

INDUSTRIAL CHEMISTRY- UNIT-II

Pulp and Paper Manufacturing Process in the paper industry

Pulp and Paper Manufacturing Process



Pulp and Paper Industry

The pulp is fed to a paper machine where it is formed as a paper web and the water is removed from it by pressing and drying.

Pressing the sheet removes the water by force. Once the water is forced from the sheet, a special kind of felt, which is not to be confused with the traditional one, is used to collect the water. Whereas, when making paper by hand, a blotter sheet is used instead.

Drying involves using air or heat to remove water from the paper sheets. In the earliest days of paper making, this was done by hanging the sheets like laundry. In more modern times, various forms of heated drying mechanisms are used. On the paper machine, the most common is the steam heated can dryer.

Paper plays a key role in our daily life and papers have been used for many years from now. Papers are made with the pulp of the woods, which is an Eco-friendly product.

Paper is made through the following processes:

- 1) Pulping procedure will be done to separate and clean the fibres
- 2) Refining procedure will be followed after pulping processes
- 3) Dilution process to form a thin fibre mixture
- 4) Formation of fibres on a thin screened
- 5) Pressurization to enhance the materials density
- 6) Drying to eliminate the density of materials
- 7) Finishing procedure to provide a suitable surface for usage

Pulp and paper are made from cellulosic fibres and other plant materials. Some synthetic materials may be used to impart special qualities to the finished product. Paper is made from wood fibres, but rags, flax, cotton linters, and bagasse (sugar cane residues) are also used in some papers. Used paper is also recycled, and after purifying and sometimes deinking, it is often blended with virgin fibres and reformed again into paper. Products such as cellulose acetate, rayon, cellulose esters that are made from cellulose will be used for packaging films, explosives.

The pulping process is aimed at removing lignin without losing fibre strength, thereby freeing the fibres and removing impurities that cause discoloration and possible future disintegration of the paper.

Hemicellulose plays an important role in fiber-to-fiber bonding in papermaking. It is similar to cellulose in composition and function. Several extractives such as waxes, oleoresins are contained in wood but they do not contribute to its strength properties; these too are removed during the pulping process.

The fiber extracted from any plant can be used for paper. However, the strength and quality of fiber, and other factors complicate the pulping process. In general, the softwoods (e.g., pines, firs, and spruces) yield long and strong fibers that contribute strength to paper and they are used for boxes and packaging.

Hardwoods produce a weaker paper as they contain shorter fibers. Softwoods are smoother, transparent, and better suited for printing. Softwoods and hardwoods are used for papermaking and are sometimes mixed to provide both strength and print ability to the finished product.

Steps involved in the Pulp and Papermaking Procedure:

Preparation of raw Material

Wood that has been received at a pulp mill can be in different forms. It depends on the pulping process and the origin of the raw material. It may be received as bolts (short logs) of round-wood with the bark still attached, as chips about the size of a half-dollar that may have been produced from sawmill from debarked round wood elsewhere.

If round wood is used, it is first debarked, usually by tumbling in large steel drums where wash water may be applied. Those debarked wood bolts are then chipped in a chipper if the pulping process calls for chemical digestion. Chips are then screened for size, cleaned, and temporarily stored for further processing.

Separation of Fibre

In the fibre separation stage, several pulping technologies will be diverged. The chips are kept into a large pressure cooker (digester), into which is added the appropriate chemicals in kraft chemical pulping.

The chips are then digested with steam at specific temperatures to separate the fibers and partially dissolve the lignin and other extractives. Some digesters operate continuously with a constant feed of chips (furnish) and liquor are charged intermittently and treat a batch at a time.

After the digestion process, the cooked pulp is discharged into a pressure vessel. Here the steam and volatile materials are tubed off. After that, this cooked pulp is returned to the chemical recovery cycle. Fibre separation in mechanical pulping is less dramatic.

Debarked logs are forced against rotating stone grinding wheels in the stone ground-wood procedure. Refiner pulp and thermo-mechanical pulp are produced by chips. These chips are ground by passing them through rapidly rotating in both processes.

In the second stage after refining, the pulp is screened, cleaned, and most of the process water is removed in preparation for paper making.

Bleaching Process

Raw pulp contains an appreciable amount of lignin and other discoloration, it must be bleached to produce light colored or white papers preferred for many products. The fibers are further delignified by solubilizing additional lignin from the cellulose through chlorination and oxidation. These include chlorine dioxide, chlorine gas, sodium hypochlorite, hydrogen peroxide, and oxygen.

Sodium Hydroxide, a strong alkali is used to extract the dissolved lignin from fibers surface. The bleaching agents and the sequence in which they are used depend on a number of factors, such as the relative cost of the bleaching chemicals, type and condition of the pulp.

Mechanical pulp bleaching varies from chemical pulp bleaching. Bleaching of mechanical pulp is designed to minimize the removal of the lignin that would reduce fiber yields.

Chemicals used for bleaching mechanical pulps selectively destroy coloring impurities but leave the lignin and cellulosic materials intact, These include sodium bisulfite, sodium or zinc hydrosulfite (no longer used in the United States), calcium or sodium hypochlorite, hydrogen or sodium peroxide, and the Sulfur Dioxide-Borol Process (a variation of the sodium hydrosulfite method).

Papermaking Procedure

Bleached or unbleached pulp may be further refined to cut the fibers and roughen the surface of the fibers to enhance formation and bonding of the fibers as they enter the paper machine.

Water is added to the pulp slurry to make a thin mixture normally containing less than 1 percent fiber. The dilute slurry is then cleaned in cyclone cleaners and screened in centrifugal screens before being fed into the 'wet end' of the paper-forming machine. The dilute stock

passes through a head-box that distributes the fiber slurry uniformly over the width of the paper sheet to be formed.

Pulping

There are a number of different processes which can be used to separate the wood fibre:

Mechanical pulp

Manufactured grindstones with embedded silicon carbide or aluminum oxide can be used to grind small wood logs called "bolts" to make stone pulp (SGW). If the wood is steamed prior to grinding it is known as pressure ground wood pulp (PGW). Most modern mills use chips rather than logs and ridged metal discs called refiner plates instead of grindstones. If the chips are just ground up with the plates, the pulp is called refiner mechanical pulp (RMP) and if the chips are steamed while being refined the pulp is called thermomechanical pulp (TMP). Steam treatment significantly reduces the total energy needed to make the pulp and decreases the damage (cutting) to fibres. Mechanical pulps are used for products that require less strength, such as newsprint and paperboards.

Thermomechanical pulp



Mechanical pulping process

Thermomechanical pulp is pulp produced by processing wood chips using heat (thus "thermo-") and a mechanical refining movement (thus "-mechanical"). It is a two-stage process where the logs are first stripped of their bark and converted into small chips. These chips have a moisture content of around 25–30 percent. A mechanical force is applied to the wood chips in a crushing or grinding action which generates heat and water vapour and softens the lignin thus separating the individual fibres. The pulp is then screened and cleaned, any clumps of fibre are reprocessed. This process gives a high yield of fibre from the timber (around 95 percent) and as the lignin has not been removed, the fibres are hard and rigid.

Chemi-thermomechanical pulp

Wood chips can be pre-treated with sodium carbonate, sodium hydroxide, sodium sulphate and other chemicals prior to refining with equipment similar to a mechanical mill. The conditions of the chemical treatment are much less vigorous (lower temperature, shorter time, less extreme pH) than in a chemical pulping process since the goal is to make the fibers easier to refine, not to remove lignin as in a fully chemical process. Pulps made using these hybrid processes are known as chemi-thermomechanical pulps (CTMP).

