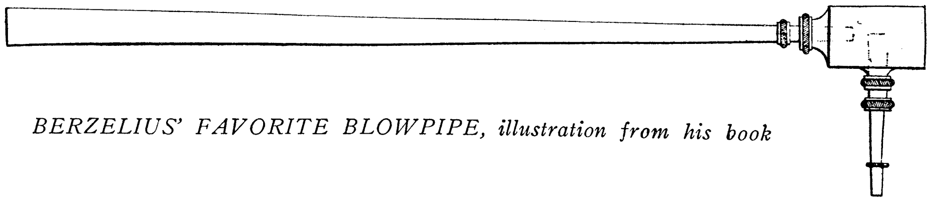
CLASSICS OF SCIENCE: Berzelius on the Use of the Blowpipe

Chemistry



BERZELIUS' FAVORITE BLOWPIPE, *illustration from his book*

Students of analytical chemistry and mineralogy will be interested to read here the source of the whole technique of blowpipe analysis given in their textbooks.

THE USE OF THE BLOWPIPE In Chemistry and Mineralogy. By J. J. Berzelius (1820). *Translated from the fourth enlarged and corrected edition, by J. D. Whitney. Boston, MDCCCXLV* (1845).

How to Blow

In using the blowpipe, the act of blowing is not directly performed by the action of the lungs, since, in this case, the effort would be injurious, and a continued blast could not be kept up. It is effected by the muscles of the cheeks, which force the air contained in the cavity of the mouth through the blowpipe. Simple as this operation is, it is not easily performed at first, since we habitually exert all the muscles concerned in respiration at once, when we attempt to blow. It is the same kind of difficulty which we experience when we attempt to move the limbs, on the same side of the body, in different directions. It requires some practice not to allow the lungs and the muscles of the mouth to act in concert. The first thing to be attempted is, to keep the mouth filled with air during expiration and inspiration. Imagine the air to escape from a small opening between the lips, the cheeks then naturally collapse, unless a farther supply of air be admitted at the next expiration. A sufficient quantity of air must then be admitted into the cavity of the mouth to keep the cheeks constantly distended. The air, being thus always slightly compressed, escapes in a uniform current from the opening between the lips. This is what takes place in using the blowpipe; the air escapes so slowly from the fine aperture in the blowpipe jet, that it is not necessary to fill the mouth at each expiration. This operation, which is attended with a little difficulty at first, is soon learnt by practice, and, after a short time, it becomes a matter of course, which does not interrupt the process of breathing, and on which it is not necessary to bestow a thought. The only inconvenience is, that the muscles of the cheeks become fatigued at first, which arises from want of practice, and from the fact that the beginner generally presses the mouthpiece of the blowpipe more strongly between his lips than is necessary. The act of blowing is, however, so simple, that it may be easily acquired by any one who has no natural defect in the roof of the mouth.

When the learner can keep up a steady blast, the next thing is, to be able to produce a good flame. For this purpose, a knowledge of the flame and its different parts is required. On looking attentively at the flame of a candle, it will be seen that it consists if several distinct portions. At its base is seen a small dark-blue portion, which becomes thinner as it gets farther from the wick, and which disappears entirely at the part where the flame begins to ascend vertically. In the midst of the flame is the dark portion, which can be seen through the more brilliant part. This space encloses the gases rising from the wick, which are not in contact with the air, and which are therefore not yet fully burned. Around this is the proper illuminating portion of the flame, and on its outer edges will be seen, on looking with attention, a thin envelope, which becomes broader near the point of the flame. This is the place in which the combustion of the burning gases is going on, and is the hottest portion of the flame. If a fine iron or platina wire be introduced into the flame, it will be seen that it is most intensely heated at the point of the flame, and if it be gradually lowered, it will be found that it is most vividly ignited at the points where it comes in contact with the surface of the flame, that is to say, where it touches this thin, feebly illuminating envelope. If a very fine wire be used, its diameter appears much magnified, and this apparent enlargement (which is a phenomenon of the same kind as the apparent diameter attributed to the fixed stars) increases, as the wire approaches the point where the lower blue edge of the flame ends, so that the point where the flame is supplied with the largest quantity of oxygen from the air, is the place of the maximum of heat. Now, when air is forced into the flame with the blowpipe, a long narrow blue flame. appears directly before the jet, being now concentrated into a small cylindrical space, whereas it before formed an envelope around the whole flame. Just before the point of this blue flame is the hottest spot, as in the flame when not acted on by the blowpipe, with this difference, that in the latter cast it formed a ring around the flame, while in the former it is concentrated into a focus; it is thus rendered sufficiently intense to fuse and volatilize substances which were not sensibly acted on by the flame in its usual state. On this is founded the whole theory of the intense heat produced by the blowpipe; the effect, which would otherwise be distributed over the whole surface of the flame, is concentrated into a small space, exactly as if the flame had been turned inside out. The surrounding illuminating portion of the flame prevents the heat from escaping.

Long practice is required to know where the maximum of heat is, since different substances are differently ignited, and the light which they emit is often deceptive. Care must be taken not to blow too strongly nor too gently; since, in the former case, the heat is diminished in intensity by the current of air, and in the latter, a sufficiency of air is not supplied to keep up the combustion. A very intense heat is required when the fusibility of a substance is to be investigated, or when different metallic oxides which part with their oxygen with difficulty, like the oxides of tin or iron, are to be reduced. But it is not a high temperature only which it is the design of the blowpipe to produce; there are other operations which require a less intense heat, and which, though diametrically opposed to each other, can be effected by the blowpipe. These are, oxidation and reduction.

