

IT NUMBER	MODULE	SCOPE	EXAMINATION
PL: 181141 Material Sciences PV: 181142	7	9	PL: KL, 90 Min. PV: LT
181141a Material Sciences I	2	3	PV

The lecture in Material Sciences 1 embarks on paper engineering. The course deals with the usage of physical science (e.g. chemistry and physics) and life sciences (e.g. biochemistry and environment) in conjunction with the converting of raw materials into useful paper products. The course introduces various principles in process engineering and manufacture of paper, coatings and related materials. From a heritage perspective, the field encompasses the design and analysis of a wide variety of thermal, chemical and biochemical unit operations employed in the manufacture of pulp and paper, and addresses the preparation of its raw materials from trees or other natural resources via a pulping process. This comprises the chemical and mechanical pretreatment of fibers in a fluid suspension, the industrial forming and dewatering of a non-woven web, the development of bulk sheet properties, and the post-treatment of with coating, calendering, and other chemical and mechanical processes.

The lecture is divided in five major topics of paper engineering.

1) Wood fibres and stock preparation The cell walls of all plants contain fibres of cellulose, an organic material known to chemists as a linear polysaccharide. It constitutes about one-third of the structural material of annual plants and about one-half that of perennial plants. Cellulose fibres have high strength and durability. Plant materials also contain non-fibrous elements or cells, and these also are found in pulp and paper. The nonfibrous cells are less desirable for papermaking than fibres but, mixed with fibre, are of value in filling in the sheet.

Besides fibre chemistry this session covers mechanical stock preparation processes. Stock preparation is the collective term for the grinding, beating and refining of paper pulp fibers to produce the desired characteristics of the papermaking furnish. Stock preparation is performed after the papermill receives the pulp from the pulpmill, either in wet or dry form.

2) Pulping and bleaching This section is about mechanical and chemical pulping. It explains the chemistry of delignification through chemical pulping and bleaching. Several types of bleaching are explained and different sequences are demonstrated. The main purpose of chemical pulping is to liberate the fibres from the wood matrix. Lignin, which acts as a cementing agent between wood fibres, can be partially depolymerized by employing chemical pulping to obtain different chemical pulps. However, delignified wood fibres appear brownish in colour. Hence, an additional bleaching is done. This section is rich in chemistry and a true challenge for non-chemists, however only the basic ideas and principles need to be understood.

3) Reactivation and recycling Nearly all kinds of papers are recyclable. The collection of used paper is the very first step in the recycling process. After collection paper is sorted. Sorting means that paper is arranged right into different paper categories, as different kinds of paper are treated differently in the next stages of the procedure to generate different types of recycled paper products. The next step is to "slush" the transported paper into pulp as well as remove large non-fibrous contaminants. The fibres are gradually cleaned and the obtained pulp is filtered and screened several times through screens with holes of different sizes and shapes to remove contaminants such as globs of glue and bits of plastic. To increase the whiteness and purity of the paper, it goes through de-inking which is achieved through a combination of mechanical actions (shredding and the addition of chemicals). The recovered paper is first dissolved in water and separated from the non-fibre impurities. Then the ink is removed in a flotation process where air is blown into the solution. It adheres to bubbles of air and rises to the surface from where it is separated. After the ink is eliminated, the fibre may be bleached. This session is about the processes in paper recycling.

4) Paper making The objective of paper making is to produce a continuous paper web of the required quality, uniform in machine and cross machine direction. The process equipment consists of the approach flow system, the headbox and wire section, the press section, the dryer section, often a size press, sometimes a coating station, a calender and a pope reeler. After the web has been reeled up this full width mother reel is cut into smaller rolls with widths and diameters according to the customer' requirements. The rolls are than wrapped and made ready for shipment. This session is about the industrial manufacture of paper.

5) Paper Finishing The main purpose of paper finishing is to improve the surface quality of paper and board. The most important parameters affected by coating are the visual properties such as printability, smoothness, gloss and brightness. Printability improves significantly with coating as the ink does not penetrate the paper's fibres and spread out. This session as about coating & coating inks, sizing, glazing and calendering.