NITROCELLULOSE

This has to be the most important ingredient in the explosives field. It is the basis for most propellants, many rocket propellants and the foundation for countless commercial blasting explosives. As with Nitroglycerine the name should really be Cellulose nitrate, as it does not contain the nitro group but the nitrate one.

Pelouze discovered this substance in 1838 but it was not until Mr. Schoenbein began work on it in 1845 that it became important. All the early attempts at controlling the substance met with disasters because of the trapped acid in the fibres. Frederick Abel was able to demonstrate that this problem could be overcome by boiling and pulping the material until no fibrous structure remained.

In 1884 Schultze put the world on the right track when he partially colloided nitrocellulose for the first time. EC powder was also a step in the right direction when it was developed in England at about this time.

EC Powder consists of the following:

INGREDIENT	PERCENTAGE
SOLUBLE NC	44.0
INSOLUBLE NC	30.4
METALLIC NITRATES	14.0
VASELINE	6.0
CAMPHOR	4.0
WATER CONTENT	1.6

The terms "Soluble" and "Insoluble" used in the table above refer to the solubility of the nitrocellulose in a mixture of Ether/Alcohol 2:1 by volume. The solubility of NC depends entirely on the nitrogen content.

11.1 to 12.6 % Nitrogen is soluble.
12.8 to 13.1 % Nitrogen in insoluble.

All forms of NC are soluble in Acetone and insoluble in water.

Nitrocellulose made from cotton and containing more than 13% nitrogen is called "Guncotton"

Paul Vielle firmly fixed his place as the father of smokeless powder by producing the first completely colloided nitrocellulose called “Poudre B” (The "B" was to honour his General. General Boulangier.

These steps produced the marvelous situation whereby the material is a very violent explosive when in fibre form and is a low order explosive when it is gelatinised.

The nitration of Cellulose is never complete and in fact creates a material which is a blend of

- Cellulose Mononitrate,
- Cellulose Dinitrate and
- Cellulose Trinitrate.

These are all in a random mixture. For such an ill-defined material the difficulty of describing it has been overcome by expressing its nature by the percentage of Nitrogen content. Because of the high nitrogen content this is one of the least stable of all the military explosives.

The physical properties of Nitrocellulose

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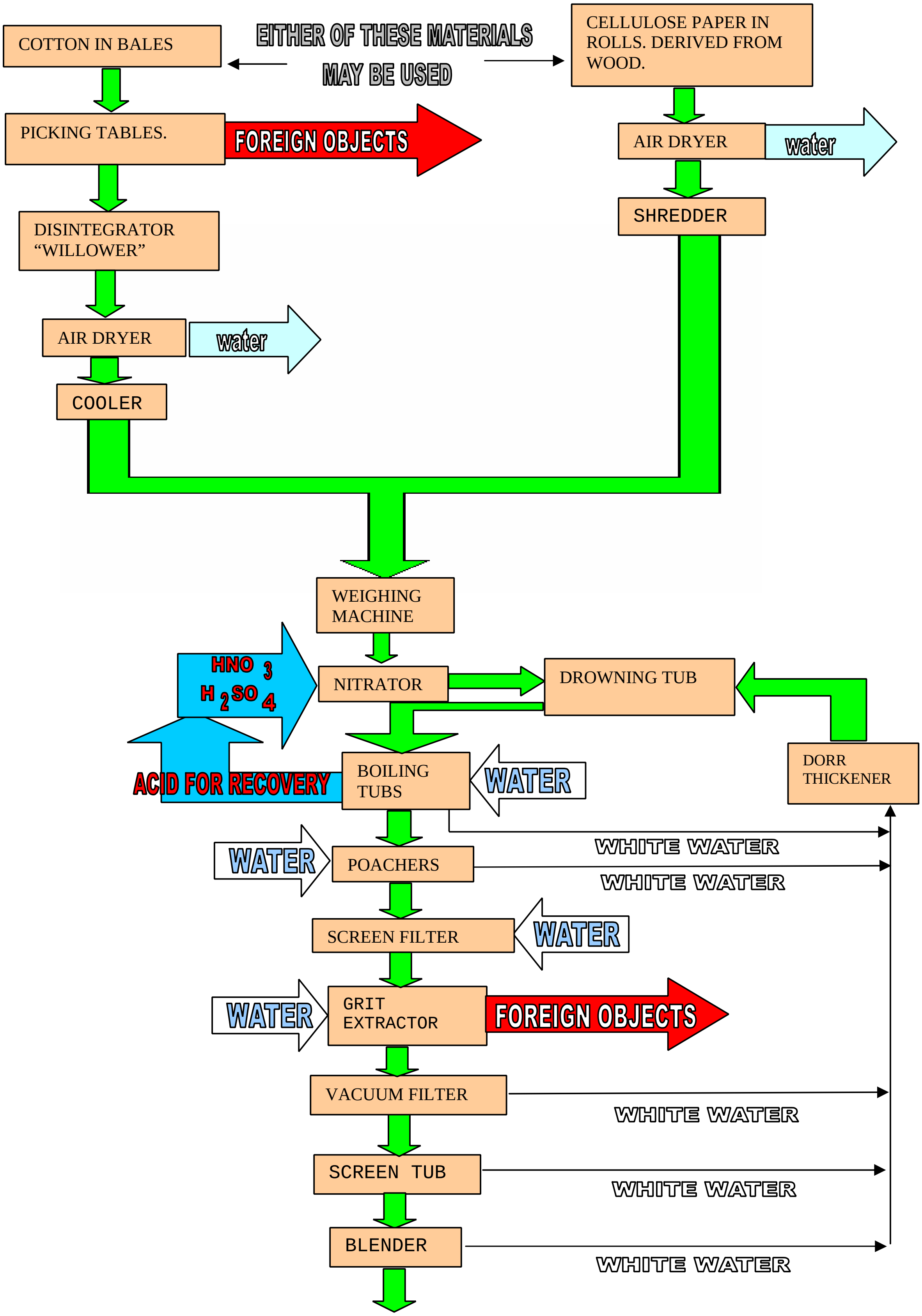
% N	MP	IP	POWER	F of I	V of D	Density
A=12.6	Will decompose before melting.	170 to 230	115	similar to Lead Azide	7300 mps	

The ability of the chemical engineers to vary the nitrogen content to suit their needs has resulted in a range of NC products.

