Notes from the Oesper Collections

The Twitchell Acidometer

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The primary purpose of the Oesper Collections is to collect chemical literature and laboratory apparatus of historical significance. However, we also collect items related to the development of chemistry in Cincinnati even though they may prove of local significance only when viewed in terms of the history of chemistry as a whole.

One such item is a wooden box containing a curious glass and brass apparatus (figures 1 and 2), which the label pasted inside the cover identifies as a "Twitchell's Acidometer." This label further reveals that the item in question was manufactured and sold locally by the Edward Berghausen Co. of 41 East Second Street in Cincinnati, which described itself as a manufacturer of (1):

... wine and cider vinegar flavors, oil of apple and oil of pears (for flavoring vinegars), essence of cider, and all kinds of flavoring extracts, raspberry, strawberry, grape, etc.; vinegar coloring guaranteed to work clear, can also be used for table sauce, mustard, chow chow, etc.

The label goes on to call the reader's attention to:

... our vinegar and pickle preserving solution. It stops musty fermentation and prevents the pickles from becoming soft. A positive success that has stood the test for ten years.

As might be inferred from both its name and its manufacturer, the purpose of the Twitcheil acidometer was to rapidly determine the acetic acid [$H(C_2H_3O_2)$] content or strength of commercial vinegar solutions. As may be seen most clearly from figure 1, it consisted of two glass cups (A and C) resting on a brass stand. These were sealed on top by means of a brass cover held in place by a thumb screw and containing an internal channel connecting the two cups. This cover also held a graduated tube (D) located above cup A which was connected to a brass tube that extended almost to the bottom of the cup. Above cup C it held a copper spoon on a wire that could be raised or lowered within C via a self-sealing rubber gasket in the lid.

To use the apparatus, the cover was removed and cup A was filled with water. The graduated test tube B

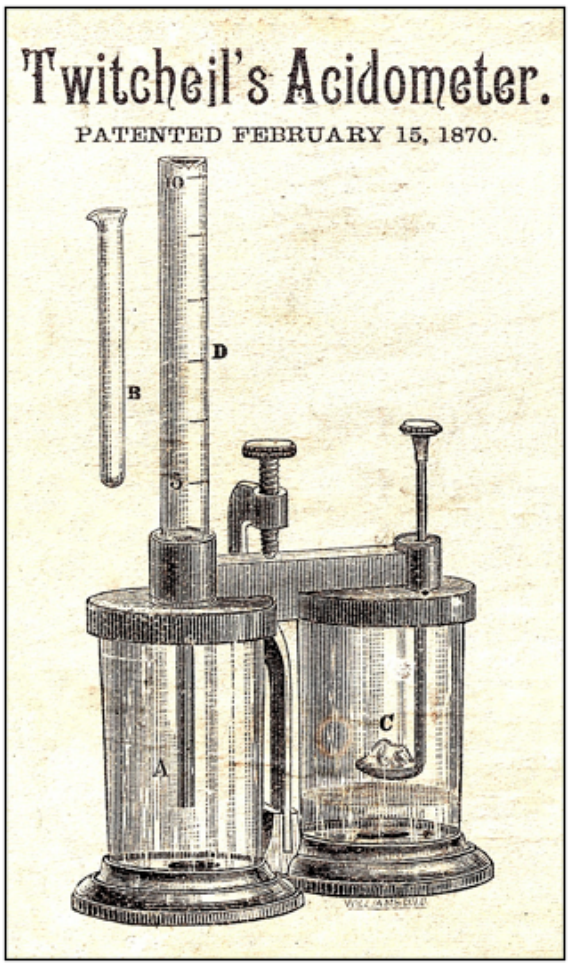

Figure 1. An etching of Twitcheil's acidometer found on the inside of the device's storage box.

was filled with a fixed amount of the vinegar sample to be tested and this was, in turn, added to cup C followed by a test tube of water to dilute it. The spoon was filled with finely powdered potassium bicarbonate [$KH(CO_3)$] and raised up to the cover, which was then clamped on top of the cups (2). Lowering the spoon into the vinegar sample allowed the acetic acid and potassium bicarbonate to react according to the equation:

$$H(C_2H_3O_2)(aq) + KH(CO_3)(s) \rightarrow K(C_2H_3O_2)(aq) + CO_2(g) + H_2O(l)$$

Figure 2. The Twitchell acidometer resting on top of its storage box. *From left to right*: the acidometer, the calibrated test tube for measuring out vinegar samples, a small tin of potassium bicarbonate for charging the reaction spoon (Jensen-Thomas Apparatus Collection).

On passing through the internal channel in the brass cover and into cup A, the evolved carbon dioxide (CO_2) gas would then push the water up into the graduated tube. The more acetic acid in the vinegar, the greater the quantity of evolved CO_2 gas and the higher the level of the water in the tube, whose graduations allowed one to directly read off the percentage of acid in the original vinegar sample.

The inventor of this clever device, which is normally called an acidimeter rather than an acidometer, was one Henry Twitchell (not Twitcheil) (3). Born in 1816 in Keene, New Hampshire, Twitchell moved to Cincinnati in 1846, where he became an assistant to Ormsby Mitchel at the Cincinnati Observatory (figure 3) and its Acting Director after Mitchel's departure in 1860 to head the Dudley Observatory in Albany, NY (4). However, the outbreak of the Civil War soon put the operations of the Observatory on hold for the duration and Twitchell was forced to resign the directorship in 1861 and seek employment as an optician in order to support his new family. He had recently married a German immigrant by the name of Caroline Jaup, who was nearly 26 years his junior, and they would eventually have three sons: Ernest, George and Carl (5, 6).

