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Ernest Gaston Joseph Solvay, a prestigious example of a scientific entrepreneur or *labor omnia vincit improbus*

Ernest Gaston Joseph Solvay, a Belgian chemist, scientist, industrialist, philanthropist, humanist, socialist, democrat and liberal in his heart, was the founder of the Solvay Company. Solvay is best known for his development of a commercially viable ammonia-soda process for producing soda ash (sodium carbonate), which is widely used in the manufacture of such products as glass and soap. He kept his position as a world leader in the production of soda ash. Solvay solved the practical problems of conducting the ammonia–soda process on a large scale, unaware that many chemists had tried and failed to do this over the past fifty years. All his life, he was a supporter of industrial, social, economic, and scientific progress. Solvay adapted to an ever-changing world for more than a century and a half. This world had to reinvent itself many times, always building on a strong heritage of social responsibility, technical excellence and a family character.

This year, the French Academy of Science is celebrating its 350th anniversary, which is the perfect occasion to remember Solvay, as he was also a member of the French Academy of Sciences.

The life of Ernest Gaston Joseph Solvay: as sacrifice, as modesty

"A well is nice if you share", Seneca

Solvay was born with the birth of the telegraph, when Samuel Morse demonstrated the operation of his telegraphic code, and with the Atlantic crossing by a steamship, the Great Western, which left Bristol to reach New York. Solvay was born on 16 April 1838 in Rebecq-Rognon in Walloon Brabant, near Brussels, Belgium, to a family of industrial chemists. In 1854, Solvay was seriously ill with a severe pleurisy and was forced to abandon his secondary education in Malonne for these health reasons. Solvay did not have the opportunity to attend university. From an early age, he demonstrated a passion for physics, chemistry and natural history. Taking into account his passion for chemistry, he was instructed in 1859 by his uncle, director of the gas works of Saint-Josse-ten-Node, to study the treatment of ammonia water, a byproduct of the manufacture of some gases.

Intelligenti pauca…

After being previously introduced to salt by his father, Ernest thereby met ammonia, the second of the two pillars of his life as an inventor. His uncle was also responsible for the development of coke ovens and CO_2 generators. Solvay imagined collecting ammonia gas and carbon dioxide in salt water. He observed that upon shaking the liquid, it thickened, and a precipitation reaction took place: the white precipitate was sodium hydrogen carbonate or bicarbonate. This bicarbonate turns into sodium carbonate after heating to 270 °C; it is this compound that is called "soda" in the industry parlance. The Solvay process is based on the low solubility of $NaHCO_3$ in an ammonia solution (basic), and its success is because the used ammonia gas can be recovered, and all operations can be carried out continuously. On April 15, 1861, Solvay filed his first patent, titled *Industrial manufacture of soda ash using sea salt, ammonia and carbon dioxide*. Solvay believed his finding was innovative, but the artificial production of soda from sea salt had already been discovered by Nicolas Leblanc, in 1783, shortly before the French Revolution. However, political circumstances had not allowed Leblanc to industrialize the process. The process was energy-intensive, costly and caused pollution through its release of hydrochloric acid and difficult-to-upgrade sulfides. In 1811, Augustin Fresnel made the same discovery as Solvay. At the Polytechnic of Paris, Fresnel mixed NaCl and NH_4HCO_3 and obtained a precipitate of NH_4Cl and $NaHCO_3$. The simplicity of the process seduced many people, including the English H.G. Dyar and J. Hemming in 1838 and the French industrialists Schloesing and Rolland in 1854; however, in the face of

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the difficulties of large-scale industrialization and a lack of money, most inventors became discouraged. Solvay solved the practical problems of conducting the ammonia-soda process on a large scale, unaware that many chemists had tried and failed to achieve this over the past fifty years. He devised carbonating towers, which allowed large amounts of ammonia, salt solution, and carbon dioxide to be mixed; his process also allowed the recovery of expensive ammonia, which could then be reused.