Nitrogen Content	Used for	Notes
10.2 to 11.0 %	Mortar augmenting charges	This material is called Celluloid and consists of 75% NC and 25% camphor
11.2 to 11.7 %	Photographic film & lacquers.	
12.2 %	SC propellant. Extruded double base rocket propellants.	Known as “Type A”
12.5 %	Neonite propellants	Known as “Nobels Rifle Neonites” NRN
12.6 %	Cast double base rocket propellants.	
12.65 %	Ballistite	
12.9 to 13.1 %	WM propellant	Known as “Waltham Abbey Modified” and “Type B”
13.15 %	NH and FNH propellants	
13.2 %	NNN propellants	
13.4 %	Neonites NPP	Known as “Nobels Parabellum powder”
14.14	No known use	This is the maximum theoretical nitration.

PREPARATION OF NITROCELLULOSE



TO POWDER HOUSE

SUMMARY OF MANUFACTURING PROCESS

The raw material is a paper product called "Alpha Cellulose Board" and is supplied in the form of a giant paper roll much like a roll of newsprint. This is first passed through a drying process to reduce the moisture content to approximately .5% to 1% the dry board is then passed through a shredder and the shredded material is loaded into a Pulp Bin. From this bin the pulp is treated with a mixture of Nitric Acid (HNO_3) and Sulphuric Acid ($H2\ S0_4$). The presence of the Sulphuric Acid is to absorb the water given off during the chemical reactions. Otherwise the reactions would be diluted and corrupted by the mere fact of the presence of that water.

The Acid is heated just prior to loading into the nitrating tank that is fitted with a stirrer. This stirrer is set in motion and the pulp is then added to the acid. The stirrer is designed to draw the fibres under the surface of the acid very rapidly. The pulp remains in the acid for approximately 20 minutes for high grade Nitrocellulose and approximately 26 minutes for lower grade Nitrocellulose. The quantity of Pulp for high grade is 9 kg and it is treated with 400 kgs of Acid. For the lower grade nitrocellulose, 20 kg of pulp and approximately 760 kgs of acid are required. You may understand from these figures just how critical these chemicals are during wars.

After the nitration process is completed the nitrated pulp is separated from the spent Acid and passed to a centrifugal wringer and wrung until all possible spent acid is removed. The spent acid is passed to a spent acid storage tank to await refurbishment with extra acid and thence re-used

The Nitrocellulose is now drowned in water and passed to a holding tub where it is kept covered with water. It is then pumped to a boiling tub, which has a central heating duct and a false bottom thus permitting the nitrocellulose to be heated without direct contact with live steam. Here the "charge" as it is known is given three boilings the first being with water containing .25% to .5% Sulphuric Acid and the next two are simply plain water. The object of these boilings is to stabilize the charge by removing unwanted impurities and unstable compounds. The water from these boilings, which is called "White water", does contain some nitrocellulose that is collected in wooden tanks prior to the water being drained off to waste. This nitrocellulose is later added to a virgin batch thus implementing a small but important economy. This recovered nitrocellulose is called "Saveall" and the recovery machine is called a "Dorr Thickener" This Saveall is treated in exactly the same way as virgin nitrocellulose and is given a distinguishing number to identify the batch.

After this stabilizing treatment the fibres still contain minute quantities of acid (The cause of some of the nasty explosions in propellant factories in the late 1800s). Thus it is absolutely vital that this acid is removed and the only way to ensure this is to destroy the fibrous structure by finely pulping the fibres in a machine called a beater.

This consists of a rotor fitted with a series of blades that ensure the fibres are cut to a very short length. To further neutralize the acid the slurry is made alkaline by the addition of Soda ash.

A final purification is carried out by boiling a large batch of slurry of approximately 2300kg in a tub called a "Poaching Tub" in water that has been made alkaline by the addition Soda ash once again. This boiling process consists of one 4-hour alkaline boil followed by one 2-hour plain water boil and then a further two 1 hour plain water boils. The tub is emptied after each boil. The aim of this neutralizing boiling is to stabilize the nitrocellulose.

After the boiling is finished the nitrocellulose from the poaching tub is run over what is called a "Packer screen" which screens out any particles over .00008mm and the slurry is then run over a felt lined trough fitted with permanent magnets. The felt and the magnets ensure that any remaining impurities are removed. The nitrocellulose is then given a final filter in a rotary vacuum machine at the same time being flushed with copious quantities of water.

The nitrocellulose is then passed to a screen tub where it is blended with Saveall and other batches of virgin nitrocellulose to achieve the desired nitrogen content. The blending takes place in a stirring tank and the size of the batch is around 11000kg. The moisture content is around the 30% to 33% and is ready for use in the manufacturing of smokeless powder.

In the past the NC would go on to either smokeless propellant or to become Guncotton. Guncotton is not now made.