Chemical pulp]



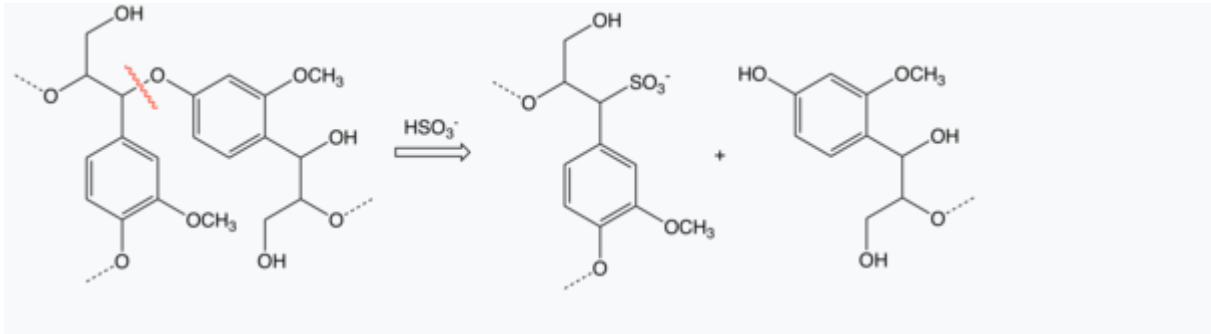
International Paper Company, a pulp mill that makes fluff pulp for use in absorbent products with the kraft process.

Chemical pulp is produced by combining wood chips and chemicals in large vessels called digesters. There, heat and chemicals break down lignin, which binds cellulose fibres together, without seriously degrading the cellulose fibres. Chemical pulp is used for materials that need to be stronger or combined with mechanical pulps to give a product different characteristics. The kraft process is the dominant chemical pulping method, with the sulfite process second. Historically soda pulping was the first successful chemical pulping method.

Sulfite process

The **sulfite process** produces wood pulp that is almost pure cellulose fibers by treating wood chips with solutions of sulfite and bisulfite ions. These chemicals cleave the bonds between the cellulose and lignin components of the lignocellulose. A variety of sulfite/bisulfite salts are used, including sodium (Na^+), calcium (Ca^{2+}), potassium (K^+), magnesium (Mg^{2+}), and ammonium (NH_4^+). The lignin is converted to liginosulfonates, which are soluble and can be separated from the cellulose fibers. For the production of cellulose, the sulfite process

competes with the Kraft process, which produces stronger fibers and is less environmentally costly.



Sulphate process

The **kraft process** (also known as **kraft pulping** or **sulfate process**) is a process for conversion of wood into wood pulp, which consists of almost pure cellulose fibers, the main component of paper. The kraft process entails treatment of wood chips with a hot mixture of water, sodium hydroxide (NaOH), and sodium sulfide (Na₂S), known as white liquor, that breaks the bonds that link lignin, hemicellulose, and cellulose. The technology entails several steps, both mechanical and chemical. It is the dominant method for producing paper. In some situations, the process has been controversial because kraft plants can release odorous products and in some situations produce substantial liquid wastes.



Soda pulping

Soda pulping is a chemical process for making wood pulp with sodium hydroxide as the cooking chemical. In the *Soda-AQ* process, anthraquinone (AQ) may be used as a pulping additive to decrease the carbohydrate degradation. The soda process gives pulp with lower tear strength than other chemical pulping processes (sulfite process and kraft process), but has still limited use for easy pulped materials like straw and some hardwoods.

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- Long Lasting & Strong Paper with security features as per RBI & IBA guidelines

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- Used for making Cheques

Sizes

- Standard Sizes in Reels & Sheets
- Gsm- 95

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Features

- Long Lasting & Strong Paper

End Uses

- Certificate, shares & bonds, archival records

Sizes

- Standard Sizes in Sheets & Reels
- Gsm- 80 – 105

JK Envelope

- **Features :** Excellent strength with folding properties
- **End Uses :** Envelope and wedding cards
- **Availability :** White, NS and BUFF in both Reel and Sheet

JK Carry

- **Features :** **High Strength, good printable surface, high bright white / natural shade**
- End Uses -Paper Carry bag
- Availability Available in reel and sheet

JK Tally

- **Features :** High smooth, better smooth, Bright white paper which retains crease for use in accounts book
- **End Uses :** Accounts book, Printing applications
- **Availability :** Reel and sheet

JK Fab Print

- **Features-** High smoothness, Dirt & specks free, base paper for Sublimation printing.
- **End Uses -** Garment Printing, Screen printing,
- **Availability -** Reel order

JK Stiffner

Features

- Stiffener Paper is used for soap wrappers, can be poly extruded

- Natural shade
- Meet ARSR specifications
- Customized product for soap wrapper application

End Uses

- Soap Wrapper (Interleaving Layer)

Availability

- Available in reel and sheet

Paper stock

Whether you're printing off a brochure, a flyer/pamphlet or book, you should always think about the different types of paper stock you may be using. This includes considering the different types of paper textures, the weight and thickness, as well as coated or uncoated paper. At BannerSHOP, we're happy to lend you a hand with choosing the right paper stock for your business needs.

Paper Types *Bond* For your stationery item needs such as letterheads, slips and envelopes, bond paper is great for those types of jobs. It can be used as regular copy paper that you would find in your office printer. However, they're not ideal for promotional items.

Coated Paper Promotional items such as flyers, brochures, postcards and posters will always need a good quality finish. Coated paper usually contains clay and has a surface sealant. Coated papers often restrict ink from absorbing the surface of the paper, giving your images, gradients and colours the sheen it needs. There are a few types of coated paper to choose from:

- **Gloss:** Gloss is the kind of paper you'd find in magazines. It is also cost-efficient with less bulk and opacity as regular matte paper.
- **Satin/Silk:** Low in gloss, satin or silk paper has a smooth surface.
- **Matte:** With little sheen, matte paper is non glossy and is more opaque with a greater bulk.

Uncoated Paper Business cards, letterheads and invitations are typically printed on uncoated paper. They contain a number of types varying in different textures.

What on earth is a GSM? If you're new to outsourcing printing services, you'll be asked what GSM you would like to print your job on. GSM is a measurement of the quality and weight of your paper. It's also an acronym which stands for "Grams per Square Metre". The higher the GSM number, the heavier the paper stock will be.

90 -100 GSM Often the cheapest and lightest option, 90-100GSM paper weights are usually ideal for brochures, flyers, envelopes, slips and letterheads.

115 - 170 GSM Perfect for your business posters, wall planners/calendars and text pages in your booklets and magazines.

200-250 GSM If you're after booklets and magazine covers, the thickness of a 250GSM will give your printing jobs the level of professionalism it needs.

300-420 GSM Ideal for your business cards, flyers and promo cards.

Structural boards

Our structural boards are developed to incorporate natural materials and sustainable manufacture. Many of the products in our range contain recycled timber, and FSC/PEFC timber. Their natural materials make them a more sustainable, healthier alternative to more traditionally used structural boards such as OSB, meaning they're a perfect solution for environmentally conscious construction.

By incorporating natural materials into every part of a construction, you can ensure that houses and workplaces are healthier, more comfortable and pleasant places to live and work. This is due to the reduction in synthetic particles and irritants present in the building materials; many building materials emit these pollutants over time, reducing the air quality in our homes or work place. Non-synthetic materials also benefit from natural breathability and vapour management properties.

