Notes from the Oesper Collections

A Snappy Retort

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Perhaps no single piece of laboratory apparatus is more intimately associated in popular culture with the practice of chemistry than is the retort. Virtually every modern-day artistic depiction of an alchemist, such as the example by the popular early 20th-century illustrator, N. C. Wyeth, shown in figure 1, will feature a retort as the centerpiece of the alchemist's laboratory. As shown in figures 2 and 3, the retort is also featured on the current merit badge for chemistry offered by the Boy Scouts of America, as well as on the current insignia for the Chemical Corps of the United States Army.

Figure 1. "The Philosopher's Stone" by N. C. Wyeth featuring a large retort as the focus of the alchemist's activities.

Origins

Retorts first appeared in the literature dealing with distillation sometime in the 14th or 15th century, possibly in connection with the earlier discovery of the three fundamental mineral acids (sulfuric, nitric, and hydrochloric). Unlike the traditional alembic, used in distillation since the 2nd century AD, in which the still head had to be luted to the distillation pot or cucurbit using a mixture of clay and egg white, the continuous all-glass transition between the body of the retort and its neck or beak eliminated the possibility of leaks when dealing with corrosive acids and other materials (1).

Figure 2. Current merit badge for chemistry offered by the Boys Scouts of America.

An early illustration of a retort, taken from the 1512 printing of Hieronymus Brunschwigk's famous *Liber de arte distillandi de composita*, is shown in figure 4 (2) and its continued importance to laboratory practice well into the late 19th century is illustrated by the etching in figure 5 which shows the chemical laboratory of the Surrey Institution of Great Britain, circa 1810. As may be seen, vast arrays of retorts are hanging from racks arranged just below the ceiling line (3).

The name retort comes from the Latin *retortus*, meaning "to twist back." We use the term in everyday speech to refer to a clever reply or snappy retort to a snide comment. With regard to the chemical apparatus of the same name, it probably refers to the fact that it is made by twisting or turning back the extended neck of a round bottom flask (called an "ostrich" or mattras during the Renaissance) onto its round body (1).

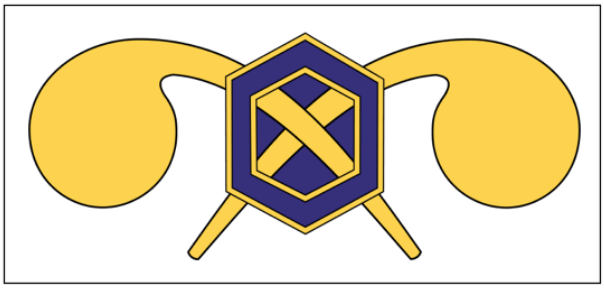

Figure 3. Current insignia for the United States Army Chemical Corps.

Figure 4. An early woodcut of a retort from the 1512 edition of Brunschwigk's famous book on distillation.

Varieties and Aesthetics

In all of the retorts shown in figures 1-5 there is a continuous unbroken transition between the body and the beak. However, by the 18th century improvements in glass blowing techniques had resulted in an optional form in which a small opening was inserted in the neck of the retort just at the point where it began to curve into the beak in order to facilitate its "charging" or filling with the necessary starting materials, as well as the subsequent removal of any reaction residues. Retorts of this sort are said to be "tubulated" in order to distinguish them from the original variety and some examples are shown in figures 6, 7, 9, and 12-14.

Likewise, the body or ball of the retort could vary from being perfectly spherical (figure 10) to having a definite egg shape (figure 11, bottom), and Thomas Thomson, in his well-known *History of Chemistry*, records that his former teacher – the 18th-century Scottish chemist, Joseph Black – was actually a connoisseur of well-shaped retorts (4):

Figure indeed, of every kind, attracted his attention; in architecture, furniture, ornament of every sort, it was never a matter of indifference to him. Even a retort, or a crucible, was to his eye an example of beauty or deformity.

In other words, metaphorically speaking, Black knew the difference between a snappy retort and one that was merely adequate.

Retorts may range in size from large industrial versions, such as those used in coking, to the much smaller versions used in the typical chemical laboratory, and the latter may be made of a variety of materials, including metal, earthenware, and porcelain (figure

Figure 5. The laboratory of the Surrey Institution of Great Britain, c. 1810. Note the arrays of large retorts hanging from racks just below the ceiling line.

Figure 6. An array of tubulated retorts (Jensen-Thomas Apparatus Collection).

