

*Lecture notes on Chemical Process
Industries II
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PAINTS

Paint: Paint is any liquid or liquefiable composition which is of the form of thin films of polymerization of polyunsaturated oil that converts into a solid form.

Varnish: Varnish is a clear, hard solution that is principally applied to wood to give it a glossy finish while forming a protective film around it.

Lacquer: Lacquer is a clear or colored wood finish that dries by solvent evaporation or a drying process that produces a hard, durable finish.

Enamel: Enamel is a colored substance that air dries to a hard, usually glossy finish, used for coating surfaces that are outdoors or otherwise. These are subjected to wear and tear or subjected to variations in temperature.

Constituents of paint

Additives:

- Additives are mixed in very small amounts and yet give a very significant effect on the product.
- Additives are used because:
 - Modify surface tension
 - Improve flow properties
 - Improve the finished appearance
 - Improve pigment stability
 - Control foaming
 - Control skinning

Solvents:

- The main purpose of the solvent is to adjust the viscosity of the paint.
- Water is the main vehicle for water-based paints.
- Solvent based paints can have various combinations of solvents as the vehicle, including aliphatic, alcohols, etc.
- These include organic solvents such as petroleum distillate, esters, glycerol ether and others.

Fillers:

- Fillers are a special type of pigments that serve to thicken the film, support its structure and simply increase the volume of the paint.
- Fillers are usually comprised of cheap and inert materials, such as talc, lime, clay, etc.

Resins:

- Resins are substances that bind or glues ingredients (pigments and additives) of paint together.
- Resin provides adhesion to the substrate.
- Resin provides durability and resistance properties:
 - U-V resistance
 - Moisture resistance
 - Chemical resistance
 - Stain resistance
 - Fade resistance
 - Chalk resistance

Prime pigments:

- Titanium dioxide
 - Provides excellent hiding power and whiteness.
 - Available as a solid (powder) or liquid (slurry).

- It is the world's primary pigment for providing whiteness, brightness and opacity.
- Zinc oxide
 - Controls mildew
 - Resists U-V light
 - Resists yellowing

The manufacturing procedure:

Raw materials: Resin, pigment and additive agents

Mixing: Resin, pigment and solvent are mixed to produce an even mill base

Milling: Mill base produced at the mixing process is sent to the disperser to finely disperse the pigment particles.

Blending: Resins, additive agents and so on are added to the mill base, the dispersion of which is completed. And the color phase is adjusted with color materials.

Filtering: Blended and toned paint is filtrated.

Packing: Filtrated paint is packed to a container.

Advances in paint technology:

- Improved indoor air quality and elimination of odors.
- Reduction of mold and mildews
- Microbicidal properties
- Enhanced durability
- Lower total paint or paint film thickness
- Desire to perform more work with less labor
- Heat reflective paint to reduce cooling costs
- Low maintenance and repaint

Titanium Dioxide:

Production by:

- Sulfate process(wet process)

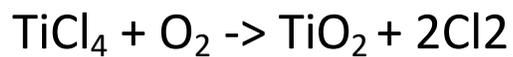
Titanium dioxides have been made from rutile and ilmenite (FeO-TiO_2).

This wet process involves:

- 1 Digestion in sulfuric acid
- 2 Removal of iron as FeSO_4
- 3 Concentration in vacuum evaporators
- 4 Precipitation of TiH_2
- 5 Calcination, grinding and bagging

- Chloride process(flame process)

The pigment properties of the flame process have superior qualities and the flame process is potentially a lower cost process than the wet process. In this process, the ore is chlorinated and volatile FeCl_3 separated from TiCl_4 if iron is present in the ore. Then TiCl_4 , which is a liquid at room temperature, is fed to a burner along with oxygen where the following reaction occurs.



The reaction takes place at a temperature of 1500°C .

The chlorine is recycled to the ore chlorination setup.

