Notes from the Oesper Collections

The Chemical Uses of Clay Tobacco Pipes

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Among the hundreds of items in the Oesper Apparatus Collections is a small selection of clay tobacco pipes (figure 1). This particular style of pipe, in both its short- and long-stem variations, dates back at least to the late 16th century and is most often associated with the countries of Northern Europe and Great Britain. Less well-known is the fact that this simple common everyday object was often employed by chemists, from the late 18th century through the first half of the 20th century, as an inexpensive substitute for more elaborate and expensive chemical apparatus – whence its presence in the Oesper Collections.

One use of such pipes in the chemical laboratory was as a substitute for more expensive crucibles when carrying out high-temperature reactions. An example dating from 1947 is shown in figure 2, where the pipe is used as a vessel for the high-temperature electrolysis of molten salts, such as potassium hydroxide (2):

$$\text{electricity} + 4K(OH)(l) \rightarrow 4K(l) + 2H_2O(g) + O_2(g)$$

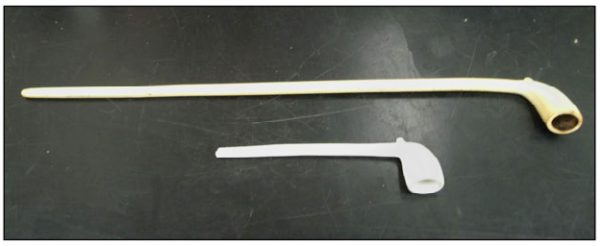

Figure 1. Typical examples of clay tobacco pipes found in the Oesper Collections.

A second example is shown in figure 3, which dates from 1928 and shows the destructive distillation of coal to produce coal gas – a complex mixture of methane, carbon monoxide and other hydrocarbons which was used in gas lamps and gas stoves throughout the 19th and early 20th centuries. In this experiment the bowl of the pipe has been sealed using a clay plug and the pipe functions as a substitute for a special form of crucible known as a Rose crucible.

Yet a third example, dating from 1925, is shown in figure 4, this time involving a long-stem rather than a short-stem version of the pipe (4). Here the pipe-stem is acting as a substitute for a ceramic combustion tube and is being used to effect the thermal decomposition of nitric acid:

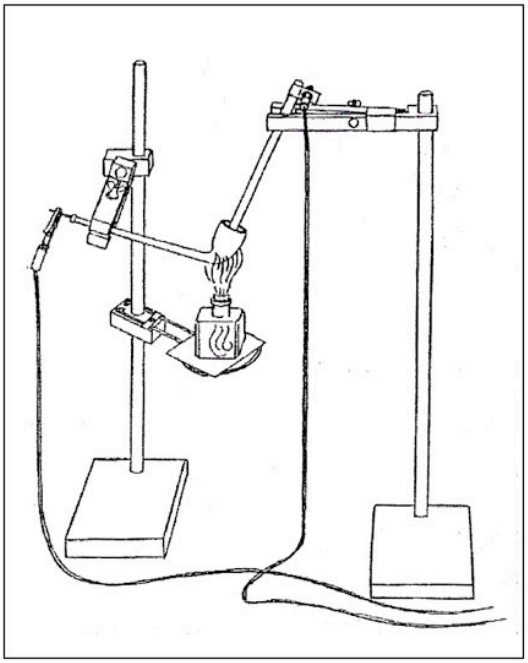

Figure 2. Electrolytic preparation of potassium using a clay pipe as the reaction vessel.

$$\text{heat} + 4H(NO_3)(l) \rightarrow 2H_2O(g) + O_2(g) + 4NO_2(g)$$

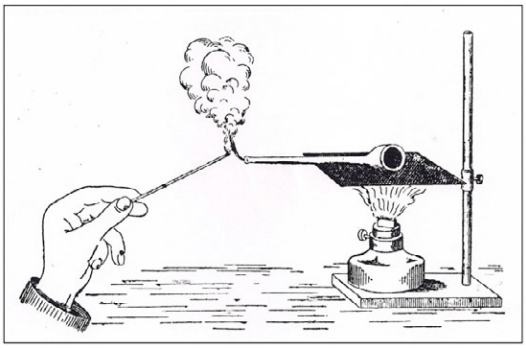

Figure 3. A “miniature gas works.”