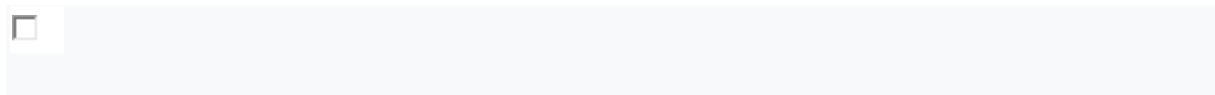
The high-quality nature of our structural boards means that they provide a durable, strong and reliable solution for construction, with added benefits for creating low emission, low energy, low wastage buildings. They benefit from high performance features including breathability and vapour control, as well as airtightness and humidity regulation, reducing the risk of condensation which can lead to mould development and damp.

SOAP AND DETERGENTS

A **detergent** is a chemical compound or mixture of compounds used as a cleaning agent. A **soap** is a cleaning agent that is composed of one or more salts of fatty acids. Thus, by its broad definition, *detergent* is an umbrella term that includes soaps and other cleaning agents with various chemical compositions. Often, however, the term *detergent* is used in a narrower sense to refer to synthetic cleaning agents that are not soaps (that is, not salts of fatty acids).

Conversely, the term *soap* is often used in a broader sense to include a variety of cleaning agents (such as "laundry soap"). Here, the term *detergent* will be used in its broader sense (to include soaps), and the term *soap* will be used for products that consist mainly of fatty acid salts.

Detergents are commonly used in products for personal hygiene, dishwashing, and laundry. They are also used as ingredients in antiseptic agents, dry-cleaning solutions, lubricating oils, and gasoline.



Although detergents are very useful, the excessive use of certain ingredients has led to adverse effects on the environment. For instance, phosphate additives used for water softeners led to an increase in phosphorus content in lakes and rivers, triggering algal blooms that in turn consumed most of the oxygen in the waters, killing fish and plants. Efforts have been made to reduce such negative effects, but the results have been mixed.

Commercial soap production

Until the Industrial Revolution, soap-making was done on a small scale and the product was rough. In 1789, Andrew Pears started making a high-quality, transparent soap in London. He and his grandson, Francis Pears, opened a factory in Isleworth in 1862. William Gossage produced low-priced, good quality soap from the 1850s. Robert Spear Hudson began manufacturing a soap powder in 1837, initially by grinding the soap with a mortar and pestle. William Hesketh Lever and his brother James bought a small soap works in Warrington in 1885 and founded what became one of the largest soap businesses, now called Unilever. These soap businesses were among the first to employ large-scale advertising campaigns to sell the output of their factories.

Forms of soap

Soap usually comes in a solid, molded form, called a *bar*, based on its typical shape. The use of thick liquid soap has also become widespread, especially from soap dispensers in public washrooms. When applied to a soiled surface, soapy water effectively holds particles in suspension, which can then be rinsed off with clean water.

Components of detergents and their functions

As noted above, soaps are salts of fatty acids. A molecule of soap may be represented as follows:



Thus, each molecule of soap has (a) an ionic end, which is hydrophilic (water-attracting) and soluble in water; and (b) a nonpolar hydrocarbon chain that is hydrophobic (water-repelling) that can attach to nonpolar materials such as grease and oil. These molecules form bridges between water and oil, breaking up the oil and forming an emulsion consisting of oil droplets suspended in water. Substances made up of such molecules are called **surfactants**. They reduce the surface tension of water, and they reduce interfacial tension between oil and water by adsorbing at the liquid-liquid interface.



Diagram of how soap works.

Surfactants are key components of detergents in general. Because of their presence in detergents, oil and associated dirt particles become solubilized and can be rinsed away with clean water.

Many types of organic compounds can function as surfactants. They (and the detergents that contain them) are often classified into four groups: anionic, cationic, zwitterionic (with plus and minus charges), and non-ionic. In the case of non-ionic surfactants, the hydrophilic nature of one end is conferred by the presence of special functional groups such as hydroxyl groups. Most brands of laundry detergent have anionic or nonionic surfactants or a mixture of the two, although cationic surfactants have also been used. The use of cationic and anionic surfactants together is incompatible in the same detergent. The usual content of surfactants in a typical detergent is about 8-18 percent.

In addition to surfactants, detergents various other components that serve different functions. A given detergent may contain several of the following components:

- Abrasives that scour the surfaces.
- Substances that modify or control pH, or affect the performance or stability of other ingredients. For example, acids may be used for descaling, or caustics to destroy dirt.
- Water softeners counteract the effect of "hardness" ions (particularly calcium and magnesium ions). Some form of sodium phosphate (such as trisodium orthophosphate, monosodium orthophosphate, or a triphosphate) can be used here. In some locations, phosphate is no longer used due to environmental concerns, as phosphates in surface waters stimulate algal bloom. As alternatives, other chelating agents or ion exchange materials are used.
- Oxidizing agents (oxidizers) that bleach surfaces and destroy dirt. In North America, sodium hypochlorite based bleach additives are more common. These work at lower temperatures and do not need activation. In Europe, peroxide-based bleaches are prevalent.
- Fillers, forming a bulk component in many laundry detergents, modify the physical properties of the material. In solid detergents, sodium sulfate or borax can be used to make the powder free-flowing. In liquid detergents, alcohols are added to increase the solubility of the compounds and to lower the mixture's freezing point.
- Non-surfactant materials that keep dirt in suspension.
- Enzymes that digest proteins, fats, or carbohydrates. They help remove biological stains (such as stains from grass or blood). Enzymes produced by the bacteria *Bacillus subtilis* and *Bacillus licheniformis* are often used.
- Ingredients that modify the foaming properties of the cleaning surfactants, to either stabilize or counteract foam.
- Additional ingredients include optical brighteners, fabric softeners, colors, and perfumes.

The material to be cleaned dictates the composition of the detergent that should be used and the apparatus to be used. For instance, the following are examples of different glass-cleaning agents that are appropriate for different contexts:

- A chromic acid solution is used to get glass very clean for precision-demanding purposes, such as analytical chemistry
- A high-foaming mixture of surfactants with low skin irritation is needed for hand washing of drinking glasses in a sink or dishpan.

- Any of various non-foaming compositions are used for glasses in a dishwashing machine.
- An ammonia-containing solution is useful for cleaning windows, with no need for rinsing.
- Windshield washer fluid is useful especially when a vehicle is in motion.

Soap making



Handmade soaps sold at a shop in Hyères, France.

Some individuals continue to make soap in the home. The traditional name "soaper," for a soap maker, is still used by those who make soap as a hobby. Those who make their own soaps are also known as soap crafters.

The most popular process for handmade soaps today is the cold process, where oils such as olive oil are reacted with lye. Some soap makers use the "melt and pour" process, where a pre-made soap base is melted and poured into individual molds. Some soapers also practice other processes, such as the historical hot process, and make special soaps such as clear soap (glycerin soap).

Use of fats and oils



Handicraft made Marseille soap.

Soap is derived from either oils or fats. *Sodium tallowate*, a common ingredient in many soaps, is derived from rendered beef fat. Soap can also be made of vegetable oils, such as palm oil, and the product is typically softer.

An array of quality oils and butters are used in the process, such as olive, coconut, palm, cocoa butter, hemp oil and shea butter. Each oil chosen by the soap maker has unique characteristics that provide different qualities to handmade soaps including mildness, lathering and hardness. For example, olive oil provides mildness in soap; coconut oil provides lots of lather while coconut and palm oils provides hardness. Most common, though, is a combination of coconut, palm, and olive oils.

If soap is made from pure olive oil it may be called Castile soap or Marseille soap. The term "Castile soap" is also sometimes applied to soaps with a mix of oils, but a high percentage of olive oil.

