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Paper Title: FOOD PACKAGING TECHNOLOGY
Module – 05: Paper and Paper based Packaging Materials

1. INTRODUCTION:

Paper and paper based materials are the oldest and most versatile packaging materials available on the market today. They are ironic material: they can be permanent or temporary, gentle or strong, cheap or expensive, in plenty or limited. They can be preserved in a museum or thrown away. They are made and used by the millions of tonnes or may be so rare that only a few tonnes of hand-made paper are produced in a year. Paper and board, alone or associated with other materials, has been used in food packaging or food contact for many years. A particular effort for alteration to the environmental concerns and the users' needs was made at the same time as the use of paper and board was increasing. Paper and board is indeed an essential part of our lives and satisfies many human needs. We use it to store and communicate information (newspapers, books, documents and writing paper), for cultural and artistic purposes, to transport and protect goods (packaging, sacks, liquid packaging board), and for personal hygiene (tissues, napkins, nappies, etc.).

2. WHAT IS PAPER?

Paper is made from cellulose fibres, which are obtained from trees, recovered papers and annual plant fibres like cereal straws. Today about 97 per cent of the world's paper and board is made from wood-pulp, and about 85 per cent of the wood-pulp used is from spruces, firs and pines. Nowadays, hardwoods such as birch, aspen and other hardwoods occurring in temperate climates are used as an ideal raw material for processing into fluting for corrugated cases as well as printing and writing papers, while eucalyptus, originally occurring in Australia and New Zealand, has been successfully cultivated in other warm climates as raw material for high-quality pulp suitable for a wide range of papers. Nonetheless, softwoods offer longer fibres (average 3 mm compared with 1 mm for hardwoods) and continue to be used for papers requiring the highest strength characteristics.

Chemically pure cellulose consists of long, ribbon-like molecules made up of smaller glucose units. The glucose units are formed from atoms of carbon, hydrogen and oxygen. These molecules are held together side-by-side by hydrogen bonds to form “sheets”, which in turn are piled together in tightly packed layers to form “microfibrils”. The microfibrils group themselves in bundles, and groups of these bundles form the paper fibre. Paper is called board when it is heavier than 224 g/m^2. The demands placed on the form of paper and board vary widely with the intended use but some are common to all grades, i.e., the paper must be strong enough to fulfil its technical function and also be able to be printed upon in a way that makes it striking to the customer. Paper and board can be used in contact with food in many different ways, either directly or indirectly, and either singly or laminated with other materials such as plastic or metal foil. In the latter case, so-called "functional barriers" are aimed at suppressing any substance transfer between food and the base paper material.

3. MANUFACTURE OF PAPER AND BOARD

Paper and board has a long history, beginning with the ancient Chinese and continuing to the present day. While hand-made methods dominated for thousands of years, paper production became industrialised during the 19th century. The first machine to manufacture paper continuously was invented by the Frenchman Louis-Nicolas Robert in 1799. Originally intended purely for writing and printing purposes, a wide variety of paper grades and uses are now available to the consumer. Each paper or board grade is produced on equipment tailored for this particular grade and mill. Production processes are optimised for each grade. There are many variables: raw material composition (mixture of chemical softwood and hardwood pulp, mechanical pulp, recovered paper, fillers, pigments, additives, etc.), machine size (width, speed), type of production equipment, and automation level.

Paper and board production involves two steps. First, the fibres need to be produced. This is done in a pulp mill where pulp is produced using chemical or/and mechanical processes. Pulp production can be integrated with paper production, or the pulp can be produced in a separate pulp mill. The paper itself is then produced on a paper machine from a mixture of fibres, chemicals and additives.

All paper and board machines are based on a similar basic process. There are seven distinct sections: head box, wire section (wet end), press section, drier section, size press, calender and reel-up.

3.1 The preparation and the cleansing of the pulp:

This untwists the fibers. Beating is a mechanical treatment intended for swelling, fibrillating and shortening the fibres. The result is a better sheet formation and the development of paper's mechanical properties.

