Claudia Flavell-While charts the turbulent history of Nicolas Leblanc's soda process

Revolutionary discoveries

ONE of the first chemicals to be produced at industrial scale, a product that laid the foundation for much of the modern chemicals industry, is sodium carbonate, commonly known as soda ash or, simply, soda.

Soda was much in demand as a raw material for soap, glass, dyes and bleaches, and the process turned soda production from nothingness to a major industry with an annual production of 400,000 t/y that laid the foundations of today's alkali industry. Yet the man credited with its development, Frenchman Nicolas Leblanc, never made a profit from the process and, after a series of personal and professional setbacks, eventually committed suicide.

Nicolas Leblanc was born near Orléans in France in 1742. Orphaned by the age of nine, he was raised by a local doctor and ended up studying surgery in Paris. This eventually brought him into the service of Louis Philippe II, the Duke of Orléans , a position that provided Leblanc with both a good income and some spare time, which he spent studying chemistry and crystallisation.

prize in sight

When, in 1783, King Louis XVI, through the French Academy of Science, offered a reward of 2,400 livres for the development of an economically viable process for the manufacture of soda from sea salt, Leblanc was one of the scientist who took up the challenge.

Until then, soap and glass were mainly produced using potash extracted from wood ash, but with wood in huge demand across Europe for shipbuilding, construction, heating etc, this was in short supply.

Working with the Duke's associate, Michel J J Dize, Leblanc began researching the problem in 1784.

developing the process

Early attempts to synthesise soda had all started by heating sea salt – sodium chloride – with a source of sulphur such as sulphuric acid, ferrous sulphide or ferrous sulphate, to produce sodium sulphate (salt cake). However, the process of converting the sodium sulphate to sodium carbonate at an acceptable cost and to reasonable levels of purity remained a problem.

Leblanc also started by mixing sodium chloride with sulphuric acid in a cast-iron pan at 800-900°C. This produces hydrogen chloride and sodium sulphate; the hydrogen chloride was commonly released to the air while the sodium sulphate, a solid, remained in the reactor. It was the second step that was to be the real eye-opener: Leblanc found that adding calcium carbonate (chalk or limestone) to a mixture of crushed sodium sulphate and charcoal and heating it in a reverberatory furnace to 1,000°C made all the difference. This second reaction yields a molten mixture consisting mostly of sodium carbonate and calcium sulphide, along with carbon dioxide, which is emitted to the air. Since sodium carbonate is water-soluble but calcium sulphide isn't, the mixture can be separated in water, after which it is treated with carbon dioxide to remove impurities and finally evaporated, leaving soda crystals behind.

While Leblanc did not fully understand the complex reactions taking place inside the furnace, the result was what he – and the French Academy – had been looking for: it allowed the economically viable production of industrial quantities of sufficiently pure soda from easily obtainable raw materials, ie, sea salt, sulphuric acid, limestone and charcoal.

waste issues

Any chemical engineer will spot the obvious drawbacks of the process: waste and pollution. The process produces 7 t of calcium sulphate-based waste for every 8 t of soda produced, and releases 5.5 t of hydrogen chloride into the atmosphere. This would kill trees, damage buildings and blight the landscape for several miles around. In the UK, which by the second half of the 19th century had built a huge soda industry, pollution from Leblanc sites got so bad that in 1863 the government passed the Alkali Act, one of the country's earliest pieces of air-pollution regulation. The act required a 95% reduction in hydrogen chloride emissions, which companies achieved by passing the emissions through water, converting the hydrogen chloride to hydrochloric acid (which initially was commonly discharged into local waterways, thus replacing air pollution with water pollution).

The problem was solved more agreeably

when, in 1874, Henry Deacon developed the catalytic oxidation of hydrogen oxide to water and chlorine, which, in turn, was much in demand for bleaching paper and textiles.