8), though by far the most common choice is glass. However, before the introduction of borosilicate glass in the early decades of the 20th century (of which Pyrex is the most successful brand) most glass laboratory apparatus subject to heating had a limited life span. The relatively soft glass was often colored brown or green due to contamination with iron, was easily corroded by strong alkalis, and often broke on heating due to the differential expansion of the unequally heated inner and outer walls. By the mid-19th century attempts to correct the latter problem had led to the introduction of glassware made of hard lime-glass or "Bohemian" glass having paper-thin walls. Though this innovation made survival on heating more likely, it also made the glassware mechanically fragile (4).

These limitations meant that pre-Pyrex retorts had very short life-spans and, as a consequence, it was necessary to have a continuous and ready source of re-

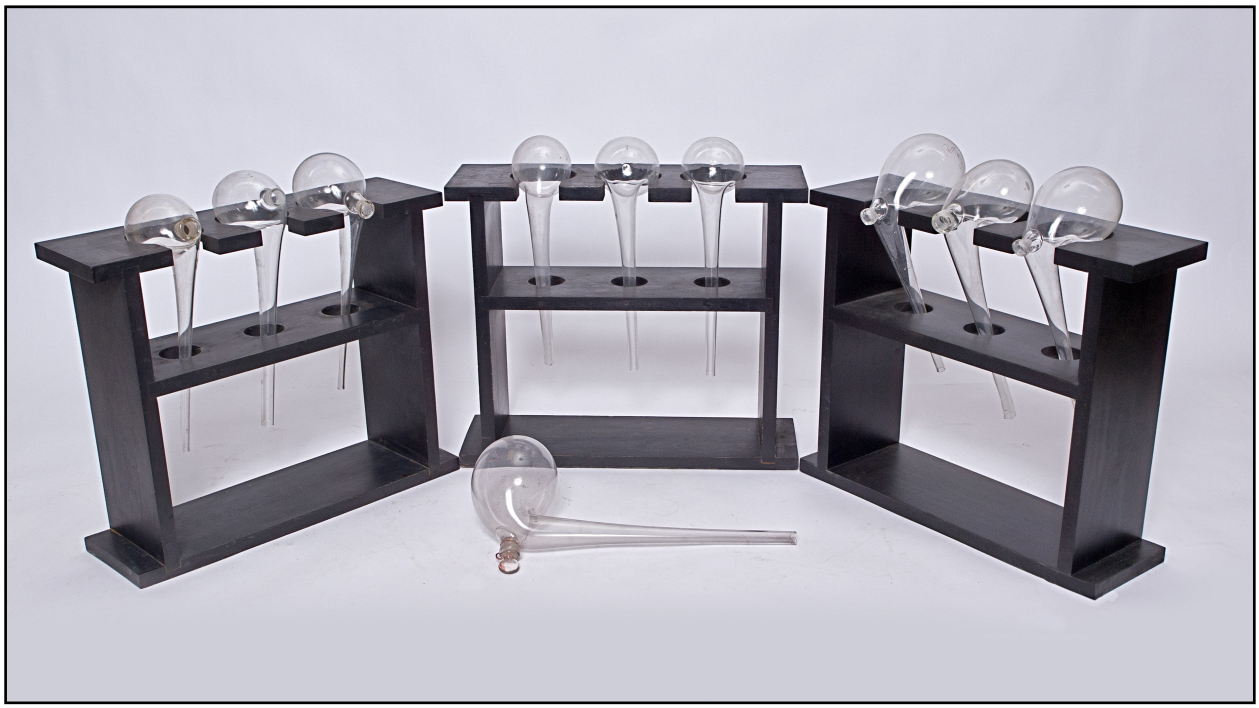

Figure 7. Storage racks of both tubulated and plain retorts (Jensen-Thomas Apparatus Collection).

placements. This presented problems for early professors of chemistry in the United States, as recounted by Benjamin Silliman, who had been appointed as the first professor of chemistry at Yale in 1804, when he attempted to circumvent the inconvenience of ordering a fresh supply from Philadelphia by engaging a local Hartford glassblower instead (5):

At the time there were very few chemical instruments of glass in this country. I had picked up a few glass retorts in Philadelphia, and I made an application to Mr. Mather, a manufacturer of glass in East Hartford, a few years later, to make some for me. On stating my

Figure 8. Examples of iron and porcelain laboratory-scale retorts. The detachable beak of the porcelain retort is missing (Jensen-Thomas Apparatus Collection).

wish, he said he had never seen a retort, but if I would send him one as a pattern, he did not doubt he could make them. I had a retort the neck or tube of which was broken off near the ball – but as no portion was missing, and the two parts exactly fitted each other, I sent this retort and its neck in a box, never dreaming that there could be any blunder. In due time, however, my dozen of green retorts, of East Hartford manufacture, arrived carefully boxed and all sound, except that they were all cracked off in the neck exactly where the pattern was fractured: and the broken neck and ball lay in state like decapitated kings in their coffins. This more than Chinese imitation affords a curious illustration of the state of the manufacture of chemical glass at that time in this country, or rather in Connecticut; the same blunder would probably not have been made in Philadelphia or Boston.