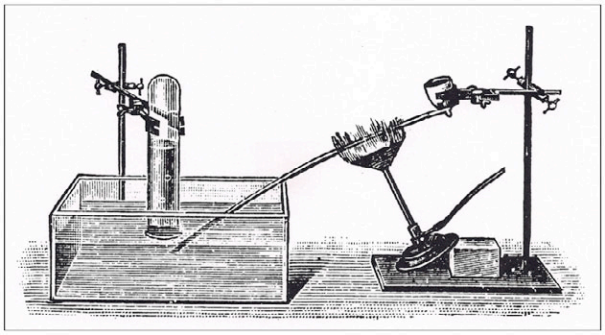

Figure 4. The thermal decomposition of nitric acid.

The bowl of the pipe has been retained as a convenient funnel for introducing a small quantity of nitric acid into the pipe stem.

Clay tobacco pipes were also used as substitutes for the porous membranes in voltaic cells, as shown in figure 5, where the broken-off bowl of the pipe serves as the separator for a small Grove cell, first introduced by the British chemist, William Grove, in 1839 (5). Here the bowl, whose stem hole has been blocked with a clay plug, acts as the cathode compartment and contains both an inert Pt electrode and concentrated nitric acid which is being reduced to NO gas:

$$NO_3^-(aq) + 4H^+(aq) + 3e^- \rightarrow NO(g) + 2H_2O(l) \quad E° = +0.96\ V$$

whereas the surrounding liquid and accompanying Zn electrode act as the anode compartment, leading to oxidation of the Zn and to an net cell potential of 1.72 V

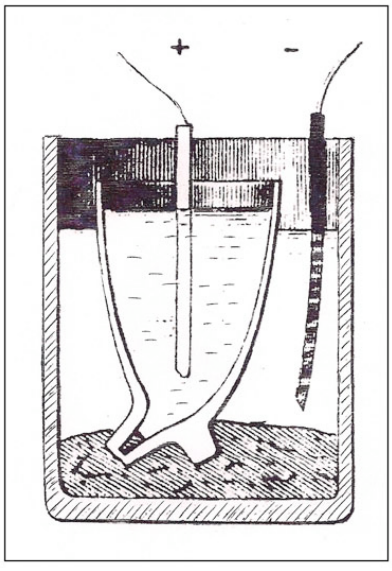

Figure 5. Use of the bowl of a clay pipe as a separator for a small Grove cell.

under standard conditions:

$$Zn(s) \rightarrow Zn^{2+}(aq) + 2e^- \qquad E° = +0.76\ V$$

A final chemical use of clay pipes, dating from 1895, is shown in figures 6 and 7 (6). Here they are being used as diffusion membranes for the separation of gases. Since, according to Graham's law of diffusion, the rate of gaseous diffusion is inversely related to the square root of the molecular weight of the gas, dihydrogen gas will diffuse much more rapidly than either the dioxygen or dinitrogen gas in the atmosphere. In figure 6 diffusion of dihydrogen gas out of the clay pipe is used to create a lower pressure above the liquid in the glass tube than that above the liquid in the lower bottle thus causing the liquid to rise in the tube, whereas in figure 7 the situation has been reversed and diffusion of dihydrogen from the surrounding beaker into the clay pipe causes the pressure above the liquid in the bottle to be greater than that outside the bottle, thus driving the liquid out of the bottle in the form of a "marvelous fountain." In both demonstrations it is necessary to seal the mouth of the pipe bowl

