

Zinc Smoke

Smoke compositions using Zinc will be found in the following types:

„Berger“ Mixture

Invented by the French chemist Ms Berger this smoke agent was a mixture of:

Zinc (dust)	25%
Carbon tetrachloride	50%
Zinc oxide	20%
Kieselguhr	5%

The mixture was prepared as a paste and pressed into a can and provided with an igniter system on top. These cans were called "Candles". These were quite advantageous as they:

- Had good storage properties
- The smoke was non toxic
- Cheap to manufacture
- Easily transported and handled
- Easy to use.

The only drawback was that they needed an ignition system. The kieselguhr was provided to prevent the zinc dust from settling out. It made the mixture into a paste that couldn't be separated into its constituent parts again. The zinc oxide was provided to slow the reactions a little. But it was not a success and the temperatures of this mixture got up around 1200°C, which gave rise to sparks and erratic burning. The general violence of the reactions meant that not all the ingredients were fully consumed. The necessity of providing an ignition system means that the mixture was too slow to be used in artillery or mortar projectiles. Be that as it may, this mixture was one of the most successful and it was copied and varied by all the belligerents to suit their tastes.

This mixture behaved in the following manner:



The heat vaporizes the zinc chloride.

This mixture is the American version of a "Berger" mixture. It was developed by the US Bureau of Mines hence the name. It had the composition of :

Zinc (dust)	35.4%
Carbon Tetrachloride	41.6%
Sodium chlorate	9.3%
Ammonium chloride	5.4%
Magnesium carbonate	8.3%

The changes to the original berger mixture were for the following reasons:

Poor combustion in the berger caused a grey smoke so sodium chlorate was added to oxidise the carbon. This changed the smoke to white. Unfortunately this addition accelerated the reactions to unstable levels. This was fixed by substituting ammonium chloride for the Zinc chloride. By absorbing the heat of reaction the smoke was cooled and the rate of burning was reduced. It added to the density of the smoke as it has some smoke properties of its own. The substitution of magnesium carbonate as an absorbent gave smoother burning as the original kieselguhr contained varying amounts of moisture and organic matter and it spluttered badly when burning.

To overcome the initial slow start of BM mixture of smoke production a layer of "fast" mixture was provided. This consisted of:

Zinc (dust)	30.2%
Carbon tetrachloride	35.1%
Sodium chlorate	24.9%
Zinc Oxide	9.8%

As mentioned this mixture needs an ignition system and this consisted of two layers of "Starting mixture" arranged as shown:

STARTING MIX No.1

Powdered sulphur	20.7%
Zinc dust	63.1%
Zinc oxide	16.2%

STARTING MIX No. 2

Powdered iron	46.6%
Potassium permanganate	53.4%

Starting mix No. 2 received the flash from a match head, burnt through to the starting mix No. 1, which passed a flash to the fast layer. The fast layer did two things:

1. it generated some smoke quickly
2. it ignited the main body of smoke mixture.

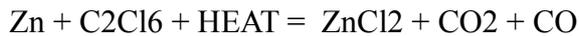
Much effort after WWI and before the start of WWII was directed to improving the mixtures in smoke candles. This effort resulted in the discovery that by substituting hexachlorethane for carbon tetrachloride a similar smoke producing agent was obtained but because it was a solid the necessity of using an inert filler was avoided. The composition of HC smoke is as follows:

Zinc dust	28%
Hexachlorethane	50%
Potassium perchlorate	22%

This mixture also requires an ignition mix that is composed of:

Antimony	76.4%
Zinc dust	11.8%
Potassium perchlorate	11.8%

This mixture behaved in the following manner:



Burning this mixture produces Zinc chloride, which is volatilised by the heat and this combines with the moisture in the air to yield a cloud of Zinc Chloride droplets. Included in this group are the compositions mixed with High Explosives to indicate the point of impact. An example of this type of mixture is the following:

Ammonium Nitrate	40%
Ammonium Chloride	40%
TNT	20%

	Fast mix	Slow mix
Zinc dust	36%	36%
Hexachlorethane	43%	44%
Ammonium perchlorate	15%	10%
Ammonium chloride	6%	10%

STARTING MIX

Potassium nitrate	42%
Antimony trisulphide	26%
Ferrous sulphide	26%
Dextrin	6%

10% LAYER OF FAST SMOKE MIX

90% HC MII SMOKE CANDLE