

The Origin of the Soxhlet Extractor

William B. Jensen

Department of Chemistry, University of Cincinnati
Cincinnati, OH 45221-0172

Question

What is the origin of the Soxhlet extractor?

John Andraos
Department of Chemistry
York University
Toronto, ON M3J 1P3
CANADA

Answer

The well known Soxhlet laboratory extractor was first proposed in 1879 in the course of a paper dealing with the determination of milk fat by the German agricultural chemist, Franz Ritter von Soxhlet (figure 1) (1). Just as there is some ambiguity over the relative contributions of Bunsen versus his machinist, Peter Desaga, with regard to the invention of the Bunsen burner (2), so there is also ambiguity over the invention of the extractor, as in his paper Soxhlet credited its most characteristic feature (figure 2) - the use of constant level siphon to return the extract to the solvent flask after the completion of a given extraction cycle - to one of his staff members, a "Herr Szombathy" (presumably the laboratory glassblower), though he hastened to qualify this attribution by noting that both the optimization of extractor's dimensions and the proper conditions for its use were the result of his own laboratory studies.

The practice of solid-liquid extraction is as old as recorded history, its most common everyday uses being in the preparation of teas and perfumes. Thus, many years ago, Levey described what is thought to be the remains of a Mesopotamian hot-water extractor for organic matter dating from approximately 3500 BC (3). By the mid-19th-century a variety of terms were being used to describe various versions of this process, including maceration, infusion, decoction, lixiviation and displacement. As summarized by Morfit in 1849, the later two processes involved packing the organic matter to be extracted in either a tall cylinder or cone known as a percolator (4). This was then filled with the hot solvent (usually either alcohol or ether) which was allowed to slowly percolate through the organic matter



Figure 1. Franz Ritter von Soxhlet (1848-1926).

and to drain out an opening in the bottom, where it was collected in a flask or beaker. This process was repeated several times using fresh quantities of solvent and the combined extracts then evaporated to recover the extracted matter.

The idea of automating this process was not original to Soxhlet. Already in the 1830s the French chemist, Anselme Payen (1795-1871), had introduced a continuous extractor in which the vapor from the boiling solvent was conducted by means of a side tube to a condensing bulb (reflux condensers were not introduced until later) mounted on top of the percolation column. After passing through the organic matter in the column, the condensed solvent drained directly into the solvent flask from which it was once more evaporated for another pass through the percolator (5). Indeed,

strictly speaking, the Mesopotamian extractor described by Levey, though very crude and inefficient, was also continuous as it recirculated the hot water for repeated passes through the organic matter. Though the Soxhlet extractor is also often described as being continuous, this is inaccurate and it is better characterized as an automated batch extractor, since the extract does not continuously drain into the solvent flask, as in Payen's apparatus, but rather drains only after it has reached the critical volume determined by the height of the siphon.

Soxhlet's motivation for introducing this innovation was apparently to quantify the extraction process with the intent of using it to quantitatively determine the fat content of organic matter, and his paper contains tables listing the number of extraction cycles for each sample. Even if this feature is not of interest, the Soxhlet extractor still has the advantage of being more efficient than a continuous extractor, since in the latter there is tendency for the condensed solvent to create a channel of least resistance on passing through the organic matter, thus exposing only a fraction of it to the extraction process and then only for a very limited period of contact, whereas in the former not only does each cycle completely surround the organic matter with condensed solvent, it also prolongs the period of contact.

Though chemists would continue to propose new types of extractors long after Soxhlet, his apparatus soon came to dominate laboratory practice. Thus the 1912 catalog of Eimer and Amend, the major American supplier of laboratory apparatus in the late 19th and early 20th centuries, listed 27 different types of extractors of which seven, or nearly a fourth, were variations of Soxhlet's original design and named after him (6). By the end of the 19th century, Soxhlet's apparatus had also inspired an number of attempts to develop similar automated extractors for liquid-liquid extraction (7).

Literature Cited

1. F. Soxhlet, "Die gewichtsanalytische Bestimmung des Milchfettes," *Dingler's Polytechnisches Journal*, **1879**, 232, 461-465.
2. W. B. Jensen, "The Origin of the Bunsen Burner," *J. Chem. Educ.*, **2005**, 82, 518.
3. M. Levey, *Chemistry and Technology in Ancient Mesopotamia*, Elsevier: Amsterdam, 1959, pp. 33-34.
4. C. Morfit, *Chemical and Pharmaceutical Manipulations*, Lindsay and Blakiston: Philadelphia, PA, 1849, pp. 313-322.
5. For an illustration of Payen's extractor, as well other contemporary percolators, see J. J. Griffin, *Chemical Handi-*

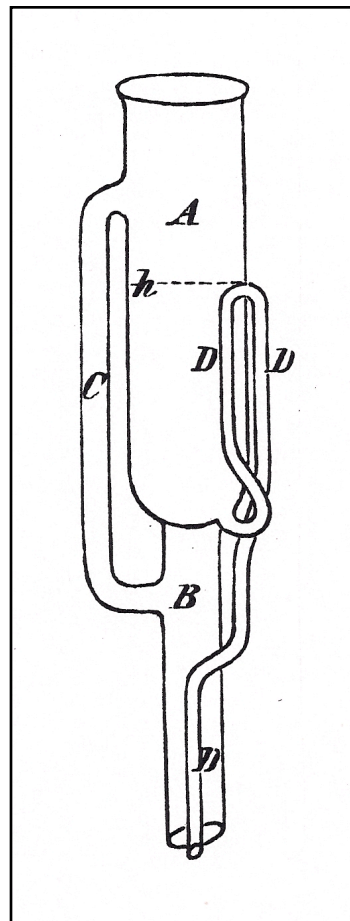


Figure 2. Soxhlet's original illustration of his automated batch extractor with its characteristic constant-level siphon (D) (1).

craft: A Classified and Descriptive Catalogue of Chemical Apparatus, Griffin & Sons: London, 1877, pp. 169-173, item 1659.

6. *Illustrated Catalogue of Chemical Apparatus, Assay Goods, and Laboratory Supplies*, Eimer & Amend: New York, NY, 1912, pp. 157-161.

7. See the descriptions in R. Kemp, "Allgemeine chemische Laboratoriumstechnik," in E. Abderhalden, Ed., *Handbuch der Biochemischen Arbeitsmethoden*, Vol. 1, Urban and Schwarzenberg: Berlin, 1910, pp. 178-185.

Do you have a question about the historical origins of a symbol, name, concept or experimental procedure used in your teaching? Address them to Dr. William B. Jensen, Oesper Collections in the History of Chemistry, Department of Chemistry, University of Cincinnati, Cincinnati, OH 45221-0172 or e-mail them to jensenwb@ucmail.uc.edu