Reactions with alkali

When fat (or oil) is reacted with lye (sodium hydroxide), the product is a hard soap. When fat is reacted with potassium hydroxide, the product is a soap that is either soft or liquid. Either reaction is known as *saponification*. The fat is hydrolyzed by the alkali, yielding glycerol and crude soap. Historically, the alkali used was potassium hydroxide, made from the deliberate burning of vegetation such as bracken, or from wood ashes.

Cold and hot processes

Hot process

In the hot-process method, lye and fat are boiled together at 80–100°C until saponification occurs. After saponification, the soap is sometimes precipitated from the solution by adding salt, and the excess liquid drained off. The hot, soft soap is then spooned into a mold.

The hot-process method was used when the purity of lye was unreliable, and when naturally produced lye, such as potash, was used. The main benefit of hot processing is that the exact concentration of the lye solution does not need to be known to perform the process with adequate success.

Unlike cold-processed soap, hot-processed soap can be used right away because lye and fat saponify more quickly at the higher temperatures used in hot-process soap making.

Cold process

In the cold-process method, fats such as olive oil are reacted with lye, at a temperature that is sufficiently above room temperature to ensure the liquefaction of the fat being used. It requires that the lye and fat be kept warm after mixing to ensure that the soap is completely saponified.

The cold process requires exact measurement of lye to fat using saponification charts, to ensure that the finished product is mild and skin friendly. Excess unreacted lye in the soap will result in a very high pH and can burn or irritate skin. Not enough lye, and the soap is greasy and oily. Most soap makers formulate their recipes with a 4-10 percent discount of lye so that all of the lye is reacted and that excess fat is left for skin conditioning benefits. (Saponification charts can also be used in hot-process soap making, but are not as necessary as for the cold-process method.)

The lye is dissolved in water. Then oils are heated, or melted if they are solid at room temperature. Once both substances have cooled to approximately 100-110°F, and are no more than 10 degrees Fahrenheit apart in temperature, they may be combined. This lye-fat mixture is stirred until it reaches a stage called "trace"—the point at which the saponification process is sufficiently advanced that the soap has begun to thicken. (Modern-day amateur soap

makers often use a stick blender to speed this process.). There are varying levels of trace: light, medium, and heavy.

Essential oils, fragrance oils, botanicals, herbs, oatmeal or other additives are added at light trace, just as the mixture starts to thicken. The batch is then poured into molds, kept warm with towels or blankets, and left to continue saponification for 18 to 48 hours.

After the insulation period, the soap is firm enough to be removed from the mold and cut into bars. At this time, it is safe to use the soap since saponification is complete. However, cold-process soaps are typically cured and hardened on a drying rack for 2-6 weeks (depending on initial water content) before use.

Purification and finishing

The common process of purifying soap involves removal of sodium chloride, sodium hydroxide, and glycerol. These components are removed by boiling the crude soap curds in water and re-precipitating the soap with salt.

Most of the water is then removed from the soap. This was traditionally done on a chill roll which produced the soap flakes commonly used in the 1940s and 1950s. This process was superseded by spray dryers and then by vacuum dryers.

The dry soap (approximately 6-12 percent moisture) is then compacted into small pellets. These pellets are now ready for soap finishing, the process of converting raw soap pellets into a salable product, usually bars.

Soap pellets are combined with fragrances and other materials and blended to homogeneity in an amalgamator (mixer). The mass is then discharged from the mixer into a refiner which, by means of an auger, forces the soap through a fine wire screen. From the refiner the soap passes over a roller mill (French milling or hard milling) in a manner similar to calendering paper or plastic or to making chocolate liquor. The soap is then passed through one or more additional refiners to further plasticize the soap mass. Immediately before extrusion it passes through a vacuum chamber to remove any entrapped air. It is then extruded into a long log or blank, cut to convenient lengths, passed through a metal detector and then stamped into shape in refrigerated tools. The pressed bars are packaged in many ways.

Sand or pumice may be added to produce a scouring soap. This process is most common in creating soaps used for human hygiene. The scouring agents serve to remove dead skin cells from the surface being cleaned. This process is called exfoliation. Many newer materials are used for exfoliating soaps which are effective but do not have the sharp edges and poor size distribution of pumice.

Uses

Detergents are mainly used in products for personal hygiene, dishwashing, and laundry. In addition, detergents are often added to a variety of products, to prevent the buildup of undesirable deposits. Some products that may contain detergents include:

- toothpastes
- antiseptic agents
- dry-cleaning solutions
- gasoline
- lubricating oils

A nature-friendly way of interrupting an ant trail is to pour soapy water on the trail. The soapy water destroys the scent the ants were following to get to food.

Disadvantages

Today, fat-based soaps have mostly been superseded by modern detergents. Washing agents do not contain soap for cleaning fabric, but for reducing foam.

The disadvantages of commercial soaps are:

- Due to the fact that most commercial soaps eliminate the glycerine from soaps to use in other industries, this deprives the skin of the natural, moisturising glycerine and generally leaves the skin feeling dry.
- Some antibacterial soaps have chemicals killing bacteria that coexist on the skin's surface and are essential to skin health.
- Soap-based products often contain the additive sodium laureth sulfate, which research has found to be harsh on skin. This product is also present in many non-soap cleaners for personal hygiene (such as shampoos, bathfoams, toothpaste).

- Soap can react mildly basically with fabrics resulting in damage over the long term. This is usually due to excess sodium hydroxide (NaOH, an alkali/base) left from manufacture, but can also be caused by the very slight presence of NaOH from the equilibrium reaction:

$$\text{R-COO-Na} + \text{H}_2\text{O} \leftrightarrow \text{R-COO}^- + \text{Na}^+ + \text{H}_2\text{O} \leftrightarrow \text{R-COOH} + \text{NaOH}$$
 However, this equilibrium strongly favors the left-hand side so the fraction of NaOH formed is minuscule
- Soap reacts with lime to form an insoluble deposit (soap scum) in "hard water":

$$2\text{Na}^+(\text{R-COO})^-_{(\text{aq})} + \text{Ca}^{2+}(\text{HCO}_3^-)_{2(\text{aq})} \rightarrow 2\text{Na}^+(\text{HCO}_3^-)_{(\text{aq})} + \text{Ca}(\text{R-COO})_{2(\text{s})}$$
 - where R stands for an alkyl group (precipitate)
- Poorly finished soaps contain alkali (NaOH) and react mildly basically with skin and fabric; commercial products are finished to neutrality or to a weak acid content to prevent this and be more compatible with the skin's slightly acidic pH.
- Commercial products use chelating molecules (sequestrants), often EDTA derivatives to bind with any free Ca or Mg ions and prevent soap scum. These also help reduce fragrance loss, discoloration. and rancidity.
- Castile soap has a very high alkalinity level, measured at about 9. pH of skin and hair has a slightly acidic pH level known to be about 5 to 6. Due to the high pH level, liquid castile soap is usually not recommended by soapmakers who market this high pH soap for washing hair because it is not pH-balanced and it may cause hair to become dry.

UNIT-V

Sugars

Green plants manufacture sugars so that they all contain some quantity of sugar. However, much of the manufactured product is used directly in plant metabolize that very little usually accumulates. Storage sugars are found in roots, as with beets, carrots, parsnips; in stems as in sugar cane, sorghum, maize and the sugar maple; in flowers, such as in palm trees; in bulbs like the onion; and in many fruits. There are several kinds of sugar, principal among which are sucrose or cane sugar, glucose or

grape sugar and fructose or fruit sugar. They all seem to serve as a reserve food supply for the plant.

Humans require sugar in their diet. It constitutes a perfect food, as it is a form that can be readily assimilated in the body. Its main value is as an energy producer, and it is especially well adapted for use after heavy exercise. A large industry has developed in connection with the extraction of sugar from plant tissues, purification and refining. Additionally over 10 thousand different chemical derivatives have been made.

