Review of
The Chemistry of Explosives

Jacqueline Akhavan

RCS Paperbacks, 1998
ISBN 0-85404-563-5

Barry Sturman
6 Corowa Court, Mount Waverley, Victoria 3149
Australia

The prestigious Royal Society of Chemistry (RSC) is the professional organization of Britain's chemists. It also publishes many books and journals on chemistry and related subjects, including RSC Paperbacks. According to the Society, "RSC Paperbacks are a series of inexpensive texts suitable for teachers and students and give a clear, readable introduction to selected topics in chemistry. They should also appeal to the general chemist."[1a] A book from this source on the chemistry of explosives is expected to be a very useful addition to the literature, especially when the author is a Senior Lecturer at Cranfield University, Royal Military College of Science, UK.

To form an opinion about a new textbook that deals with subjects with which one is somewhat unfamiliar, one naturally turns to those sections about which one does have prior knowledge. In this instance, it was appropriate to look at the sections on the history of explosives and on pyrotechnics. It did not take long to get the impression that all was not well.

On the very first page it is stated that "in 220 BC an accident was reported involving black powder…".[1b] This statement surely needs a supporting reference, but there is none. In the second paragraph the old legend of "a German monk called Berthold Schwartz" is repeated as if it were fact, complete with a date (1320).[1b] Almost 40 years ago, Professor J. R. Partington wrote of Berthold Schwartz: "Black Berthold is a purely legendary figure like Robin Hood (or perhaps better, Friar Tuck); he was invented solely for the purpose of providing a German origin for gunpowder and cannon".[2] Dr. Akhavan does not cite Partington, but she does cite "The Chemistry of Powder and Explosives" by Professor T. L. Davis.[3] Davis, who wrote in the early 1940s, refers to Berthold Schwarz and it is clear that the issue of whether Schwarz was a historical figure (as distinct from a legendary one) was controversial even then.[3a]

The section on pyrotechnics includes a table of pyrotechnic smoke compositions.[1c] Column 1 of that table, labeled "Pyrotechnic composition", includes "silicon tetrachloride and ammonia vapour", an example of a *non-pyrotechnic* smoke producing system. The list also includes "phosphorous (sic) pentoxide and phosphoric acid". These materials, far from being an example of a "pyrotechnic composition", are the *products of combustion* of white phosphorus burning in air. Incidentally, it is most surprising to see the word "phosphorus" spelled incorrectly in a publication of the Royal Society of Chemistry.

The section on light generating compositions contains the statement "In order to emit light in the visible region the temperature of the reaction must be greater than 3000 K".[1c] This is obviously wrong. A candle flame emits visible light, and its temperature is nowhere near 3000 K. Dr. Shimizu lists the burning temperatures of several fuel and oxidant combinations useful for coloured flames; they range from 2025 to 2455 ºC (2298 to 2728 K).[4]

The section on coloured light also contains a fundamental error. Dr. Akhavan identifies the chemical species responsible for the emission of red, green and blue light from compositions containing compounds of strontium, barium and copper, respectively, as the ionized metal monochloride molecules $SrCl^+$, $BaCl^+$ and $CuCl^+$.[1d] This contradicts the pyrotechnic literature, which clearly identifies the principal emitting species as the neutral monochloride molecules. See, for example references 4a, 5, and 6.

In the section on noise-generating pyrotechnics, Dr. Akhavan states "A louder bang can be achieved by using a pyrotechnic flash powder which generates more gas than black powder and therefore produces a louder bang".[1e] Is it true that flash powder "generates more gas than black powder"? Flash powder can be a simple mixture of potassium perchlorate and powdered aluminium.[7] The gas responsible for the explosive effect of such a flash powder is presumably potassium chloride and aluminium oxide that have been vaporized by the heat of the reaction. Simple chemical calculations show that a flash powder consisting of a stoichiometric mixture of aluminium and potassium perchlorate would produce 0.004751 moles of potassium chloride and 0.006334 moles of aluminium oxide per gram of powder. If all the products were vaporized, they would produce 0.011085 moles of gas per gram of powder. If the vaporized products were dissociated to some extent at the temperature of the reaction, then the number of moles of gas would be correspondingly greater. As for black powder, Davis[3b] cites the results of Noble and Abel, who found that 1 gram of black powder produced 271.3 cc of permanent gas measured at 0 ºC and 760 mm. This corresponds to 0.0121 moles of gas per gram of powder, even without taking account of the possibility that some of the solid products would be vaporized, and some of the gaseous products dissociated, at the temperature of reaction. These calculations show that it is most unlikely that flash powder "generates more gas than black powder". Flash powder produces a louder bang than black powder, *despite* producing less gas per unit mass, because it reacts faster and at higher temperatures, thus producing a more rapid release of high-pressure gas.

Having found so many errors and misleading statements in so few pages, this reader lost confidence in Dr. Akhavan's book. The other sections of the book might be models of accuracy; they might also be as unreliable as the statements just discussed.

The statement on the back cover indicates that the book is "ideal for 'A' level students and new graduates with no previous knowledge of explosive materials. It will also be useful to anyone needing succinct information on this subject".[1f] Regrettably, one cannot agree with these statements, at least in regard to pyrotechnics. It is to be hoped that a properly revised and edited second edition will be published in due course.

References

1) Jacqueline Akhavan, *The Chemistry of Explosives*, The Royal Society of Chemistry, Cambridge, 1998; [a] back of title page; [b] p 1; [c] p 155 ; [d] p 156; [e] p 157; [f] back cover.
2) J. R. Partington, *A History of Greek Fire and Gunpowder*, W. Heffer and Sons, Ltd, Cambridge, 1960, Chapter III. The quote may be found on p 96 of the 1999 edition (The Johns Hopkins University Press, Baltimore and London).
3) T. L. Davis, *The Chemistry of Powder and Explosives,* Angriff Press, Hollywood, 1975; [a] p 29; [b] p 43.
4) T. Shimizu, *Fireworks, the Art, Science and Technique*, Maruzen, Tokyo, 1981; [a] p 55; [b] pp 57–61.
5) A. A. Shidlovskiy, *Principles of Pyrotechnics*, Mashinostroyeniye Press, Moscow, 1964, pp 182–186.
6) J. A. Conkling, *Chemistry of Pyrotechnics*, Marcel Dekker, New York, 1985, pp 150–163.
7) R. Lancaster, *Fireworks Principles and Practice*, 3rd edition, Chemical Publishing, New York, 1998, p 246.

Editor's note: The author was given the opportunity to respond to these two reviews; however, no response has been received.