Henry's early death of pneumonia in 1875, at age 59, left his young family in dire economic straits and forced his widow to seek employment as an elementary school teacher. Though the eldest son, Ernest (1863-1929), managed to graduate from the University of Cincinnati in 1886 with a B.S. degree in chemistry, the two younger sons had to begin working as clerks immediately upon finishing high school. Ernest would eventually become a prominent Cincinnati industrial chemist and Chemical Director of the Emery Candle Co. (7). He would later be awarded the prestigious Perkin Medal of the American Chemical Society for his contributions to the industrial chemistry of soaps and fats (8) and would also endow the Twichell Fellowship in the Department of Chemistry of his *alma mater* – an act that was no doubt prompted by the University's decision to award him an honorary doctorate degree in 1915 (9). George (1865-1933) was able to eventually work his way through medical school, as well as earn a local reputation as a competent amateur paleontologist (10). Not to be outdone by his older brother, upon his death he would donate his extensive collection of fossils and microscopic slides of fossil cross-sections to the University's Department of Geology.

Described as having no formal education, but as being "something of a mechanical and optical genius," Henry was credited not only with the invention of his acidometer, but also with having developed a novel hydrometer and an early form of the chronograph for use in making transit measurements at the Observatory (11). Of these inventions, Twitchell considered the acidometer important enough to patent in February of 1870 (12) and it was still being offered for sale by several laboratory supply houses well into the 20th cen-

Figure 3. The original Cincinnati Observatory in Mount Adams where Twichell was employed from 1846-1861.

tury, along with a slightly modified version for testing the acidity of wine (13).

These accomplishments are of interest in light of those period accounts which suggest that Henry was of a rather laid-back disposition and lacking in ambition. He had worked as a sailor before his arrival in Cincinnati at age 30 and his 15-year association with Mitchel at the Observatory appears to have been that of a devoted, albeit highly skilled and underpaid, amateur with nothing better to do (4):

... a roving sailor without education, he drifted aimlessly up from Florida. On Mount Adams he found what he had searched for in every quarter of the globe. Bothered not at all, like [Mitchel], by his bodily needs, he swung his hammock in a tiny cottage on the grounds. He had the same long suffering endurance – an equal single-minded willingness – to lose himself, regardless, among the stars. His cunning hands, his mechanical instincts, all his skill and genus were called upon to satisfy the crying demands he was glad to serve.

Apparently he remained content with this rather Spartan existence until the departure of Mitchel put an end to it. Only then, when well into his mid 40's, did he seek a wife and begin a family. In sharp contrast, a biographical account of his eldest son characterized Henry as not only "an astronomer of superior rank," but also as "a noted chemist" and "optician of the highest authority." Whether these evaluations are reasonable or merely the hyperbole of a dutiful son is impossible to assess at present given the absence of unbiased independent testimony (14).

Acknowledgements

I would like to thank John Ventre, historian for the Cincinnati Observatory, for his assistance in tracking down basic biographical data on Henry Twitchell and Dr. Richard Davis of the College of Mount St. Joseph for sharing his insights into the career of George B. Twitchell.

References and Notes

1. The Berghausen Company of Cincinnati was founded in 1863 and still exits, albeit now as an international corporation.

2. The quantity of $KH(CO_3)(s)$ employed did not need to be exact since it was the acetic acid that was the limiting reagent in the reaction.

3. This curiously Germanic misspelling of Twitchell as Twitcheil may well illustrate the pervasive German influence on the printing trade in Cincinnati in the last half of the 19th century. There is, however, no doubt that Henry Twitchell was indeed the inventor. He is credited with the acidometer in reference 7 and also on the Cincinnati Public Library's web page for Cincinnati inventors.

4. M. Burress, "The Cincinnati Observatory." Manuscript copy on file in the Oesper Collections. Also *The Centenary of the Cincinnati Observatory,* Historical and Philosophical Society of Ohio: Cincinnati, OH, 1944, pp. 40-41, 42.

5. M. Burress, "The Henry and Caroline Jaup Twitchell Family: Early Home City Residents." Manuscript copy on file in the Oesper Collections. Home City roughly corresponds to the current Cincinnati suburb of Sayler Park.

6. A daughter named Susan was also born to the couple in 1871 but died in infancy.

7. M. B. Graff, "American Contemporaries: Ernest Twitchell," *J. Ind. Eng. Chem.*, **1929**, *21*, 607.

8. C. F. Chandler, "Presentation Address on the Occasion of Award of the Perkin Medal to Ernest Twitchell," *J. Ind. Eng. Chem.*, **1917**, *9(2)*, 193.

9. J. M. Cattell, J. Cattell, Eds, *American Men of Science*, Vol. 4, New Science Press: New York, NY, 1927, p. 1001.

10. "Sigma Xi Memorial for George B. Twitchell." Manuscript on file in the Oesper Collections.

11. A modern chronograph is basically a highly sophisticated stopwatch.

12. H. Twitchell, "Apparatus for Ascertaining the Amount of Acid in Liquids," US Patent No. 99976, 15 February 1870.

13. See for example, *Illustrated Catalogue and Price List of Chemical Apparatus*, Henry Heil Chemical Co: St. Louis, MO, 1904, p. 12, Item 1012; *lllustrated Catalogue of Assayers' and Chemists' Supplies and Scientific Apparatus*, Denver Fire Clay Co: Denver, CO, 1910, Items 101 and 102; *Illustrated Catalogue of Chemical Apparatus, Assay Goods, and Laboratory Supplies*, Amend & Eimer: New York, NY, 1912, p. 1, Item 2008. The average selling price was $12.00.

14. I have been unable to locate a portrait of Henry, though the Oesper Collections do contain several of his eldest son Ernest. Likewise no Twitchells are listed in the current Cincinnati phone book, and thus presumably any direct male descendants no longer live in the Cincinnati area.