Sugar is an especially valuable product derived from the plant world. Only wheat, maize, rice and potatoes surpass it in importance. Yet there are relatively few sources for this industry. Only the sugar cane, sugar beet, sugar maple, maize, sorghum and several palms are commercial sources. Sucrose is the type of sugar stored in all of these plant species.

Sugar Cane

Most sugar is derived from Sugar Cane, *Saccharum officinarum*. It is a vigorous and rapid-growing perennial grass reaching a height in cultivation of 8-12 ft and a diameter of about 2 in. It grows in clumps with bamboo like stems arising from large rootstalks and with very ornamental feathery plumes of flowers. The stem is solid with a tough rind and numerous fibrous strands, and contains about 80 percent juice, the sugar content of which varies considerably from area to area and season to season.

Commercial sugar cane is a cultivar that is not known in the wild state. The plant was most likely first domesticated in Southeastern Asia or the East Indies from some wild ancestor from that region. By 327 B.C. it had become an important crop in India. It reached Egypt in 641 A.D. and Spain in 755 A.D. Since that time sugarcane has gradually been introduced into most humid tropical and semitropical regions. The Portuguese and Spaniards were great disseminators of the plant into the New World. They carried it to Madeira in 1420 and to America by the beginning of the 16th Century. Within another 100 years it had spread all over the West Indies, Central and

South America. Sugar cane first arrived in the United States in Louisiana in 1741. The name “sugar” is derived from Sanskrit “sarkara,” meaning gravel, and refers to the crude sugar, which was the only kind known for centuries.

Sugar cane has been the principal export crop of the tropics and is unaffected by many of the conditions that influence the growing of other crops. It will grow well in any moist hot region where the average rainfall is 50 in. or more per year and where there is abundant sunshine and where temperatures do not drop below 70 deg. Fahrenheit. Backyard stands of sugar cane are possible in colder climates, however. Cultivation styles vary considerably, but in general extensive, flat, low-lying fields are utilized and these are plowed deeply. Cuttings of varying length made from the upper joints of old canes propagate the sugar cane. These cuttings, known as seed, are placed in trenches and nearly covered with soil. They begin to sprout in about two weeks. When the cane is grown for human consumption, the cuttings are usually placed in holes. The crop has to be cultivated, weeded and fertilized extensively during the first few months. It is harvested from 10-20 months after sprouting. Harvest is 10-20 months after sprouting. The sugar content is carefully monitored and the canes are cut at just the right stage. This is usually when the flowers are beginning to fade. The stems are cut close to the ground because the lower end of the cane is richest in sugar. Cane knives have been ordinarily used in poorer countries. The rhizomes normally give rise to two or three more crops, known as ratoons, before another planting is required. There have been up to 20 ratoon crops obtained, however.

Cultivated varieties today are usually hybrids of *Saccharum officinarum*, the “noble cane,” with other hardier species.

Sometimes small owners of a stand of sugar cane extracted their own sugar in a primitive mill, but more often large “centrals” have been established which draw their supply from a wide area. In the milling process the canes are first carried to crushers where they are torn into small pieces. They are then passed through three sets of rollers. In the first set 2/3rds of the juice is expressed. They are then sprayed with water to dilute what sugar remains, and are passed through the second set. These rollers exerts a very high pressure and remove nearly all of the moisture. After passing

through the last set the residue is almost dry. This bagasse, as it has been named, can be used as a fuel for the mills, as a source of paper or wallboard because of its fibrous nature. It also contains a wax with some commercial value.

The juice that flows from the mill is a dark-grayish sweet liquid full of impurities. It contains sucrose, and other sugars, together with proteins, gums, acids, coloring materials, soil and pieces of cane. The purification of the sugar involves the separation of the insoluble materials and the precipitation of the soluble nonsugars. The juice is first strained or filtered to remove the solid particles. It is then heated to coagulate the proteins, a process which is aided by the addition of sulfur. Lime is then added to neutralize the acids present, to prevent the conversion of sucrose into lower carbon sugars and to precipitate some of the substances in solution. These are removed by a series of filter bags or a filter press. Carbon dioxide may be added to aid in the process. The chemical processes involved in the purification of sugar are under constant supervision. The juice is now clear and dark colored and ready for concentration. It is boiled down to a syrup of such density that the sugar crystallizes out. This operation is done in open kettles or vacuum pans. The resulting sticky mass is known as massecuite. It is placed in hogsheads with perforated bottoms. The juice slowly percolates through the holes leaving the crystals of sugar behind. The juice constitutes the familiar molasses of commerce. In modern refineries the massecuite is centrifuged with the molasses passing out through fine perforations. The raw or crude sugar thus obtained is brown in color and 96 percent pure.

Besides the bagasse, by-products of value are molasses, which is used in cooking and candy making. It is also used in the manufacture of rum and industrial alcohol. The better grades of molasses are obtained when the cruder methods of sugar milling are employed, for in such cases the sugar content of the molasses is higher. A mixture of bagasse and molasses, known as molascuit, is a valuable cattle feed.

Refining is the final stage of sugar preparation for markets. This is usually done in factories located in seacoast areas of the United States and Europe. The process involves washing to remove the film of dirt from around the crystals of crude sugar, dissolving the sugar in hot water, the removal of any mechanical impurities by filtering

through cloth, decoloring by passing through bone black, recrystallization by boiling, and the removal of the liquids from the granulated sugar by centrifuging or other means. A hundred pounds of raw sugar usually yields 93 lb. of refined sugar and three-quarter gallon of refined molasses. The granulated sugar is washed, dried, screened, and packed. Loaf, cube and domino sugars are made by treating granulated sugar with a warm concentrated sugar solution and pressing it into molds. Loaf sugar is often sawed into blocks, strips or other forms. Powdered sugar is made from loaf sugar or imperfect pieces of other types by grinding, bolting and mixing with starch to prevent lumping. The refining of sugar is a very old process and was probably first done in North Africa. The first type of refined sugar was the sugar loaf, which appeared in England in 1310 and was familiar in America until late in the 19th Century.

Starches and Starch Products

One of the most important and widely available vegetable products, starch constitutes the principal type of reserve food for green plants. It is a complex carbohydrate. It is stored in thin-walled cells in the form of grains. There are several types of starch that differ in the size and shape of the grains and other physical and microscopic characteristics. Important sources of starch are the cereal grains and underground tubers, although nuts, legumes and other plant organs may contain substantial amounts. Besides being a staple food for animals and humans, it also has many industrial applications.

Soluble starch is a form that is used in the textile industry to strengthen the fibers and cement the loose ends thus making a thread that is smoother and easier to weave. It also gives a finish to the end product. It serves as a mordant in calico printing, a thickener for the colors. Starch is also used as a sizing agent in paper industry, in laundry work, in medicine, in the preparation of toilet powders, as a binding for china clay and as a source of many other products.

Sources of Commercial Starch

Relatively few plants are used for the commercial production of starch. The main ones are potato, maize, wheat, rice, cassava, arrowroot and sago.

Cornstarch

Maize or Indian corn is the source of over 80 percent of the starch that is made in the United States. The grains are soaked in warm water with a small amount of sulfurous acid to loosen the intercellular tissue and prevent fermentation. Then the corn is ground so as not to injure the embryos. The ground material is placed in germ separators where the embryos are removed. The starch material is then ground very fine and is either passed through sieves of bolting cloth or is washed in perforated cylinders to remove the bran. The resulting milky liquid is run onto slightly inclined tables where the starch grains settle out and the remaining material flows off. The starch is later collected and dried in kilns and is then ready for the market. The best grades of cornstarch are used for food while inferior grades are for laundry starch and sizing and as a basis for glucose.

