Origins of the Modern Chemical Industry

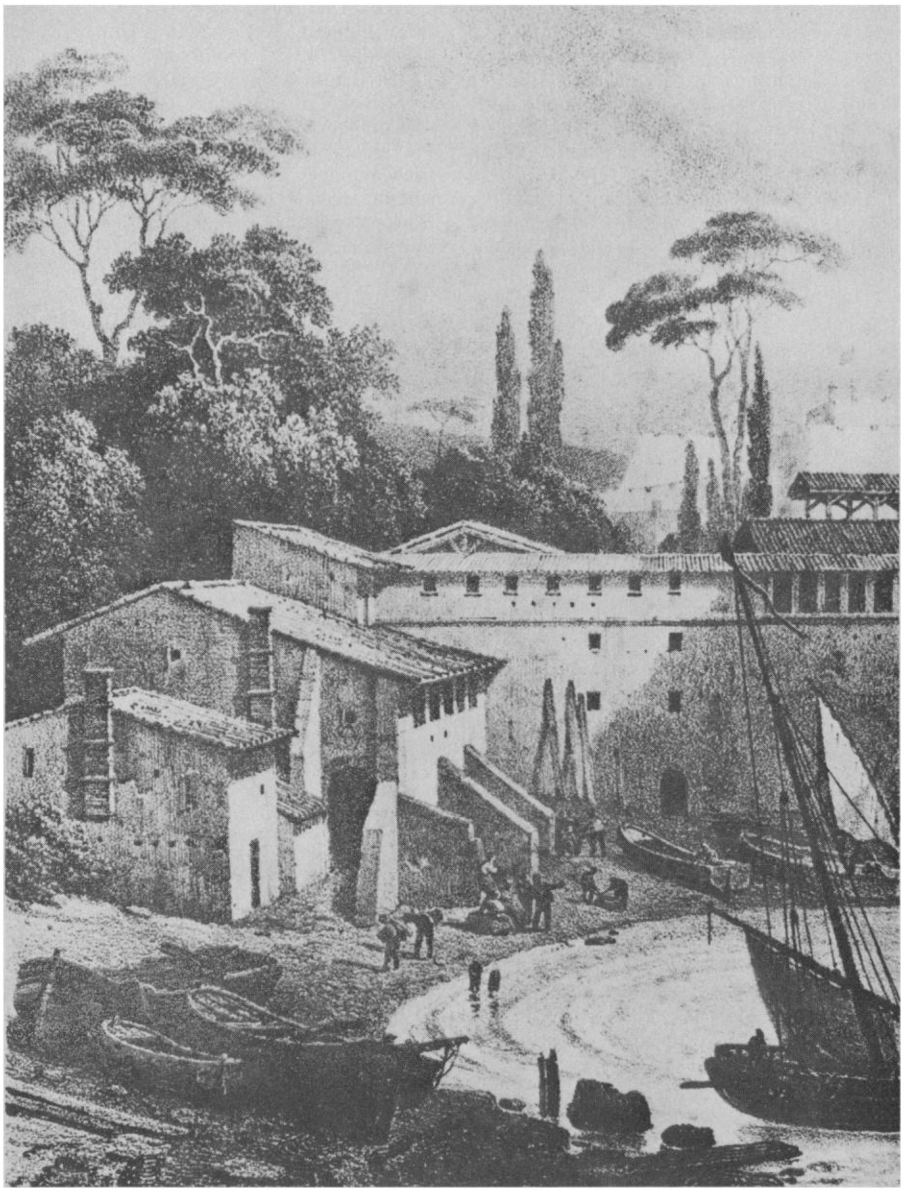
The Origins and Early Development of the Heavy Chemical Industry in France. JOHN GRAHAM SMITH. Clarendon (Oxford University Press), New York, 1979. xiv, 370 pp., illus., + plates. $98.

