

WASC 2251 ●

Steve Chadlock's

notes on

Cordite

? Could add the description of making ^{MAIF} MD from
(this) to the Cordite process paper.

Cordite Production Methods

Cordite is basically a composition obtained by incorporating liquid nitroglycerine in guncotton or nitrocellulose and a few details of the material and its origins are given in Appendix B.

Over the years various forms of cordite were produced at RNCF. During the First World War a little of the original Cordite Mark I was produced but the bulk production was of Cordite MD. Cordite MD was preferred because it did not erode gun barrels as severely as did the Mark I material. Both types were made in the same way by the classical solvent process and both contained the same materials - nitrocellulose, nitroglycerine and mineral jelly - but the ratio of NC/NG was much greater in the MD version.

In 1927 the solvent process was abandoned and solventless cordite, or cordite SC was introduced. This involved major changes in the manufacturing technique and the composition of the cordite itself was also changed with the ration of NC/NG being intermediate between that used in the Mark I and the MD materials. At the same time however, the nitrogen content of the nitrocellulose was also reduced. The mineral jelly was replaced by another stabiliser known as Carbamate or Centralite. This component also assisted the gelatinisation of the cordite in the absence of acetone, the conventional solvent which had been used hitherto. Apart from certain disadvantages in terms of safety. It avoided for example the well-known hazards associated with the manual handling of the dry guncotton and the nitroglycerine / guncotton paste and it also eliminated the need for highly flammable solvents. It was also a more efficient manufacturing method because the long and expensive stoving processes of both guncotton and cordite was more stable, less prone to irregular shrinkage - which was a common feature of the earlier cordites - and it also burned with a cooler flame.

One of the major problems with propellants of the SC type was that they gave rise to an enormous flash which gave away the position of the gun. For this reason efforts were made to find means of reducing or eliminating the flash, and the most effective way was found to be to introduce into the cordite another ingredient which reduced the temperature of combustion. One of the most satisfactory materials for this purpose was picrite, or nitro-guanidine, and this additive was introduced into Naval service in cordites of the NF type in 1939. However, because picrite is soluble in water it was found necessary to return again to the use of solvents in the manufacturing process. Brief details of picrite manufacture and of the modified solvent process for flashless cordite production will be given later.

However, whatever form of cordite was being made, the essence of the process was the bringing together of those two most formidable materials, nitrocellulose and nitroglycerine, and to finish up with the solid, stable product in the desired physical form..

Cordites MK I and MD

The traditional solvent process involved, first of all, the drying of the nitrocellulose. This process has already been described in the section dealing with the production of nitrocellulose, which, for cordite MD, was in fact guncotton because of its high nitrogen content (guncotton it will be remembered is the name given in the armed services the nitrocellulose containing 13% or more of nitrogen).

Dry guncotton was then weighed into waterproof, rubberised bags which were taken to the Paste Mixing Houses where a measured quantity of nitroglycerine was poured on to the guncotton. This mixture was emptied on to a lead table where the charge was then given a preliminary kneading by hand before being gently pressed through a sieve of half inch holes at the end of the table when it fell into a bag attached below. This must surely have been a perilous operation. Marshall suggests, superfluously one would have thought, that 'no unnecessary violence must be used'.

Add in
guncotton
section



The so-called 'paste' thus obtained was transferred next to the Incorporating Houses where it was placed in an incorporator. These machines were rather like a baker's dough mixing machine which could be warmed or cooled as appropriate with a water jacket. The appropriate amount of acetone was then added and the mixture was blended together for a period of about three hours after which the mineral jelly was added to the extent of 5% of the total mix and the incorporation process was continued for a further period of about three hours.

At this stage the produce, now called 'dough' was taken to the presses on the Cordite Ranges towards the north-west of the factory. Here the cordite dough was pressed behind a rope mantle screen through a die in a hydraulic press, from which it emerged in the familiar cord-like form. The product was collected by hand as it emerged from the presses and cut into measured lengths. The cords were loaded on wooden trays of the kind already described which were, in turn, placed in a truck and taken to the drying stoves.

In the stove area the trays were placed initially in the Acetone Recovery Stoves. Here the trays were stacked in chambers heated by steam pipes. As each chamber was filled it was sealed with the exception of a small opening at the bottom of the door. Air was drawn by suction through the stoves over the cordite which was maintained at about 43°C. The acetone vapour passed through a pipeline, supported about eight feet from the ground, to the acetone recovery plant. After a period of about a week, when the amount of acetone given off had diminished to such a low level that it became uneconomic to continue the recovery process, the cordite was removed and taken to the final drying stoves. These were similar to those just described except that no acetone recovery equipment was fitted. This final drying period varied according to the diameter of the cords but it could take as long as four or five weeks.