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Potato Starch

Cull potatoes are utilized for making starch. These are washed and reduced to a pulp in graters or rasping machines. The resulting paste is passed through sieves to remove fibrous matter. After washing the solid starch is separated by sedimentation, the use of inclined tables, or centrifuging, and is then dried. Potato starch finds uses in the textile industry and as a source of glucose, dextrin and industrial alcohol. Europe is the principal producer.

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Wheat Starch

The oldest commercial sources of starch were from wheat. It was known to the Greeks and was widely used in Europe in the 16th Century in connection with the linen industry. The gluten in wheat makes the removal of the starch a difficult process. It is

accomplished by extraction with water or by the partial fermentation of the grain. Wheat starch is used mostly in the textile industry.

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Rice Starch

Rice grains that are broken or imperfect are used for making rice starch. These are softened by treating with caustic soda and are then washed, ground and passed through fine sieves. More alkali is added and after a time the starch settles out as a sediment. This is removed, washed and dried. Occasionally dilute hydrochloric acid is used to free the grains. Rice starch has found use in laundry and for sizing.

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Cassava Starch

Cassava flour and tapioca are used in industry mainly as sizing materials and as the source of certain starch products.

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Arrowroot Starch

The tubers of several tropical plants provide a source for arrowroot starch. West Indian arrowroot is from *Maranta arundinacea*. Florida arrowroot is from *Zamia floridana*. Queensland arrowroot is from *Canna edulis*, and East Indian arrowroot from *Curcuma angustifolia*. The tubers of these plants are peeled, washed and crushed and the pulp passed through perforated cylinders. A stream of water carries the starch into tanks where it settles out. Arrowroot starch is easily digested and thus is valuable as a food for children and invalids. There is little use in industry.

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Sago Starch

The stems of the Sago palm, *Metoxylon sagu*, contain starch. Cultivation is in Malaya and Indonesia. The flowers appear when the trees are about 15 years old and just prior to this time the stems store up a large amount of starch. The trees are felled and the starch pith is removed. This is ground up, mixed with water and strained through a coarse sieve. The starch is freed from the water by sedimentation and washed and dried. This is known as sago flour. Commercial sago is prepared from this by making a paste and rubbing it through a sieve in order to cause granulation. The product is dried in the sun or in ovens and appears as hard shiny grains, known as pearl sago. Both sago starch and pearl sago are used almost entirely for human consumption.

Starch Products

Soluble Starch

Starch grains are insoluble in cold water but they readily swell in hot water until they burst to form a thin, almost clear solution or paste. This soluble starch has been used for finishing textiles and in the paper industry.

Dextrin

When starch is heated or treated with dilute acids or enzymes it becomes converted into a tasteless, white, amorphous solid known as dextrin or British Gum. Dextrin possesses adhesive properties and has been used as substitutes for mucilage, glue and natural gums. Bread loaves brushed with dextrin aids in crust formation. In steel manufacture, the sand for the cores used in casting is held together with dextrin. Other uses include cloth printing, glazing cards and paper and making pasteboard.

Glucose

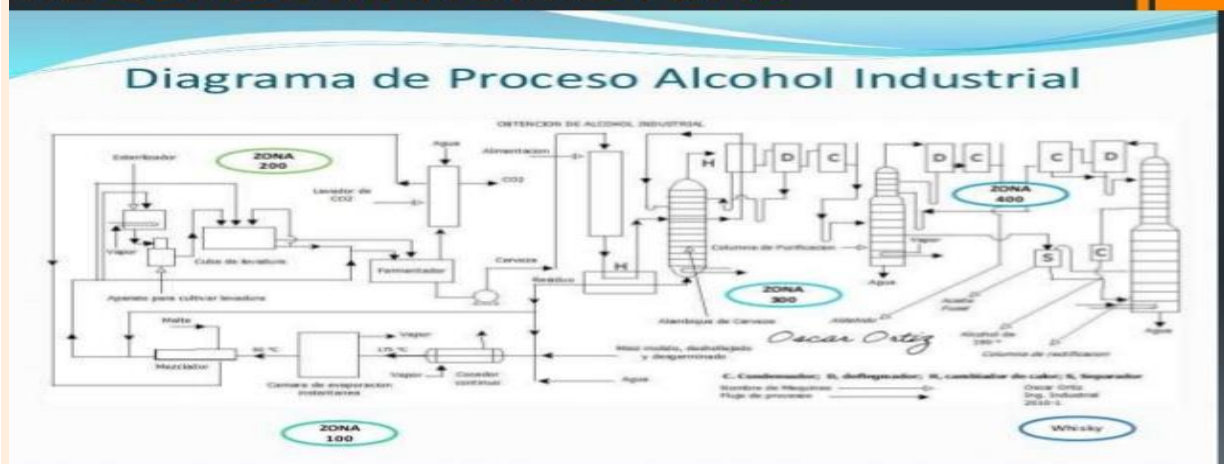
When starch is treated with dilute acids for a long time it becomes more completely hydrolyzed and is converted into glucose sugar. Often the same factory that extracts the starch also converts it into glucose. This operation is done in large copper boilers under pressure. About six pounds of dilute hydrochloric or sulfuric acid are used for each 10,000 pounds of starch. After all the starch has been converted, the free acids are neutralized with caustic soda. The liquid is then decolorized with boneblack and concentrated into thick syrup. One of the common brands of corn syrup is

“Karo.” Glucose may be considered as an inferior substitute for cane sugar. However, it is an excellent food material. Its use is in table syrup, for sweetening, in candies, jellies and other kinds of cooking. It is often mixed with maple syrup, brown sugar, honey or molasses it is used for making vinegar and in brewing.

Industrial Alcohol

Starch is the source of an enormous quantity of industrial alcohol. Maize and potatoes constitute the chief sources, although the other starches and even cellulose, various products of the sugar industry and fruit juice may be utilized. The process converts the starch into sugar by means of diastase and the fermentation of the sugar by yeasts to yield alcohol. The operations are carried out under different conditions from those followed in making alcoholic beverages. When fermentation has stopped, the alcohol is extracted from the mash by fractional distillation. The alcohol thus formed as a result of the fermentation of sugar is known as ethyl alcohol, as distinguished from methyl or wood alcohol, a product of the destructive distillation of wood. To render it unpalatable, ethyl alcohol is often “denatured:” by adding methyl alcohol or other substances. Industrial alcohol is the most important and most widely used solvent and is the basic material in the manufacture of hundreds of products. It is also used in medicine, pharmacy and other industries.