This work makes an important contribution to the history of technology. It lends substance to the assertion that the Industrial Revolution owes as much to advances in chemical technology as it does to mechanical inventions. It locates the center of innovative chemical manufacture in France and links the mass production of heavy chemicals that emerged between 1770 and 1820 to the revolutionary progress of chemical science in the generation of Lavoisier.

But though the connections between science and technology in that era appear more obvious in the chemical industry than in the mechanical arts, they defy easy generalization. At any rate, the author makes no generalizations on this or any of the other major topics he discusses. Neither does he venture an explanation of why he eschews interpretation. His book has no overt thesis. But it provides future analysts of the origins of the modern chemical industry with new perspectives and much fresh information based on exhaustive research, often in remote archives.

Specifically, this monographic study focuses on the commercial synthesis of sulfuric acid, chlorine bleach, and soda, the main commodities of 19th-century chemical processing. In 1750, only soda (sodium carbonate) was used in appreciable quantity. Soda was indispensable for making glass, but since it was more expensive than potash (potassium carbonate) the latter served as the main industrial alkali. Soda was then made from the ashes of the barilla plant, which grew on Spain's Mediterranean coast, whereas potash was leached out of much more common wood ashes. Until 1760, French consumption of sulfuric acid was minor and the French relied on imports from Great Britain, where the lead chamber process was just being introduced. Nitric acid was the main commercial acid of the time, but it was expensive. Chlorine was not recognized as a commercial bleaching agent until 1785, by Claude Louis Berthollet. Before that, linen, hemp, and cotton textiles were laboriously bleached by alternate boiling in lye (bucking) and exposure to sunlight.

By 1810, at the height of Napoleon's empire, dramatic changes had occurred in the commercial use of inorganic chemicals. Chlorine, soda, and sulfuric acid, together with their derivatives (alkali bleach in solution and powder, lye, and alum) were now being produced by the ton according to recently discovered syntheses and processing techniques. They found ready markets in the rapidly growing industries of the period: cotton, beet sugar, lamp oil, iron, paper. Moreover, production of these heavy chemicals often occurred in cleverly integrated factories in which the by-products of one process served as reagents



"An early soda works near Marseilles. Lithograph by Deroy depicting a factory at les Goudes. In the background can be seen the fort of Mont Rose. The date of the print is not known but we would guess it to have been produced towards the mid-nineteenth century. The factory at les Goudes seems to have been established between 1828 and 1837. . . . At the end of the 1830s it was a works of moderate size, producing 2.4 million kg of soda a year." [Coll. Musée du Vieux-Marseille, Ancien fond; reproduced in *The Origins and Early Development of the Heavy Chemical Industry in France*] for another. For example, in the process discovered by Nicolas Leblanc for making soda, sea salt was made to react with sulfuric acid, yielding sodium sulfate and hydrochloric acid. The sodium sulfate was then changed to sodium carbonate by treatment in a furnace with coke and calcium carbonate. The hydrochloric acid could be dissolved in water and sold as such, or it could be oxidized to chlorine by reaction with manganese dioxide.

Processing and finding of uses for hydrochloric acid were often motivated by the undesirability of venting it into the atmosphere. Smith documents several instances in which local French officials forced a factory to stop polluting or move to a site away from population centers.

Environmental problems were just one of many factors that determined the success or failure of the first chemical factories. As Smith chronicles the fate of these enterprises, one cannot escape noticing their high rate of failure and the restless flux of partnerships, relocations, processes, and products that characterized the industry. Tempestuous political conditions only added to the instability, but a more fundamental destabilizer was the revolutionary growth of chemical science. The variety of known reactions was such that late-18th-century entrepreneurs seeking to manufacture soda had four major processes, each with variations, from which to choose. Only after two decades of hard-earned experience could Leblanc's method be declared the clear winner.