EXPLOSIVES

An explosive is defined as a substance which can undergo extremely rapid, self propagating decomposition with the formation of a large volume of gaseous products and evolution of heat. It is generally prepared from one or several ingredients in solid form. Reaction may be initiated by heat, impact, friction or a compression wave from another explosive. Explosive differ widely in degree of sensitivity for initiation and in ultimate force-time (impulse) characteristics.

Classification:

1 Initiators or Detonators : exothermic reaction as readily started by brief application of heat, friction, or impact. Small quantities used to initiate less sensitive higher power explosives.

Examples: lead azide, mercury fulminate.

2 Non Initiating high explosives: a high power explosive which requires an initiator to set off explosive reaction.

Examples: TNT; amatol (mixture of TNT and ammonium nitrate); dynamite (mixture of nitroglycerine, ammonium nitrate, sodium nitrate, sulfur, carbonaceous solid filler); akremite (mixture of prilled ammonium nitrate, fuel oil and dynamite).

Low explosive or propellants: materials whose reaction rates are relatively slow and controllable.

Examples: Colloidal cellulose nitrate; black powder (KNO_3 -75%, charcoal-15%, sulfur-10%)

Permissible explosives: Must yield a very low flame temperature of short time duration. Used in coal mines where gaseous or coal dust explosions may be avoided. Low flame temperature achieved by:

1. Using ingredients which are strongly exothermic (NH_4NO_3)
2. Adding materials which are inactive in explosion reactions but have high heat capacity (H_2O , hydrate inorganic salts).

Properties of Explosives

- Power or brisance- combination of force*velocity to achieve shattering characteristics.
- Sensitivity-measured by impact loading , friction, and initiating temperature
- Explosion or adiabatic flame temperature
- Velocity of detonation wave

DYNAMITE

Dynamite manufacture is highly regulated and the process strictly controlled to prevent accidental detonations. The equipment used is specially designed to reduce the exposure of the mixture to heat, compaction forces, or ignition sources. Bearings in the product mixers, for example, are mounted outside of the apparatus frame to prevent contact with the explosive mixture. Buildings and storage areas (called magazines) are constructed at great distances from other structures and with specialized heating, ventilation, and electrical systems. These buildings are "hardened" with bullet-resistant roofs and walls and extensive security systems. Other important precautions include thorough inspection systems which insure correct mixing, grading, packaging, and inventory control. Employees are also highly trained to work with the explosives, and special health precautions are required. Exposure to nitroglycerin commonly produces throbbing headaches, although immunity to the toxic effects can be developed. Interestingly, nitroglycerin is also used in medicine to treat some forms of angina and other ailments. In the body, it acts as a vasodilator and relaxes muscle tissue.

MANUFACTURING PROCESS

Process begins with the compound liquid such as nitroglycerin (explosive oil), a **dope** substance and an antacid. Ethylene glycol dinitrate, composing approximately 25-30% of the explosive oil, is used to depress the freezing point of the nitroglycerin which allows the dynamite to be safely used at low temperatures.

MIXING

The explosive oil is carefully added to a mechanical mixer where it is absorbed by the "dope," which can be diatomaceous earth (now no longer used), wood pulp, sawdust, flour, starch, and/or other carbonaceous substances and combinations of substances.

NEUTRALIZATION

Approximately 1% antacid such as calcium carbonate or zinc oxide is added to neutralize any acidity present in the dope. The mixture is monitored carefully and when the correct ingredient level is attained, the mixture is ready for packaging into the various forms. This process produces what is termed "straight dynamite," in which the dope does not contribute to the explosive strength of the dynamite. For example, 40% straight dynamite contains 40% nitroglycerin and 60% dope; 35% straight dynamite contains 35% nitroglycerin and 65% dope. In some cases, sodium nitrate is mixed with the dope, which acts as an oxidizer and gives additional strength to the explosive.

