **16**, 161
50 Examination of Spiritous Liquids for Secondary Constituents, (with W Chattaway), 1891, **16**, 102
51 Notes on Acetin, (with D Homfray), 1891, **16**, 167, 201
52 Neutrality: A Paper read before the Chemists' Assistants' Association, 1892, **17**, 186, 215
53 Note on Tabarie's Method of Determining Alcohol, 1892, **17**, 5
54 Proportion of Water in Butter, 1892, **17**, 104
55 Vinegar, (with CG Moor), 1893, **18**, 180, 240
56 The Vinegar Question, 1894, **19**, 8, 26
57 Note on GS Cox's Paper on Cider Vinegar, 1894, **19**, 91
58 The Examination of Urine for Small Quantities of Sugar, 1894, **19**, 178
59 On the Extraneous Mineral Matter contained in Commercial Ginger, 1894, **19**, 217
60 Change in the Composition of Butter by long keeping, (with CG Moor), 1894, **19**, 128
61 Notes on Commercial Condensed Milks, 1895, **20**, 274
62 Note on the Concentration of Condensed Milks, 1896, **21**, 281
63 Composition and Analysis of Commercial Cream of Tartar, 1896, **21**, 174, 209
64 Preparation of Pure Hydofluoric Acid, 1896, **21**, 87
65 Note on the Titration of Quinine, 1896, **21**, 85

66 Note on the Presence of Heavy Metals in Cheese (with FH Cox), 1897, **22**, 187-189
67 White-wine Vinegar, 1896, **21** 253
68 Improved Method of determining Proteid and Gelatinoid Substances (with AB Searle), 1897, **22**, 258
69 Note on the Presence of Heavy Metals in Cheese, (with FH Cox), 1897, **22**, 187
70 Detection of Arsenic in Beer, 1901, **26**, 10
71 Is the British Pharmacopoeia the Legal Standard for the Preparations described therein?, 1901, **26**, 86
72 A Contribution to a Knowledge of the Chemistry of Cider, 1902, **27**, 183
73 Certain Reactions of the Alkaloids of Ipecacuanha (with GE Scott-Smith), 1902, **27**, 345
74 The Analysis of Preparations containing Opium (with GE Scott-Smith), 1902, **27**, 350
75 Existing Defects and Possible Improvements in the Laws relating to Adulteration, 1903, **28**, 264
76 The Determination of Boric Acid in Cider, Fruits etc. (with AR Tankard), 1904, **29**, 301

d) Papers read before The Chemical Society

1 On meta-Stannic Acid, and the Detection and Estimation of Tin, Journal of the Chemical Society, 1872, **25**, 274
2 An Improved Method of Determining Urea by the Hypobromite Process, Proceedings of the Chemical Society, 1896, **31**, 33

e) Papers published in the Chemical News

1 On the Employment of Potassium Ferricyanide as a Test for Cobalt, Nickel, and Manganese, 1871, **23**, 290
2 Suggestions for the Improvement of the method employed for Qualitative Analysis, 1871, **23**, 301
3 Note on the Solubility of Gold, and the Stability of Auric Nitrate and Sulphate, 1872, **25**, 85
4 Estimation of Silicon and Graphite in Pig-irons, 1874, **29**, 91
5 Chemistry applied to the Detection of Adulteration, 1874, **29**, 129, 140, 167, 189, 221; 1874, **30**, 2, 116; 1875, **32**, 77
6 The Action of Water on Lead, 1882, **46**, 145
7 Constitution of Butter-fat (controversy with JA Wanklyn), 1891, **64**, 223, 249, 263
8 On the Reaction of Glycerides with Alcoholic Alkalies, 1891, **64**, 179
9 The Saponification of Beef-fat, 1891, **64**, 223, 282
10 The Volumetric Determination of the Alkaloids, 1892, **66**, 259
11 Note on the Assay of Electro-Plating and Gilding Solutions, 1897, **76**, 199
12 On the Synthesis of Albumin, 1898, **78**, 97
13 The Detection of Arsenic, 1900, **82**, 305

f) Papers read before the British Pharmaceutical Conference

1 Report on the Permanganate of Potassium of Pharmacy, 1871, 564
2 On the examination of Tea for the detection of Adulteration, 1873, 540
3 On the Horsley-Stoddart Method of estimating the Fat of Milk, 1875, 585
4 The Distinctive Tests for Carbolic Acid, Cresylic Acid and Creosote, 1878, 575
5 Notes on Petroleum Spirit or "Benzoline", 1879, 478
6 Further Notes on Petroleum Spirit and Analogous Liquids, 1880, 523
7 Further Notes on Shale and Petroleum Products, 1881, 490
8 The Determination of Ethyl Nitrite and the Change undergone by the Spirit of Nitrous Ether on keeping, 1885, 463
9 The Assay of Amyl Nitrite, 1885, 469
10 Notes on Crude Carbolic Acid and its Substitutes, 1887, 566
11 Vermin-killers containing Strychnine, 1889, 434
12 Suggestions for the Assay of Aconite and its Preparations, 1891, 451
13 Experiments on the Alkaloid of Tea, 1892, 415
14 White Wine Vinegar, 1896, 321
15 Condensed Milk, 1896, 326