FLOW SHEET FOR ALCOHOL MANUFACTURE

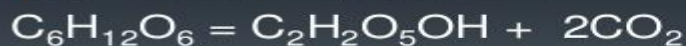


Reactions involved:

- Monosaccharide production:-



- Gay-Lussac Equations for fermentation:-



PROCESS DESCRIPTION

STEP:1(Raw material preparation)

- *The corn is degerminated, dehulled, milled, either wet or dry. Then it is cooked in cooker to gelatinize the ground grain so that barley malt amylases can convert the starch to fermentable sugars.*
- *Cookers can be batch or continuous. Grain is precooked for 1-5 min and stillage in the continuous cooker under pressure 60 to 10 kPa gage.*

STEP:1 (continue)

- *This mash is fed to steam heater so that its temperature rises instantaneously to 175 C. Then it is fed to the flash chamber where its temperature drops to about 60 C*
- *This mash is now mixed with melted barley and water and then pumped through a converter (pipeline) for 2 min at 60 C. starch gets hydrolyzed to about 70% maltose and 30% dextrans in the converter.*
- *Stillage/sulphuric acid is added to this converter mash to lower pH(4.8 to 5.0), furnish nutrients and add buffering action.*

PROCESS DESCRIPTION

STEP:2 (Fermentation)

- *Around 5% of total volume of selected years is grown in the yeast tub on a corn- barley malt mash which has been previously sterilized under pressure and cooled. Conditions maintained are such that wild yeasts and bacteria do not thrive.*
- *The treated mash is pumped into the fermentor and as soon as 10% of the malt has been pumped, yeast is added.*
- *Cooling is required to keep the maximum temperature no more than 33 C. the fermentation cycle may vary from 40 to 72 h. the liquors in the fermenters after fermentation is complete are called beer. It contains 6.5 to 11% alcohol by volume.*

PROCESS DESCRIPTION

STEP:3 (Product purification)

- *This step includes three distillation columns.*
- *The beer is pumped through several heat exchangers to the upper sections of the beer still (1st column). The liquid discharge from the bottom of the still is called stillage. It contains proteins, residual sugars and also some vitamin products, hence it is often evaporated and used as animal feed.*
- *The overhead is a mixture of alcohol, water and aldehydes. It is passed through a condenser/dephlegmator where around about 50% of alcohol is condensed. This condensate is known as high wines.*

STEP:3(continue)

- *The high wines are sent to aldehyde column(2nd column) where low boiling impurities, mostly aldehydes are removed.*
- *The effluent liquor is sent to 3rd column i.e. rectifying column where final purification takes place.*
- *Alcohol of 95 to 95.6 % purity is obtained from near the top through a condenser and sent to storage and sale.*

Industrial and military explosives

As a result of military activities and due to improper management and disposal practices many energetic substances and their by-products have contaminated environments to levels that threaten the health of humans, livestock, wildlife, and ecosystems. In humans TNT is associated with abnormal liver function and anemia, and both TNT and RDX have been classified as potential human carcinogens. TNT toxicity has been demonstrated using earthworm reproduction tests, and studies with *Vibrio fischeri* have established TNT as being “very toxic” to aquatic organisms. Mutagenicity studies have been carried out using TNT and its metabolites on *Salmonella* strains and mammalian cell lines. TNT was found to be mutagenic, with some metabolites more so than the TNT itself.

The effects of RDX on mammals are generally characterized by convulsions. Deaths in rats were associated with congestion in the gastrointestinal tract and lungs (oral rat LD₅₀ = 0.07–0.12 g/kg). Factory employees in Europe and the US have suffered convulsions, unconsciousness, vertigo, and vomiting after RDX exposure. Information is limited concerning health effects of HMX. The USEPA has established lifetime exposure drinking water health advisory limits for TNT, RDX, and HMX at 2.0, 2.0, and 400 µg/L, respectively.

Acute exposure to NG can cause headaches, nausea, convulsions, cyanosis, circulatory collapse, or death. Chronic exposure may result in severe headaches, hallucinations, and skin rashes. Perchlorate adversely affects human health by interfering with iodine uptake in the thyroid gland.

Energetic compounds may enter the soil environment via numerous avenues including the following: (i) ammunition production facilities, for example, wastewater lagoons, filtration pits; (ii) packing or warehouse facilities; (iii) waste disposal and destruction facilities, for example, open dumps, burn pits, incinerators; (iv) weapons firing ranges; (v) weapon impact areas.

Soil contamination by energetics at manufacturing sites, conflict areas, and military ranges is an international concern. In the US alone, thousands of military sites are listed as contaminated by energetic compounds. Approximately 50 million acres are affected by bombing and other training activities. An even greater number of contaminated sites may exist in Europe and Asia. Significant public health emergencies resulting from soil contamination have launched demands by local citizenry for remediation measures. During

the past two decades an increased environmental awareness has compelled military agencies in the US, Canada, and many European and Asian nations to identify sites of energetics contamination and to evaluate the impacts of military activities on the quality of soil, groundwater, and surface water.

Types of Energetic Materials

Energetic compounds are chemicals that, when exposed to physical or chemical stimuli, decompose extremely rapidly with the evolution of energy in the form of flame, heat, and light. In addition, rapid liberation of heat causes the gaseous products of the reaction (e.g., N₂, CO₂, H₂O) to expand and generate high pressures.

Explosives

Explosives are classified as primary, secondary, or tertiary based on their susceptibility to initiation. Primary explosives are highly sensitive to initiation and include silver azide, lead styphnate, and mercury fulminate. Primary explosives are often used to initiate secondary explosives in a so-called firing train . Common secondary explosives include TNT, RDX, HMX (Table 1, Figure 1), and tetryl (N-methyl-2-4-6-trinitrophenylnitramine). The energetic compounds most commonly used in military explosives include TNT, RDX, and HMX. Their environmental fate will be addressed in this paper. Tertiary explosives, also termed blasting agents, are so insensitive to shock that they cannot be detonated by reasonable quantities of primary explosive and instead require a secondary explosive. A common tertiary explosive is a physical mixture of ammonium nitrate and fuel oil.

Organic secondary explosives can be further divided into nitroaromatics, nitramines, and nitrate esters. Nitroaromatics, which include TNT, tetryl, and ammonium picrate, contain NO₂ groups bonded to carbon atoms on the aromatic ring. Nitramines contain NO₂ groups bonded to nitrogen present within an alicyclic ring, for example, RDX and HMX; nitrate esters contain NO₂ groups bonded to an oxygen atom attached to an aliphatic carbon, for example, nitroglycerin.

In addition to the infusion of specialized compounds, an explosive formulation may contain impurities or decomposition by-products. For example, TNT may contain dinitrotoluene and trinitrotoluene isomers, and HMX may occur as an impurity in RDX .

TNT

TNT was first used on a significant scale during World War I. It is one of the most common bulk explosives in use today both in military ordnance and in mining and quarrying operations. TNT is used as a booster for high-explosive munitions. It is used alone and in mixtures with other energetic compounds (e.g., RDX and HMX) in explosive formulations including amatol, pentolite, torpex, tritonal, picratol, and others.

TNT is chemically and thermally stable, has a low melting point, and is amenable for melt casting. TNT is popular in the military and industry because of its insensitivity to shock and friction, which reduces the risk of accidental detonation. The TNT molecule is slightly soluble in water and has a low vapor pressure and Henry's law constant. The octanol:water partitioning coefficient of TNT ($\log = 1.86$) indicates that dissolved TNT will not sorb strongly to soils and therefore may be mobile in the biosphere.

Physical and chemical properties of selected explosives and propellants.

2-amino-4,6-dinitrotoluene (2-A-4,6-DNT) and 4-amino-2,6-dinitrotoluene (4-A-2,6-DNT) are generated in the biosphere from biotic transformation of TNT nitro groups to amino groups. Both amino dinitrotoluene isomers are relatively nonvolatile and have solubilities of 17 and 36 mg/L, respectively. Amino dinitrotoluenes have low octanol:water partitioning coefficients (\log of 2.8 and 2.6); however, they are known to bind covalently to soil organic and mineral components.

RDX

RDX is a highly stable nitramine compound. It is typically used in mixtures with other explosives. RDX is slightly soluble in water (56.4 mg/L at 25°C) and has a low vapor pressure. RDX will not readily volatilize from aqueous solution (Henry's law constant = $6.3 \times 10^{-8} \text{ atm}\cdot\text{m}^3 \text{ mol}^{-1}$) and will not sorb strongly to soil.