Oxidation takes place when the assay is heated just before the extreme point of the flame, when all the combustible particles are immediately oxidized. The farther from the point of the

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Use of the Blowpipe—*Continued*

flame, the better the operation goes on, provided the heat be sufficiently intense; and it must be observed that too high a temperature often impedes the oxidation, especially if the assay be supported upon charcoal. Oxidation goes on best at a low red heat. For this purpose the blowpipe-jet must have a large aperture.

Reduction succeeds best with a fine jet, which should not be inserted too far into the flame, since, in this case, a highly illuminating flame is produced, the elements of which, not undergoing complete combustion, do not take oxygen from the assay, which may be considered as being heated in an inflammable gas. If in the course of the operation the assay becomes coated with soot, it is a proof that the flame is too smoky, which diminishes the intensity of the heat. The blue flame was formerly regarded as the proper reducing flame; this is, however, untrue, for it is the brilliant portion of the flame which causes deoxidation, but the assay must be held in it in such a manner as to be surrounded by it on all sides, and protected from the contact of the air. I mention once more that it is the combustible atmosphere which surrounds the assay which effects reduction, and not the charcoal; the reduction which takes place at the points of contact of the assay and the charcoal would take place equally as well in the outer as in the inner flame.

The most important matter is to be able to produce at will oxidation or reduction, which is soon learned by practice. Oxidation is so easily performed that it is only necessary to be told how to do it; reduction requires more practice, and a better knowledge of the management of the flame. It is an excellent plan, if one wishes to practice in making a good reducing flame, to fuse a small grain of tin upon charcoal, and raising it to a white heat, to endeavor to keep its surface brilliant. Tin has so strong an attraction for oxygen, that the moment the flame is changed in the least, the metal becomes covered with an infusible crust of the oxide of tin. One can begin with a very small grain, and gradually increase its size; the larger the quantity of tin which he can keep melted in the metallic state, the more skilful is he in his art.

The Support

Charcoal. The substance to be examined by the blowpipe must rest upon something or be held firmly in some way. The best substance for a support is charcoal. That of mature pine, or soft wood in general, is preferable. The charcoal of the fir often snaps and throws off the assay, while that of hard and compact woods gives so large a quantity of ashes, which often contain a large proportion of iron, that it can only be used in case of necessity. . . .

Platina. In certain cases, in which the reducing action of charcoal might impede the desired reaction, platina may be employed as a support . . . sometimes as a fine wire. . . .

Platina Wire. GAHN, who saw at once the inutility of the platina spoon, but was not acquainted with the use of the foil, contrived another method of using platina as a support, which far surpasses either of the others, and permits us to dispense with the spoon and foil in most cases.

A platina wire is bent into an eye at one end, which eye serves as a support in the following manner. It is moistened by the mouth, and then dipped into the flux, of which a small quantity adheres to it, which, when melted to a bead, remains attached to the eye. The assay is then moistened so that a part of it adheres to the bead, and the two are then subjected together to the action of the flame. The melted mass is then in a position in which it can be conveniently examined; since it is free from the deceptive play of colors, which is often caused on charcoal, by the adherence of the assay to the dark-colored ground.

Glass tubes. In case the assay is to be roasted in such a manner as to detect the substances which may be volatilized in the operation, I make use of a glass tube at least three inches long and one-twelfth of an inch in diameter, open at both ends. The assay is placed in this, near one end, and the tube is to be held with this end slightly inclined downwards. According as more or less heat is required, the spot where the assay lies is to be heated with a spirit-lamp or by the blowpipe flame; and the tube can be inclined more or less as a stronger or lighter draught of air is required. Substances which are volatilized by this operation, but not gaseous, sublime into the upper part of the tube, and can then be recognized. Although straight tubes require no previous preparation, and are therefore easily procured, there is one difficulty attendant on their use, which is, that the assay is apt to fall out if the tube be inclined before it is so softened by the heat that the substance under examination can fasten itself to it. It is, therefore, better to bend the tubes near the lower opening, at an oblique angle. The assay is then to be laid in the angle, and the tube can then be inclined at an angle sufficient to allow the gaseous vapors to rise without danger of its falling out.

Glass matrasses. When the assay is to be examined for water or other volatile matters, or when it is liable to decrepitate, it must be heated in a glass tube closed at one end, and slightly enlarged at the other, so as to have the form of a small matrass, since the volatile matters are more easily driven off when the air is allowed to circulate in the apparatus.

When, on the other hand, combustible substances are to be sublimed from the assay, as sulphur, arsenic, etc., the tube must not be enlarged at the closed end, to avoid combustion, which might be caused by the circulation of air.

The Reagents

Cronstedt used generally but three reagents; basic carbonate of soda, borate of soda and the double salt of the phosphate of soda and ammonia, which I shall call hereafter, for the sake of brevity, by their common technical names, soda, borax and salt of phosphorus. These reagents are all still in use, and among the great number of those which have been tried since that time, not one has been found to replace either of these. It is singular enough that, in the very beginning of the art, the very best reagents should have been hit upon. In addition to these, which are constantly required, others, intended for certain special purposes, are not so often used, but must be at hand, as occasion may require.

Jons Jakob Berzelius was born near Linköping, Sweden, August 20 (or 29th), 1779, and died at Stockholm, August 7, 1848. He received the degree of M. D. from the University of Upsala at the age of 23, and began to teach in the University of Stockholm. In 1814 he published "Theory of Chemical Proportions and the Chemical Action of Electricty." In 1818, at the age of 39, he published the first table of atomic weights, the result of ten years of research. To Berzelius is due in large part our familiar chemical symbols, and the theory of compounds made up of radicles having different electric charges.

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