Oesper Holdings

The Jensen-Thomas Apparatus Collection contains roughly two-dozen glass retorts (figure 6-7) ranging in size from

Figure 9. Range of glass retort sizes illustrated using a 1.5 L, c. 1860, lime-glass, tubulated retort and tubulated receiver and a 25 mL, c. 1900, soft glass, plain retort with a plain receiver (Jensen-Thomas Apparatus Collection).

1.5 L to 50 mL (figure 9) and in age from roughly 1860 (lime glass) to 1960 (Pyrex). In addition, it contains several reproductions of typical 18th-century examples. Thus figure 10 shows a reproduction of an 18th-century retort, pneumatic trough, and charcoal furnace similar to those used by Lavoisier; whereas figure 11 shows a reproduction of an 18th-century, brown-glass retort with luting, quilled receiver, and charcoal furnace; and a reproduction of an 18th-century tubulated retort, gas bladder, and charcoal furnace similar to those used by Scheele.

Figure 10. Reproduction of an 18th-century retort, pneumatic trough, and charcoal furnace similar to those used by Lavoisier (Jensen-Thomas Apparatus Collection).

Figure 11. *Top:* Reproduction of an 18th-century, brown-glass retort with luting, quilled receiver, and charcoal furnace. *Bottom:* Reproduction of an 18th-century tubulated retort, gas bladder, and charcoal furnace similar to those used by Scheele (Jensen-Thomas Apparatus Collection).

Retort Accessories

In addition to the retorts themselves, the Jensen-Thomas Apparatus Collection also contains a variety of retort accessories, including gas bladders (figure 11), beak adapters (figure 12), and both quilled (figures 11-13) and tubulated (figures 9 and 14) retort receivers.

Figure 12. Medium retort with adapter and quilled receiver (Jensen-Thomas Apparatus Collection).

End of an Era

Ironically, despite its continued use as a symbol for the practice of chemistry, the retort had already begun to disappear from day-to-day laboratory practice by the early decades of the 20th-century, displaced by the countercurrent condenser and distillation flask, on the one hand, and by heatable modular gas generators made of flasks, corks, thistle tubes, and right-angle glass bends, on the other. By the time the author entered graduate school in 1970, its only use was in the introductory laboratory for the preparation of nitric acid and, within a decade, even that experiment was gone for good. Whereas the 1912 catalog for the American firm of Eimer and Amend listed more than 54 varieties of retorts for sale (7), the most recent online catalog for Fisher Scientific lists none (8).

Figure 13. Large retort with an alternative orientation for a quilled receiver fitted with a safety tube (Jensen-Thomas Apparatus Collection).

References and Notes

1. W. B. Jensen, *Philosophers of Fire: A Survey of 600 Years of Chemical History for Students of Chemistry,* Oesper Collections: University of Cincinnati, Cincinnati OH, 2003, Chapter 1.

2. H. Brunschwigk, *Liber de arte distillandi de compositа*, Zentralantiquariat: Leipzig, 1972. Photoreproduction of the 1512 German edition.

3. S. Parkes, *The Chemical Catechism*, 4th ed., Parkes:

London, 1810.

4. W. B. Jensen, "The Origin of Pyrex," *J. Chem. Educ.*, **2006**, *83*, 692-693.

5. T. Thomson, *The History of Chemistry*, Vol. 1., Colburn & Bentley: London, 1830, p. 332.

6. F. Fischer, *Life of Benjamin Silliman*, Vol. 1, Scribner: New York, NY, 1866, pp. 126-127.

7. Eimer & Amend, *Chemical Apparatus, Assay Goods, and Laboratory Supplies*, New York, NY, 1914, pp. 326-327.

8. *Fisher Scientific Catalog On Line*.

Figure 14. Examples of tubulated retort receivers of varying sizes and ages (Jensen-Thomas Apparatus Collection).