HMX

HMX is used as burster charges for artillery shells and as a component of plastic explosives. HMX has also been used as an ingredient of solid fuel rocket propellants and to implode plutonium-239 in nuclear weapons.

The HMX molecule is of low volatility, has a water solubility of 4.5 mg/L and an octanol : water partitioning coefficient of 0.1. Dissolved HMX does not readily sorb to soil and therefore may be mobile in the biosphere.

Propellants

Solid propellants for guns, artillery, and mortars comprise low-explosive materials formulated to burn at a controlled rate and produce gases that propel rockets or accelerate projectiles from guns . The primary component of gun, artillery, and mortar propellant formulations is commonly a nitro-containing organic chemical such as nitrocellulose (NC) often combined with other energetic compounds such as nitroglycerin (NG), nitroguanidine (NQ), or dinitrotoluenes (DNT) . Solid propellants containing NC are divided into three classes based on presence of added energetics . Single-base propellants contain NC as the sole energetic material. Double-base propellants contain NC impregnated with an organic nitrate such as NG. Triple-base propellants include NC and NG in combination with nitroguanidine (NQ) . Additional ingredients include compounds that modify burn rate, binders or plasticizers that facilitate loading the propellant into the shell, and compounds that enhance propellant stability during storage .

Nitroglycerin

Nitroglycerin is a nitrate ester widely used by the military for the manufacture of propellants and dynamite. Its solubility ranges from 1,250 to 1,950 mg/L, and it has a log of 1.62. Nitroglycerin was found to be extremely sensitive to slight shocks; to address this concern Alfred Nobel in 1866 absorbed nitroglycerin (75%) in kieselguhr (diatomaceous earth) (25%) to create dynamite. Kieselguhr, an inactive ingredient, stabilizes nitroglycerin and makes dynamite a much safer explosive to handle. Nitroglycerin is often encountered in soils of live-fire military training ranges, particularly near firing points .

Nitroguanidine

Nitroguanidine (Figure 1) melts at 450°F (232°C) and decomposes at 480°F (250°C). Its solubility at 25°C is 4.4 g/L, and its vapor pressure is bar . Nitroguanidine is not flammable and is an extremely low-sensitivity explosive; however, its detonation velocity is high. In triple-base smokeless powder NQ reduces the propellant's flame temperature without loss of

chamber pressure. Nitroguanidine is typically used in large-bore guns where barrel erosion and flash are key concerns .

Nitrocellulose

Nitrocellulose is composed of polymerized cellulose chains in which nitrate esters replace most hydroxyl functions. Other compounds are incorporated to control the physical properties of the propellant, its burning rate, and long-term stability . Nitrocellulose is insoluble in water.

Dinitrotoluenes

2,4-Dinitrotoluene (DNT) is used in the production of smokeless powders, as a plasticizer in rocket propellants and as a gelatinizing and waterproofing agent.. Both dinitrotoluene isomers (2,4-DNT and 2,6-DNT) may occur as impurities during manufacture of TNT or may be formed during biotic and abiotic transformation of TNT . 2,4- and 2,6-DNT have similar chemical properties. They have low aqueous solubility, are relatively nonvolatile, and have octanol : water partitioning coefficients of 1.98 and 2.02, respectively . Both are listed as US EPA priority pollutants . 2,4-DNT is often detected in surface soils of live-fire military training ranges.

Perchlorate

Perchlorate is a highly oxidized (+7) chlorine oxyanion which, when reacted with , K^+ and Na^+ , serves as an oxidizer in solid propellants for rockets, missiles, explosives, and pyrotechnics. Composite propellants, used in many rocket motors, typically consist of an organic fuel (such as ammonium picrate) combined with an inorganic oxidizer (commonly perchlorate, powdered aluminum, or barium nitrate) and an organic-binding agent. In a 2001 DOD survey of weapons systems containing perchlorate, 259 different munitions and related items such as fuses, flares, illumination rounds, simulators, and grenades, as well as 41 missile systems were listed.

Most perchlorate salts are highly soluble in water ; sodium perchlorate has a solubility of about 2 kg/L. The periodic replacement and use of solid propellant have resulted in the discharge of more than 15.9 million kg of perchlorate salts into the environment.

Manufacture of safety matches

Introduction of matches change the way we use fire in a profound way. With the ability for everyone to instantly create fire and make it portable, modern human civilization changed in many ways. The discovery of matches was a long process filled with numerous various designs that used vastly different chemical ingredients and modes of igniting the flames. However after the long period of innovation, one match design finally emerged as a winner. “Safety match” was created by the Swedish chemist Gustaf Erik Pasch in first half of 1800s and popularized by the industrialist John Edvard Lundström in second part of 19th century.

Gustaf Erik Pasch’s “safety match” was not called “safe” for no reason. Before it arrived on the worldwide market, the most popular type of matches was Charles Sauria’s white phosphorus match. Even though it was produced in by the billions every year, this match had few fatal flaws (white phosphorus was toxic, and the matches had tendency of self-inflammation due to slight friction) that eventually forced them out of production. Safety matches moved to red phosphorus that was located not on a match, but on a dedicated striking surfaces.

Here is the procedure for creating modern matches.

Raw Materials:

- Straight grained wood, usually white pine or aspen.
- Ammonium phosphate and Paraffin wax for the treatment of wood.
- Antimony trisulfide and potassium chlorate for the match head.
- Powdered glass and other inert materials for better friction and burning rate.
- Animal glue for binding ingredients.
- Zinc oxide for coloring of the match head.
- Sulfur, rosin, small amount of paraffin wax and phosphorus sesquisulfide for the base of the match.
- Water-soluble dye for coloring of the base.
- Striking surface contains red phosphorus, powdered glass, and an adhesives (gum arabic or urea formaldehyde)
- Cardboard for match boxes and match books.

Manufacturing process consists of a several distinct stages:

1. Preparing of wood. Wood is cut, into small matches, soaked in fire retardant ammonium phosphate and left to dry. Striking end of the stick is then soaked in hot paraffin wax, which will provide small amount of fuel to the wood, enabling it to burn more easily.
2. After matches are transferred to the conveyor belt that is filed with holes in which sticks are inserted, then they are carried to the tanks that contain two mix of chemicals. One to serve as a base, and one as a finalized layer of match head. Conveyors then move matches away from the tanks, allowing them to get dry.
3. Packaging and storing.

Question Bank

Two marks

1. Define pulp?
2. How to pulp prepare from wood chips?
3. Write the three types of chemical pulp?
4. What is structural boards?
5. How will you prepared paper stock?
6. Define soap?
7. What is saponification reaction?
8. What is detergents?
9. How to prepare liquid detergents?
10. How to clean the dirt applying soap?
11. Define sugar?
12. Define fermentation?
13. What is absolute alcohol?
14. What is industrial alcohol?
15. Write the classification of alcoholic beverages?
16. What is distilled spirit?
17. How to citric acid prepare from sucrose?
18. How to acetic acid prepare from ethyl alcohol?
19. Define explosives?
20. Write the chemical composition of match sticks?

Five marks

1. Write the procedures involved in paper industry?
2. Distinguish between three chemical pulps?
3. Illustrate about manufacture of paper?
4. Write short notes on speciality paper?
5. Explain cleansing action and biodegradability of surfactants?
6. Explain the manufacture of sugar from sugar cane?
7. Explain the procedure for wines ,beer and liquors?
8. Write short notes on vinegar and citric acid?
9. Write the preparation method in safety matches?

Ten marks

1. Briefly explain the process involved in making pulp and paper?
2. Explain about evaluation methods and application of detergents?
3. Explain the process involved for industrial alcohol?
4. List out the explosives used in military?