3.2 Before sending to the paper machine:

The pulp is initially purified, diluted and air bubbles are eliminated. Sometimes pulp is also bleached if made from recycled paper.

3.3 The wet-end part:

Raw material fibres and chemicals (and 99% of the water) are pumped to the head box, which feeds the stock evenly onto the wire section. This is a woven plastic mesh conveyor belt that can be 35 metres long and up to 10 metres wide. As the paper stock flows from the head box onto the wire, the water drains away through the mesh leaving small fibres as a mat on top of the mesh. The paper machine can travel at speeds of up to 2000 m/minute and by the time the paper stock has travelled half way down the wire, a high percentage of water has drained away. By the time the thin mat of fibres has reached the end of the wire section, it has become a sheet of paper, although very moist and of little strength.

3.4 The press section:

This section consists of a number of sets of felts and heavy cylinders through which the moist paper web passes. More water is pressed out to felts and drawn away by suction. Pressure binds the fibres together and consolidates the web.

3.5 Dryer:

This section consists of a large number of steam-heated drying cylinders which have a temperature of slightly over 100°C. Synthetic drier fabrics carry the paper web round the cylinders until the paper is dry.

3.6 Coating/Calendering:

In many applications, the surface of the sheet needs improvement in order that any characters imposed on the sheet be legible. This is achieved by calendering, a process

which reorients the surface fibres in the base sheet of paper (or the coating applied to the surface) by the use of pressure. This serves to smooth the surface, control surface texture and develop a glossy finish. Such papers are known as machine finished.

3.7 Finishing:

At the end of the drying process, the sheet is smoothed using an "ironing" method, which consists of hot polished iron rollers mounted in pairs with synthetic material rollers, one above the other. This also helps to consolidate, polish and glaze the surface of the paper: the characteristics of the surface of the sheet are improved.

3.8 Shipping:

Still travelling at very high speeds, the paper comes off the machine ready for reeling up into large reels (called parent reels), which can be cut or slit into smaller ones, according to customer requirements. These large reels are produced and changed without any interruption of the production process.

3.9 Quality control:

Sensors and computers verify parameters such as the production speed, the pressure, and the resistance at every step of the process to ensure that the paper or board is of a consistently high quality. Moreover, for food contact applications, microbiological, chemical and organoleptic controls have to be carried out.

A board machine often has several formation devices in the wet end producing a multiply sheet, combined on the forming table and press. Basis weight of the boards can be as high as 500 g/m^2, whereas the printing and writing papers are usually 40-120 g/m^2.

Paper and board machines are each different – the size of the production capacity and technology varies. Each one is tailored to the specification of the paper mill.

4. RECOVERED PAPER AND BOARD

Recovered or recycled paper is an important raw material in terms of volume and utilisation for the paper industry in many countries. The recycling of paper is an example of sustainable use of resources. Although recycling is both economically and ecologically sound, recovered paper cannot be used in all paper grades. The final production process for recycled paper is the same as the process for paper made from primary fibres. The main difference is that recovered paper fibres have already been used, so that non-fibre material, will have to be removed.

The major steps in the recycling process are:

1. **Collection and Transportation:** Recovered paper is sorted, graded, formed into bales and delivered to a paper mill.
2. **Repulping and Screening:** After reaching the paper mill, recovered paper is mixed with water and chemicals, which separates the paper into individual fibres.
3. **Cleaning:** The pulp mix is diluted with water and passes through a system of centrifugal cleaning equipment and screens. The pulp is filtered and screened through a number of cycles to make it more appropriate for papermaking. This is done to remove large contaminants like wood, plastic, stones, glass and paper clips, along with small contaminants like string, glue and other sticky materials. Pulp is cleaned in a large spinning cylinder and the heavy contaminants move to the outside of the cylinder and are removed.
4. **De-inking:** For certain uses (e.g. for the production of graphic, sanitary and domestic papers but rarely for manufacture of packaging materials) and for certain types of recovered papers (e.g. newspapers and magazines), the fibres have to be de-inked. The deinking process can be carried out by flotation, with or without washing, with or without kneading, with or without bleaching.