Progress made since Lavoisier in quantifying chemical studies enabled manufacturers to figure the maximum theoretical yield and thereby measure how much further they could go in improving the efficiency of their operations. Among sulfuric acid makers, the quest for higher yields was retarded until the quantitative studies made in 1806 by Nicolas Clément and Charles-Bernard Desormes, who showed that the oxidation of sulfur proceeds first to sulfur dioxide and then to the trioxide provided nitrogen oxide gases, usually released from saltpeter, were present. Theirs was the first catalytic explanation in modern chemistry. It led Gay Lussac to invent a procedure recycling the nitrogen oxide gases, a considerable cost advantage. Meanwhile, further savings were realized by a whole series of clever innovations that made it possible for sulfuric acid to be made by a continuous-flow process. This technical triumph foreshadowed the abandonment by the chemical industry of batch processing wherever possible.

Though Smith is quick to point out trend-setting advances, he is careful not to distort their character and importance within the historic setting in which they occurred. For instance, in his study of bleaching operations he shows precisely how limited were the changes made in the traditional process when treatment with chlorine came to be substituted for exposure to sunlight.

Smith is at his best in describing old processes and the modes of thought that underlay them. He is also good at explaining what is going on in terms of modern chemistry. Though I regret his timidity in reaching general conclusions and in linking his findings to the broader currents of political and business history, his book must rank as an outstanding contribution to the history of chemical technology.

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Alternative Energy Sources

Progress in Biomass Conversion. Vol. 1. KYOSTI V. SARKANEN and DAVID A. TILLMAN, Eds. Academic Press, New York, 1979. xii, 260 pp. $16.50.

Although biomass in general and wood in particular have been vigorously advocated as viable and appropriate alternative sources of energy and chemicals since the advent of the oil embargo of 1973–1974, this advocacy has been based on the virtues of biomass as an available, renewable, and environmentally compatible resource, more in line with traditional applications and processes than with modern technology and prevailing economic systems.

The foreword and preface of this volume naturally reflect the general enthusiasm about the long-range potential of biomass. The subsequent chapters, however, get down to the business of describing precisely not only how biomass could replace petroleum and natural gas through different processes and under different circumstances, but also at what price and to what extent. The descriptions are thorough and comprehensive, often providing comparison with alternative resources, including coal and petroleum, and taking into consideration such problems as corrosion and erosion.

The question of how additional fuel could be obtained from forest industry or silvicultural energy farms, with related technical details and economics, is discussed in separate chapters by R. L. Jamison and Jean-Francois Henry. A truly critical assessment of methanol production from wood is presented by R. M. Rowell and A. E. Hokanson. James G. Abert and Harvey Alter have surveyed practices for recovery of energy from municipal waste in the United States and Europe. Some of the efforts to update old, destructive distillation methods by using a vertical bed reactor are described by J. A. Knight, and the fuel values of wood residues are analyzed by Tillman.

These papers provide a valuable demonstration of how technical feasibility can be distinct from economic viability and how changes in one can affect the other. A case in point is the utilization of forest residuals as fuel, which is becoming more and more attractive economically as prices of petroleum increase and as combustion technology develops. However, it is interesting to note that tax incentives and lowering of institutional barriers (governmental regulations) are recommended as a more effective short-term approach to increasing economic viability than technological developments, on the grounds that the latter have already made energy systems more complex and costly. Whether or not this approach can be justified, the technical complexity of the proposed energy systems and the costs and problems involved are defined well and presented clearly. Consequently, the volume provides a source of authoritative and specific information for all those who are concerned with energy, economy, and biomass utilization.

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Latimeria

The Biology and Physiology of the Living Coelacanth. Papers from a symposium, June 1977. JOHN E. MCCOSKER and MICHAEL D. LAGIOS, Eds. California Academy of Sciences, San Francisco, 1979. vi, 176 pp., illus. Paper, $10. Occasional Papers of the California Academy of Sciences, No. 134.

This volume contains the supplemented proceedings of a AAAS symposium. Included are an introduction by the editors and 11 papers on various aspects of the living coelacanth (*Latimeria*), ranging from natural history through anatomy to physiology and biochemistry. Featured in addition are historical accounts by M. Courtenay-Latimer, who found the first specimen and