These presentations were subsequently published in the Pharmaceutical Year Book

g) Papers read before the Society of Dyers and Colourists

1 On the Assay of Commercial Picric Acid, 1888, **4**, 84
2 On some of the Constituents of Natural Waters with Observations on Lead Corrosion, 1889, **5**, 54
3 Experiences of a Public Analyst, about 1900

These presentations were subsequently published in the Journal of Dyers and Colourists

h) Papers published in the Pharmaceutical Journal and Transactions

1 Analytical Examination of Tinctures, 1878-1879, **9,** 1035
2 The Determination of Ethyl Nitrite in the Spirit of Nitrous Ether and Kindred Preparations, 1884-1885, 673
3 Methyl Orange and other Indicators, 1888-1889, **19**, 903, 1028
4 Note on the Constitution of Certain Antipyretics and Allied Bodies, 1890-1891, **20,** 62

i) Papers published in the Pharmaceutical Journal

1 Alkaloids of the Veratrums (from advanced sheets of Commercial Organic Analysis),

1895, **1**, 242 and 1896, **2**, 146
2 A Proposed New Method of Examining Pepsin, 1897, **5**, 561
3 Notes on Pepsin Assaying (from advanced sheet of Commercial Organic Analysis), 1898, **6**, 416
4 On the Synthesis of Albumin, 1898, **7**, 243
5 Analysis of Opium Containing Preparations, (with GE Scott-Smith), 1902, **15**,524
6 Certain Reactions of the Alkaloids of the Ipecacuanha, (with GE Scott-Smith), 1902, **15**, 552
7 Analytical Examination of Urine, (with AR Tankard), 1904, **19**,8

j) Miscellaneous Papers

1 Neutrality: Proceedings of the Chemist's Assistances Association, London, (reprinted in the Analyst), 1891, **2**, 56
2 The Assay of Commercial Cyanide of Potassium (pamphlet), 1884, Sheffield
3 The Chemistry of Whisky, Journal of the Federated Institute of Brewing, 1897, **106**, 24
4 Lead Poisoning, - a monograph on the subject of poisoning by lead compounds with special reference to the action of drinking water on lead, about 1885, London, J&A Churchill
5 The Examination of Urine for Small Quantities of Sugar, Lancet, 1894, **144**, 212
6 Notes on the Analytical Examination of Urine, (with AR Tankard) Lancet, 1904, **163**, 1720

k) Editions of Commercial Organic Analysis

First Edition, J&A Churchill, London

1 Volume 1, 1879: Cyanides, Alcohols, Neutral Alcoholic Derivatives, Acid Derivatives of Alcohols and Vegetable Acids, Phenols and Acid Derivatives.
2 Volume 2, 1882: Hydrocarbons, Fixed Oils and Fats, Sugars, Starch and its Isomers, Alkaloids, and Organic Bases.

Second Edition, J&A Churchill, London

1 Volume 1, 1885: Alcohols, Neutral Alcoholic Derivatives, Sugars, Starch and its Isomers, Acid Derivatives of Alcohols and Vegetable Acids
2 Volume 2, 1886: Fixed Oils and Fats, Hydrocarbons and Phenols
3 Volume 3, Part1, 1889: Aromatic Acids, Tannins, Dyes
4 Volume 3, Part 2, 1892: (also reprinted 1899 and with Addenda in 1902), Amines and Ammonium Bases, Hydrazines, Tar Bases, Vegetable Alkaloids
5 Volume 3, Part 3, 1896: Vegetable Alkaloids, Non basic Vegetable Bitter Principles, Animal Bases, Animal Acids, Cyanogen
6 Volume 4, 1898: Proteids (including milk), Albuminous Principles (including meat

extracts, blood)

Third Edition, P Blakiston's Son & Co, Philadelphia and J&A Churchill, London

1 Volume 1, 1898: (Revised (partially) and additions by Dr H Leffman), Alcohols, Neutral Alcoholic Derivatives, Sugars, Starch and its Isomers, Vegetable Acids, P Blakiston's Son & Co

2 Volume 2, Part 1, 1899: (Revised by author and Dr. Leffman), Fixed Oils, Fats, Waxes, Glycerol, Nitroglycerin and Nitroglycerin Explosives, P Blakiston's Son & Co

3 Volume 2, Part 2, 1900: (Revised by author and Dr Leffman), Hydrocarbons, Petroleum and Coal-Tar Products, Asphalt, Phenols, and Creosotes, P Blakiston's Son & Co

4 Volume 2, part 3, 1907: (written by the author and AR Tankard), Acid Derivatives of Phenols, Aromatic Acids, Resins and Essential Oils, J&A Churchill

5 Volume 3, part 1, 1901: (revised and edited by Dr J Merritt Matthews), Tannins, Dyes and Colouring Matters, Writing Inks, J&A Churchill

I) Other Books.

1 Milk and Milk Products, 1897, J&A Churchill, London

2 The Chemistry of Urine, A Practical Guide to the Analytical Examination of Diabetic, Albuminous and Gouty Urine, 1895, J&A Churchill, London