The finished recycled pulp is now ready to be made into paper and is either sent on a mile-long conveyor to the mill for papermaking, or is formed into sheets of pulp for shipment and sale. Depending on the grade of paper being produced, quantities of virgin pulp from sustainable sources may be added. Some papers, such as newsprint and corrugated materials, can be made from almost 100% recycled paper. Once the paper is used, it can be recycled and the process starts again. Individual fibres will gradually be degraded in the process so a continuous addition of new fibres is necessary to sustain the recycling cycle.

There are different grades of recovered paper and board to satisfy the needs of different producers according to specifications. More than 50 grades of recovered

paper and board are defined in the European List of Standard Grades of Recovered Paper and Boards.

They can be described as follows:

1. **Low grades** (mixed papers, old corrugated containers, board, etc.): These constitute the main part of the recovered paper consumed. These are used to produce secondary packaging papers and boards, and are not intended to be in direct contact with food
2. **De-inking grades** (newspapers and magazines, graphic papers, etc.): They are usually also considered as low grades because they need extensive recycling treatments. These are for graphic and sanitary papers.
3. **High grades** (scraps, sheets, print offcuts, etc.): They require little or no cleaning. They can be used for the production of any paper product as pulp substitute. They may therefore be suitable for food contact packaging.

5.0 TYPES OF PAPER

Paper is divided into two broad categories: fine papers, generally made of bleached pulp, and typically used for writing paper, bond, ledger, book and cover papers, and coarse papers, generally made of unbleached kraft softwood pulps and used for packaging.

5.1 Kraft Paper

This is typically a coarse paper with exceptional strength, often made on a fourdrinier machine and then either machine-glazed on a Yankee dryer or machine-finished on a calender. It is sometimes made with no calendering so that when it is converted into bags, the rough surface will prevent them from sliding over one another when stacked on pallets.

5.2 Bleached Paper

These are manufactured from pulps which are relatively white, bright and soft and receptive to the special chemicals necessary to develop many functional properties. They are generally more expensive and weaker than unbleached papers. Their aesthetic appeal is frequently improved by clay coating on one or both sides.

5.3 Greaseproof Paper

This is a translucent, machine-finished paper which has been hydrated to give oil and grease resistance. Prolonged beating or mechanical refining is used to fibrillate and break the cellulose fibres which absorb so much water that they become superficially gelatinized and sticky. This physical phenomenon is called hydration and results in consolidation of the web in the paper machine with many of the interstitial spaces filled in. The satisfactory performance of greaseproof papers depends on the extent to which the pores have been closed. Provided that there are few interconnecting pores between the fibres, the passage of liquids is difficult. However, they are not strictly greaseproof since oils and fats will penetrate them after a sufficient interval of time. Despite this, they are often used for packaging butter and similar fatty foods since they resist the penetration of fat for a reasonable period.

5.4 Glassine Paper

Glassine paper derives its name from its glassy, smooth surface, high density and transparency. It is produced by further treating greaseproof paper in a supercalender where is it carefully dampened with water and run through a set of steam-heated rollers. This results in such intimate inter-fibre hydrogen bonding that the refractive index of the glassine paper approaches the 1.02 value of amorphous cellulose, indicating that very few pores or other fibre/air interfaces exist for scattering light or allowing liquid penetration. The transparency can vary widely depending on the degree of hydration of the pulp and the basis weight of the paper. It is frequently plasticized to increase its toughness.

