

## Forestry 240 – Wood Science

### Chapter 17 – Pulp and Paper

## Paper

- Not until the late 1800s did wood become an important source of papermaking fiber.
- Currently wood provides 99% of the fiber in the US and 90% worldwide.
- In the US, 750 lbs of paper is produced per person.

## Paper Manufacturing

- Wood is reduced to constituent fibers (pulping).
- Suspension of fibers in water.
- Beating or refining the pulp.
- Blending of additives (fillers, binders, etc).
- Formation of a fiber mat.
- Dewatering.
- Drying the sheet.

## Pulp Production

- Mechanical (ground wood) pulping
  - Stone groundwood – large abrasive stone is rotated while the tangential surface of the bolt is pressed against it.
  - Refiner mechanical – newer, uses opposing serrated steel disks to reduce chips to fiber.
- 90-95% of the wood becomes usable fiber.
- Cellulose, hemicellulose, and lignin still present, making pulp not suitable for certain papers and certain species.

## Semimechanical Pulping

- Thermomechanical process – chips are steamed, softening the lignin.
- Chemi-thermomechanical – chemicals (sodium sulfite, etc) added during steaming, good for denser hardwoods.
- Semicheical-mechanical – chips are refined at lower pressure and temperature
  - Provides highest quality mechanical pulp

## Semicheical Pulping

- Uses more severe chemical treatment, but still requires mechanical treatment to complete fiberization.
- Get good yield and good fiber quality, degrading the lignin.
- Neutral sulfite semicheical process (NSSC) most commonly used, on a wide range of hardwoods for a variety of products.

## Chemical Pulping

- 84% of pulp produced in North America.
- Wood chips are digested in chemical solution (cooking liquor) and heated in a pressurized vat (digester).
- Lignin is dissolved, fibers come apart.
- Lower yields, 40-50%.
- Two processes:
  - Sulfit
  - Kraft (sulfate)

## Sulfit Process

- Sulfurous acid reacts with lignin and is then reduced by basic bisulfites (ammonium, magnesium, calcium, sodium) to a soluble lignosulfonic salt.
  - Results in high quality pulp for fine papers.
  - Recovery of cooking liquor was difficult and expensive (have fixed today).
  - Would not work with resinous (SYP) species.

## Kraft (sulfate) Process

- Uses cooking liquor made of sodium hydroxide and sodium sulfide which breaks down the lignin and makes it soluble.
- High recoverability of cooking liquors.
- Can be used with a variety of species.
- Makes a sulfurous smell, eliminating is expensive.

## Kraft (sulfate) Process

- Lower yield and quality than sulfit process, but higher strength and liquor recovery.



## Fiber Recycling

- About half of the paper consumed was recovered by recycling.
- Used for lower grades of paper.
- Can only be recycled a limited number of times, 50% is considered to be the maximum.



## Washing and Bleaching

- After digesting, the cooking liquor and fibers are blown from the digester to the blow pit.
- Fibers are separated from the liquor.
- Fibers are washed to remove liquor.
- Lignin still remains, giving pulp a brown color
  - Paper bags, linerboard
  - Strength good, color bad.



## Washing and Bleaching

- Originally chlorine was used to attack residual lignin, making white paper.
- Today oxygen bleaching is used more.
- Higher degrees of bleaching increase costs.
  - High quality papers – more complete removal
  - Catalog stock, etc. less bleaching.

## Beating and Refining

- Fibers are pounded or ground to flatten them and to partially unravel microfibrils from the cell walls, increasing bonding potential.
- Disk or Jordan refiners accomplish this.

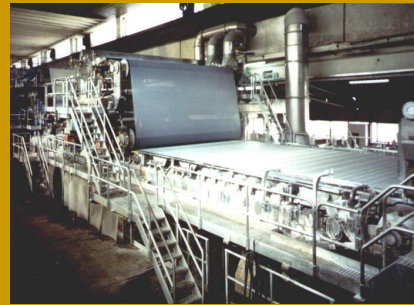


## Sheet Formation

- Fiber is mixed with water.
- Additives are included, including:
  - Starch – strength
  - Clays – brightness, opacity
  - Rosin size – decreased liquid absorption
- The mixture is formed on a fiber mat, called Fourdrinier.

## Sheet Formation

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## Sheet Formation

- After formation, the fiber mat is wet pressed, then dried.
- It is then pressed again to desired thickness and wound onto rolls.
- It can then be coated, polished (calendering) and wound onto a reel where it can be trimmed to size.



## Paper Quality

- Strength
  - Tensile, burst, tear, wet tear
- Quality
  - Opacity, inkability, brightness, permanent whiteness, surface smoothness, folding endurance
- Depends on
  - Wood density and fiber length, vessels
  - Interfiber bonding

## Types of Papers

- Corrugate
  - Linerboard – unbleached kraft, on surface.
  - Corrugate medium – inner plies, stiff, resistant to crushing.



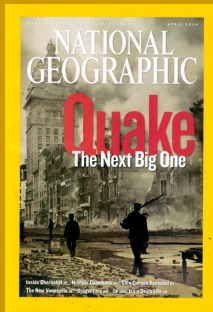
## Newsprint

- Must be able to run through high speed printing press, low cost, reasonably good printing surface.



## Publication Grades

- Coated to improve gloss, detail, and brilliance.



## Fine Paper

- Very white, highly bleached, uncoated.
- Small amounts of mechanical pulp.
- May incorporate cotton or linen

## Tissue

- Good wet strength and absorbability.
- Low density and soft.



## Kraft Sack Paper

Unbleached softwood kraft pulp, high strength.