PACKAGING

The appearance of dynamite typically resembles a round cartridge approximately 1.25 inches (3.2 cm) in diameter and 8 inches (20 cm) long. This type is produced by pressing the dynamite mixture into a paper tube sealed with paraffin. The

paraffin enclosure protects the dynamite from moisture and, being a combustible hydrocarbon, contributes to the explosive reaction. Dynamite can also exist in many other forms, from smaller sizes of cartridges for specialized demolition work to large 10-inch (25 cm) diameter charges that are used for large strip mining operations. Regulations limit the length of these big charges to 30 inches (76 cm) and the weight to 50 pounds (23 kg). Dynamite is also available as a bag powder and in a gelatinized form for underwater use.

Dynamites are also made using other substances besides nitroglycerin. For instance, replacing a larger portion of the explosive oil with ammonium nitrate can increase the explosive strength of the dynamite. This form of dynamite is referred to as ammonia dynamite.

QUALITY

Accurate dynamite strength measurement and testing by detonation assure safe performance of the explosive. The relative strength of dynamite is graded by comparison to straight dynamite and by the percentage of weight of the explosive oil. For example, ammonia dynamite is compared to straight dynamite and is graded accordingly. Fifty percent ammonia dynamite is equal in explosive strength to 50% straight dynamite.

After manufacture and batch testing of the dynamite, it is dispensed to the job site under strict transportation and storage regulations.

APPLICATION

The following brief example is one of many scenarios for the proper application of dynamite. It must be noted that no one but a certified blasting expert with the correct procedures and equipment should ever attempt to detonate dynamite.

In this example, a rock formation must be blasted to make way for a construction project. The first step in the blasting procedure is to determine the size of the charge by various means, including charts, calculations, and the blaster's experience. Close examination of the affected area and surrounding terrain is made to determine the safe zone. Signs are placed a minimum of 1000 feet (305 m) outside the safe zone to warn the public of the blasting. The charge is then withdrawn from the magazine and transported to the blast site using closed and secure trucks. The detonators are brought to the job site in a separate vehicle.

The charges are unloaded and placed into the blast holes drilled in the rock formation. They slide into the blast hole by air pressure or by tamping with wooden or plastic rods. The blaster

takes great care that the lead wires to the detonators are shorted together until all charges have been placed. Only the blaster is allowed to make the final electrical connections to the main firing switch.

During this time, a 5-foot (1.5 m) gap in the wiring immediately ahead of the main switch is used as a "lightning gap," another safety practice to eliminate the possibility of static electricity setting off the charges. Once all of the preparation for the blast is complete, a warning horn sounds a one-minute series of blasts prior to the detonation signal. At this time, the final connections to the firing switch are made. At one minute to detonation, a series of short horn blasts are sounded. The blaster then unlocks the main switch and detonates the charges. After the explosion, all electrical circuits to the blasting equipment are once again locked into the safe positions, and the area is inspected for misfired charges and general safety. A prolonged horn blast signals the all clear.

BYPRODUCTS

Explosives manufacture and use contribute some measure of hazardous waste to the environment. Nitroglycerin produces several toxic byproducts such as acids, caustics, and oils contaminated with heavy metals. These must be disposed of

properly by neutralization or stabilization and transported to a hazardous waste landfill. The use of explosives creates large amounts of dust and particulate from the explosion, and, in some cases, releases asbestos, **lead**, and other hazardous materials into the atmosphere. Also, uncontrolled or improperly calculated explosions may rupture nearby tanks and pipelines, releasing their contents into the environment as well.

FUTURE

Since their development in the 1950s, advanced forms of plastic explosives and shaped charges have replaced dynamite. These explosives are now referred to as blasting agents, since their stability is improved and require a more powerful primer to detonate. One of the most common blasting agents is ANFO, or ammonium nitrate and fuel oil. ANFO is readily available, considerably cheaper than dynamite, and can be mixed on site. However, concrete demolition crews requiring relatively small charges still use dynamite as the blasting agent.