The solid waste had a much less immediate but considerably longer-lasting impact. The 'black ash,' also known in some regions as galligu, consisted mainly of calcium sulphide as well as sodium sulphide, lime, salt, charcoal and ash, along with traces of sodium carbonate. The waste was deposited in landfill sites near to the early soda factories, but calcium sulphate, in time, reacts with water to produce sulphur dioxide and hydrogen sulphide, so posed a significant health hazard to local residents and gave off a stench of rotten eggs. An alternative disposal method, dumping the calcium sulphide in the ocean, merely displaced the pollution and killed off marine life instead.

scale up, not cash in

However, in the 1790s pollution was much less of a concern than it is today, and Leblanc's process would lay the foundation

for some of the earliest industrial-scale chemical plants in Europe. While it took Leblanc until 1793 to fully scale up the process, he obtained a 15-year patent for the process in 1791. The experts examining his patent reportedly found that "the invention is new and very superior to all that up to now have come to our knowledge as regards to economy, speed and certainty of the method as well as regards to the abundance and purity of the products."

Having obtained a 15-year patent, Philippe provided Leblanc and Dize with 200,000 livres to build a soda plant using the process at Saint Denis, near Paris, though he would not receive the promised prize money because the French Academy of Science had been disbanded following the start of the French Revolution in 1789.

Ordinarily, developing a successful industrial process and owning the first full-scale production plant based on the process would normally be a certain way of getting very rich very fast. Unfortunately for Nicolas Leblanc, he lived in extraordinary times.

revolutionary twists

The first complication arose in 1793, when Leblanc's supplies of sulphuric acid dried up. This was because saltpetre – which, when burnt with sulphur, produces sulphuric acid – was being commandeered by the revolutionary government to produce gunpowder, which was desperately needed to defend the fledgling republic against the advancing royalists.

Leblanc's luck turned from bad to worse in the months and years that followed. The revolutionary government ordered Leblanc to reveal the details of his process. In November 1793, Philippe, who had appeared to embrace the revolution and retitled himself Philippe Égalité, was accused of being a royalist sympathiser and sent to the guillotine. In January 1794 the government seized control of Leblanc's soda factory at Saint Denis, together with Philippe's other assets.

Despite Leblanc's cooperation and patriotism in revealing the details of his patent, the government shut down the Saint Denis plant, though it commissioned several new factories based on Leblanc's process to be built elsewhere in the country. Leblanc and his family, who lived in a house in the factory grounds, were evicted. Neither he nor Dize received any compensation for their soda patent or their share in the Saint Denis plant.

dispirited endings

Thereafter Leblanc struggled to support his family – while he held a number of positions on a variety of government committees during the revolution and in the early days

> "for some 60 years in the middle of the 19th century, the Leblanc process drove the development of the European chemicals industry… and its effects can still be felt today"

of Napoleon's administration, he received no payment for most of them. Leblanc and his family remained in dire financial straits.

Leblanc continued to campaign for the return of the Saint Denis factory, for restoration of his exclusive rights to the process and for the prize money from the French Academy of Sciences. The French government did eventually agree to pay him 3,000 francs for his services to science but Leblanc only ever received 60 francs.

While he was eventually able to persuade Napoleon's government to sign over the Saint Denis soda factory to him, the seven turbulent years that had passed between it being idled in 1794 and its return in 1801 meant that the factory needed significant repairs before it could be returned to service – repairs Leblanc could not afford. Leblanc continued to campaign for restitution and, in 1804, arbitrators awarded him a sum of 52,473 francs as compensation for the assets that had been seized by the revolutionary government. However, the sum fell well short of Leblanc's hopes and expectations, and was nowhere near sufficient for him to restart his factory.

Depressed and withdrawn, Leblanc shot himself in the head in 1806.

His process lived on, however: by 1818, France was producing 10,000-15,000 t/y of soda; in the UK, James Muspratt and Charles Tennant built huge soda works near Liverpool and Glasgow and British soda production soon dwarfed France's, eventually reaching more than 200,000 t/y before it was made obsolete by the more environmentally friendly Solvay process. For some 60 years in the middle of the 19th century, the Leblanc process drove the development of the European chemicals industry… and its effects can still be felt today. **tce**

Next month: **Victor Mills,** the Procter & Gamble engineer without whom Pampers and Pringles would never have happened