Finally, after drying, the cordite was blended in one of more of several ways so as to ensure a constant quality product with uniform ballistics. All that then remained was for to be packed, bonded and despatched by rail or, primarily, by barge from Rocklea jetty to Priddy's Hard or to Upnor Castle on the river Medway in Kent.

Appendix B

A Brief History of Cordite and its Precursors

The invention of smokeless powders, including cordite as alternatives to gunpowder, which had been known for more than five centuries, was presaged by the discovery in 1846 of nitroglycerine. The chemist responsible was an Italian called Sobrero who obtained the material by the action of nitric acid on glycerine. In 1863 the celebrated chemist and engineer Alfred Bernard Nobel began to use nitroglycerine as a blasting explosive. It was called 'Nobel's blasting oil' and was rather dangerous to handle because of the capricious occurrence and great violence of its explosion. However, three years later the discovery by Nobel that Kieselguhr, a diatomaceous earth, would absorb up to three to four times its weight of nitroglycerine turned out to be the key to the problem. Experiment showed that the glycerine, making it safer to handle and to transport, but it also conferred the additional benefit of making the mixture more convenient to detonate than the nitroglycerine alone. This material was patented as dynamite in 1867.

Meanwhile, the development of another extremely powerful organic explosive was nearing completion. This material, which was to be called guncotton, was made by the action of nitric acid on cotton, and the discovery had its foundations in work done by Pelouze in 1838 and by Schonbein in 1845, but it was not until 1865 that the practical difficulties of applying guncotton as a shattering explosive were overcome by Sir Frederick Abel. Attempts were then made to reduce its furious rate of burning to a level where it could be used as a propellant, and ultimately in 1886 a Frenchman named Vieille achieved some success with a solvent modified derivative of guncotton, named Poudre 'B'.

However, it was left to the genius of Nobel to unite the two lines of research, starting from glycerine and cotton, and to show that the explosive properties of nitrated cotton could be tamed for propellant purposes by gelatinising the fibrous material with nitroglycerine. The discovery that the two most powerful explosives then known could be blended to give a slow burning propellant 'was so startling that it was received with incredulity, which soon gave place to extreme astonishment'. This resulting smokeless powder was named Ballistite and was patented in 1888.

At about the time of the discovery of Poudre 'B', the British Government appointed a committee to investigate and report on the subject of a suitable smokeless powder for the British service. Samples of ballistite and a number of other powders were obtained, but the committee was not satisfied with any of them and finally devised a new one, to which the name 'cordite' was given. The name derived from the fact that it was made in the form of 'cords'.

This work was conducted in Sir Frederick Abel's laboratories at Woolwich Arsenal, and the material was patented in 1889 on behalf of the government in the names of Sir Frederick Abel and Professor (later Sir) J. Dewar, who were members of the committee. Nobel claimed that his ballistite patent of 1888 was infringed through the production of cordite, which was commenced at the Royal Gunpowder Factory, Waltham Abbey, later in 1889 - or possibly early in 1890. Certainly cordite was, like ballistite, essentially an admixture of nitroglycerine and guncotton, but there were a number of differences and these proved to be important enough to ensure that the ensuing lawsuits ended in favour of the British Government.

One of the most important differences between ballistite and cordite was that the latter used acetone as a solvent to assist in the incorporation of the nitroglycerine with the guncotton. A second important difference was that cordite had a proportion, amounting to 5% by weight, of mineral jelly, a vaseline, included in the formulation. The mineral jelly was originally included in the hope that it would lubricate the barrels. This does not happen because it is entirely consumed in the explosion, but it does have another very desirable effect. The presence of the jelly reduces the rate of erosion of the barrel by lowering the temperature of the explosion. This early product was known as Cordite Mk I and, in spite of the presence of mineral jelly, it still caused severe wear in gun barrels in the Boer war. As a consequence the composition was modified to reduce the temperature still further by decreasing the proportions of

to
MkI
A

nitroglycerine from 58 to 30%, and by increasing the guncotton concentration from 37 to 65%. The new version was known as Cordite MD and it was this material that was produced at Holton Heath for Naval use during World War I.