5.5 Vegetable Parchment

Vegetable parchment takes its name from its physical similarity to animal parchment which is made from animal skins. The process for producing parchment paper was developed in the 1850s, and involves passing a web of high-quality, unsized chemical pulp through a bath of concentrated sulphuric acid. The cellulosic fibres swell and partially dissolve, filling the spaces between the fibres and resulting in extensive hydrogen bonding. Thorough washing in water, followed by drying on conventional papermaking dryers, causes re-

precipitation and consolidation of the network, resulting in a paper that is stronger wet than dry (it has excellent wet strength, even in boiling water), free of lint, odour and taste, and resistant to grease and oils. Unless specially coated or of a heavy weight, it is not a good barrier for gases.

Because of its grease resistance and wet strength, it strips away easily from food material without defibering, thus finding use as an inter-leaver between slices of food such as meat or pastry. Labels and inserts in products with high oil or grease content are frequently made from parchment. It can be treated with mold inhibitors and used to wrap foods such as cheese.

5.6 Waxed Paper

Waxed papers provide a barrier against penetration of liquids and vapours. Many base papers are suitable for waxing, including greaseproof and glassine papers. The major types are wet-waxed, dry-waxed and wax-laminated. Wax-sized papers, in which the wax is added at the beater during the papermaking process, have the least amount of wax and therefore give the least amount of protection.

Wet-waxed papers have a continuous surface film on one or both sides, achieved by shock-chilling the waxed web immediately after application of the wax. This also imparts a high degree of gloss on the coated surface. Dry-waxed papers are produced using heated rolls and do not have a continuous film on the surfaces. Consequently, exposed fibres act as wicks and transport moisture into the paper. Wax-laminated papers are bonded with a continuous film of wax which acts as an adhesive. The primary purpose of the wax is to provide a moisture barrier and a heat sealable laminant. Often special resins or plastic polymers are added to the wax to improve adhesion and low temperature performance, and to prevent cracking as a result of folding and bending of the paper.

6. FOOD PACKAGING APPLICATIONS OF PAPER & BOARDS

Paper and board comes in a variety of forms for applications:

1. **Paper packaging:** Natural or bleached, rubbed, coated or associated with other materials, paper can be found in the shape of bags e.g. for fruits and vegetables, vegetable parchment paper.

2. **Folding box board:** It is often referred to as carton board, it may be single or multi-ply, wood coloured or grey, coated or non-coated, and it can present various properties like barrier to grease, humidity, gas and it can be found in the shape of pastry boxes or container. It is mainly used in cartons for consumer products such as frozen food and for liquid containers.
3. **Corrugated board:** It is brown and white, of low grammage or high density, resistant to bursting, to humidity or to compression, it can be found in different shapes such as showcases for use in stores, or small boxes for mass-market products. Corrugated cases constitute the highest volume of paper and board for food contact applications.

For food contact applications, the package has to be strong enough to protect the food. It is generally printed to ensure its attractiveness to the customer because it is part of the food delivery structure. To a limited extent, some barrier properties are expected, to protect the food against degradation by the external environment. Specific barrier properties may be obtained with dedicated chemical treatments or through lamination with other materials such as metal or plastic.

There has been a significant increase in the use of paper and paper based packaging in the past 50 years for many reasons.

1. It is robust and flexible – corrugated board can be used to protect delicate porcelain or large electrical items, but also delicate fruits and vegetables.
2. It is practical – cartons can be delivered flat to the packager, reducing space and transport costs.
3. It can be easily recycled.
4. It is made from renewable materials, recovered paper and wood pulp.

7. Conclusion

Paper is a very versatile material. It is produced from cellulosic, naturally renewable fibres. It is therefore considered as an environmentally friendly material, being easily recycled, composted or incinerated after use. It may be used in food packaging applications within a wide range of grammages, being

designed as wrapping paper, folding box board or corrugated board, for direct or indirect contact, i.e. as primary, secondary or tertiary packaging. Other paper grades, such as tissue paper, may be used in occasional contact with foodstuffs. When paper and paper based products are intended, or likely, to come into contact with food, manufacturers follow relevant and acknowledged regulations and guidelines to design manufacturing processes and recipes, and ensure consumer safety.

Reference:

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