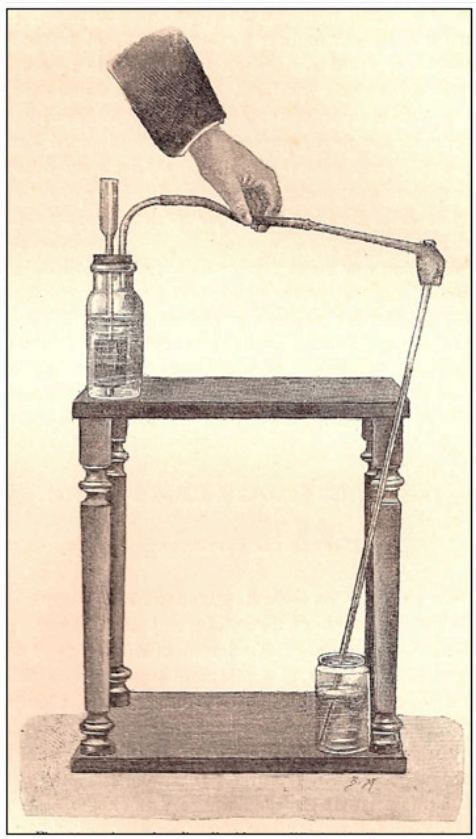

Figure 6. Ascension of a liquid via diffusion of dihydrogen gas.

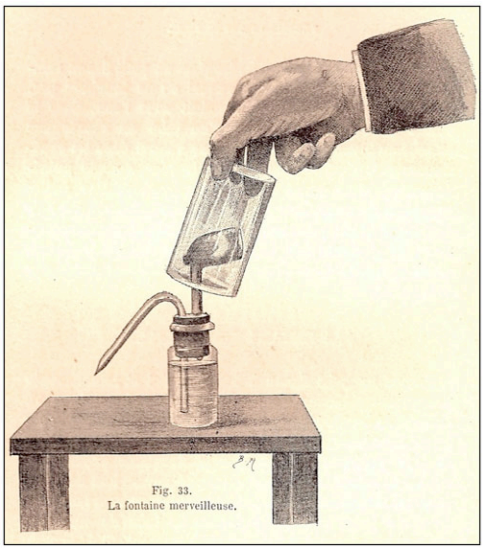

Figure 7. "The marvelous fountain"

using a cork that has been coated with wax.

Günther Beer has found a similar collection of clay tobacco pipes among the holding of the *Museum der Göttinger Chemie* in Göttingen Germany and has traced references to their uses in the chemical laboratory dating back as far as 1780, including not only those noted above, but far more mundane applications, such as the use of broken pipe stems as stirring rods and sample pipettes (1). However, the earliest reference to clay tobacco pipes in connection with chemical laboratories that I am aware of occurs in the 1680 edition of Johann Becher's *Tripus hermeticus.* This contains a large foldout plate of essential instruments for the operation of a chemical laboratory of which item 64 shows two clay tobacco pipes, a poach of tobacco, a candle, an hour glass, and a vial of a poison antidote known as theriak (7). In this case the clay pipes and tobacco were presumably for the the chemist to smoke and not for use as actual apparatus. Interestingly Becher's list of laboratory essentials also included an apron and a lucky rabbit's foot!

References and Notes

1. This column was inspired by a correspondence in 2008 on this subject with Dr. Günther Beer, who is curator of the *Museum der Göttinger Chemie* in Göttingen Germany. See G. Beer, "Die Verwendung von Tonpfeifenteilen als Ersatz-Geräte im chemischen Laboratorium: Eine Literaturauswahl von 1787 bis 1947," *Museumbrief*, **2008**, *25*, 37-43.

2. K. Thöne, *Chemischen Laboratorium. Anleitiung zur Einrichtung und zum Selbsbau der erforderlichen Apparate*, Otto Meyer Verlag: Ravensburg, 1947, p. 68.

3. C. R. Gibson, *Chemical Amusements and Experiments*, Seeley, Service & Co: London, 1928, p. 17.

4. J. Partington, *A Text-Book of Inorganic Chemistry*, Macmillan: London, NY, 1925, p. 565.

5. W. R. Grove, "On a Small Voltaic Battery of Extrordinary Energy," *Rep. Brit. Assoc. Adv. Sci.* **1839**, 36-38; also "On a Small Voltaic Battery of Great Energy," *Phil. Mag.*, **1839**, *15 (Series 3*), 287-293.

6.. F. Faideau, *La chimie amusante*, Librairie Illustreé: Paris, 1892, pp. 72, 74, 76,

7. This plate is reproduced in F. Ferchl, A. Süssenguth, *A Pictorial History of Chemistry*, Heinemann: London, 1939, p. 117.