Audaces fortuna juvat…

Despite several difficulties, the Solvay brothers decided to found the company Solvay & Cie in 1863 with the support of several family members and friends. *Per aspera ad astra!* That same year, Solvay's second patent gave a description of each unit, each piece of equipment needed to prepare soda. Since 1865, the date of the startup of the plant, a continuous fight was initiated that was dedicated to the constant improvement of equipment and the resolution of a series of difficulties inherent in any new industry. Initially, Solvay used a series of absorbers and horizontal rolls, arranged in a cascade to slowly reacting the salt water, ammoniac and carbon dioxide. In 1869, Solvay began pursuing the idea of towers made of superimposed cylinders. Carbon dioxide was injected at the base at a pressure of several atmospheres, while the ammoniacal brine dripped from above. The famous “Solvay vertical column” guaranteed the company's success for decades to come. Since 1869, the Solvay process proved its economic superiority over the Leblanc process. Solvay, without a university degree, was truly a pioneer of Chemical Engineering. In 1874, Solvay & Cie began to create a network of European soda ash plants located close to salt deposits, and the first plant was located at Dombasle-sur-Meurthe in French Lorraine. In 1888, when the company was celebrating its twenty-fifth birthday, it already had a soda works network in major industrialized countries. After the death of his brother in Cannes on 23 January 1894, Solvay somewhat disconnected from Solvay & Cie to turn to the civil community as a generous patron and philanthropist. Although he had become one of the biggest manufacturers in the world, Solvay lost neither the simplicity of his beginnings nor his incredible intellectual activity. Despite amassing a large fortune, he never attached an exaggerated value to money but regarded it as a means of action.

Beati possidentes…

Solvay, self-taught, was a scholar and a theorist: his concerns ranged from chemistry and physics to sociology and economics, through physiology and even political management. Henri Van Laer, president of the Chemical Society of Belgium, offered the Jean Stas medal, engraved in 1897 by Fernand Dubois, one of the most renowned Brussels medalists, to Solvay.

Nobility of mind…

Solvay was very interested in the IUPAC and the IACS; he made an important donation of money for the organization of the reception in honor of the members of the Council of IACS. Solvay also donated a significant amount of money to IACS, and it was decided that its meetings would be held every two years in Brussels. Solvay himself was a protector of the Chemical Society of Belgium. In September 1919, he promised the Chemical Company interest-bearing capital, which was returned to him by the AICS at its dissolution. On the death of J.S. Stas, the heirs offered his laboratory, a library and personal memories to the Belgian State, but the government refused this offer. It was Solvay who, upon the proposal of Professor ULB Paul Heger (1846–1925), bought the collection and confided it to the Solvay Institute of Physiology, Leopold Park, in Brussels in 1893.

Moral elegance is not a question of money, but rather self-confidence, and it comes with education…

Solvay founded various institutes: the Institute of Physiology (1893); the Institute of Social Sciences (1899), which was extended by the Institute of Sociology (1902); and the Institute of Trade (1903). There was also another scientific institute, the Institute of Hygiene, Bacteriology and Therapeutics (1894), founded by Alfred Solvay, brother of Ernest Solvay. To promote research and exchange of knowledge, Solvay finally founded the International Institute of Physics and Chemistry, which organized gatherings, including triennial international scientific meetings.

Ernest Solvay died on 26 May 1922, exactly one month after the first Chemistry Council. His contribution to his company and its impressive industrial and social heritage remain, to this day, an important example for all generations. Solvay's company has been developed into an international network of factories, close to salt deposits and consumer markets, while constantly improving the production process. With 24 manufacturing facilities worldwide, Solvay was, on the eve of the First World War, an undisputed industry leader. Solvay provided only his reason for living. Solvay was also concerned with social issues. He developed his reflections on the conditions for more equal opportunities for all through education and state intervention in the economy, social security and labor exchanges. At the forefront of social progress, his company was the first to provide sickness benefits for its workers (1878), to extend the 8-h day (1907), to create a pension fund and to offer paid leave with double salary (1913), while Belgium did not require such. True to a paternalistic concept of management, he spared neither time nor money to improve the living conditions of his personnel: cooperatives, housing, schools, training centers, a library, a hospital, and recreation organization — everything was made available.

The personal life and professional life of Solvay can be compared to the musical life of Beethoven. How liberal was Beethoven in his orchestration! Each instrument was requested to give its opinion, just like Solvay! What a liberal scientific entrepreneur was Solvay! In this case, the main idea in the opera of Beethoven was various original versions or spirit manifestations: sublime, sadness, and joy, but in harmony. For example, the *Appasionata* of Beethoven contains a melody that repeats many times like a rational moral principle, which Beethoven repeated to calm the