Problem in the Process & Quality by Using Secondary Fiber and its Remedies

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ABSTRACT

Secondary fibers obtained from paper scraps is generated during the papermaking and converting, whereas recovered fibers come from products that have reached the consumer and after recycled back again into the papermaking process. Secondary fibers on mixing with certain amount of primary fibers ensure the strength and other properties of the paper. For effective use of secondary fiber it is necessary to collect, store, sort and then classify the materials suitable enough for various quality grades.

When using secondary fiber for the production of high quality paper, it must be processed in such a way that not only coarse contaminants, but also printing inks, stickies, fines and fillers do not enter into the process. Recycling of fibers causes reduction in fiber length and strength and hence numbers of recycling are limited. New developments in fiber processing are essential to create a sustainable equilibrium between future demands of fiber resources and recycle possibilities to produce quality product so as to ensure smooth operation of paper machine.

Keywords: Recycled fiber, adhesive, stickie, pitch, deposits, deinking

Introduction

Industrialized nations, with 20 percent of the world's population, consume 87 percent of the world's printing and writing papers. Global production in the pulp, paper and publishing sector is expected to increase by 77% from 1995 to 2020. Less than half of the paper used in the UK is recovered and over five million tonnes gets dumped in landfill sites adding to the mounting waste disposal problem faced by many others around the world.

Modern society is increasingly convinced of the need to manage the waste it generates in a responsible way. Paper, whether it is packaging, graphic, tissue or specialty paper, constitutes an important part of household and industrial waste streams. Worldwide, paper recycling has seen a remarkable increase in recent times. Today, paper has one of the most closed eco-cycles of any product. The foundation of this performance has been the economic reality of paper recycling as an industrial process, coupled with increasing public awareness and public participation in collection systems.

Technical barriers - the effect of recycling on fibre strength

The decline in quality of fibre with recycling depends on its type and processing, both in initial papermaking and recycling. In mechanical pulping, wood fibres are separated from each other physically and this results in severe fibre shortening. In contrast, chemical pulping dissolves the binding lignin so there may be little reduction in fibre length. The cell walls remain largely intact in mechanical pulping while in chemical pulping a very open and porous network of cellulose fibrils is produced. These differences affect the water retention properties of the fibres. Water uptake and thus swelling, an important factor in the development of paper strength, is greater in chemical fibres than mechanical. The chemical fibres undergo irreversible collapse when dried and these results in a reduction in bonding ability with recycling. Mechanical fibres, in contrast, do not collapse on drying and so their bonding potential is not greatly affected by recycling.

Quality Issues:

About 20-25% of paper cannot be recycled e.g. archive papers, and for hygienic reasons, tissue paper, sanitary products and food parchment papers. In addition, some technical limitations exist. Paper fibres, for example, degenerate each time they are used so there will always be some which cannot be used again and will require disposal. Fibre can be recycled up to five times but each time that it is recycled it loses some of its essential properties, notably fibre length. Additives and contaminants also affect paper quality. Whilst not affecting basic fibre strength they can interfere with bonding and impact sheet strength. One study predicts only modest strength losses for newsprint even at recycling levels of 80% and claims that the"incorporation of large amounts of recycled fibre into paper grades such as newsprint is possible without major strength losses, since they benefit from 'downcycling' of fibres from stronger grades".

Magazine strength losses in comparison are more severe since the recycled fraction contains weaker newsprint fibres. Despite these impacts it is thought that, rather than strength loss, those factors more likely to inhibit maximum recycling include de- inking efficiency, residual filler material, and the availability of suitable sources of wastepaper, age, capabilities and operation of papermaking equipment.

Problems in Secondary fiber processing:

Adhesives

Pressure-sensitive adhesives (PSA), or self-adhesives, are the type of adhesive used on address labels and sticky notes, as well as peel-and-stick stamps. These adhesives do not dissolve in the water which is used to transform the paper into pulp so it can be recycled back into paper. The particles from the adhesive instead fragment into smaller particles, which deform under heat and pressure stick to papermaking equipment, creating weak spots in the final paper product or causing pieces of finished paper to stick together. According to

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California's Department of Resources Recycling and Recovery, PSAs cost the paper recycling industry approximately $700 million a year.

Stickies problem

In the recycling of waste paper, more man-made contaminants are introduced. These contaminants are hot melts, SBR, adhesives, glue, and coating agents which are inherent to secondary fiber recycling. They cause Stickie problem as they are usually soft and amorphic; having the ability to change shape; they are not affected by pH or temperature as much as the other type of deposition.As they are hydrophobic, they grow by agglomeration over time. Most paper recycling systems today use water as the medium to transform recovered paper into "pulp," which is then transformed back into paper. PSAs do not dissolve in water, but rather fragment into smaller particles during the repulping process. These particles known as "stickies"deform under heat and pressure, making them difficult to screen or filter out of the pulp.

Stickies can cause runnability and quality problems in case of recycled fiber, and their variable nature and composition make them difficult to control. The common locations of depositions are :- Washers, Decker Face, Wire,Screen, Stock Chest, Stock Pump, Consistency regulators, Refiners, Head-box, Foils,and Forming Fabric, Felt and Dryer Fabric.

Pitch problem

It derives from natural substances which are caused by accumulation of extractives from chemical and mechanical pulp. Cellulosic fiber derived from coniferous wood has natural resin. If not processed properly, it may end up with serious pitch problem in wire, press and dryer part of the paper machine.

Inorganic problem

During pulping, organic and inorganic substances are rendered soluble by high temperature and high pH, when ambient conditions are returned to normal during paper making , depositions will occur. If these agglomerated substances are small, it does affect physical properties of the paper. When they are large enough, they become problematic. Generally water soluble inorganic salt will not poise deposition problem unless there is availability of high concentration of precipitating contra charge ions. e.g. oxalate from tree bark will remain soluble; however when high concentration of Ca ions from underground is added with conducive pH >6, hard inorganic precipitate will occur. This phenomenon causes inorganic depositions.

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De-Inking

One of the biggest problems with recycling paper is the need to remove ink from recovered paper that has already been used for printing. While this isn't necessary for all types of paper, paper that doesn't have the ink removed will have a grayish tint. Grades of paper requiring high levels of whiteness and purity require the removal of printing inks. Additional chemicals must be used to remove the inks, which then must be washed away in large amounts of water. Sometimes the paper pulp is also bleached using hydrogen peroxide or, less ideally, chlorine, which, according to Waste Online, can sometimes combine with organic matter to produce toxic pollutants.

Limited Life Cycle

Unlike some other materials that can be recycled an infinite number of times, paper can only be recycled somewhere between five and seven times. The fibers in the paper get shorter each time they are recycled, eventually becoming too short to be made into new paper. Each time the paper is recycled, some new fibers must be added in to replace the unusable fibers, so new materials must still go into the manufacture of recycled paper.

Drying effect

Papermaking pulps from recycled wastepaper or pulp performs differently on the paper machine than do similar never-dried pulps. Secondary fibers are homified; that is, irreversible fiber bonding within the fiber wall occurs that resists reswelling. Another factor in the runnability difference is that recycling depolymeriszes cellulose, generates fines and shortens the fiber length, thus a lower freeness is observed. The dried fibers are also more difficult to wet because of their glassy crystalline nature compared to highly amorphous, hydrophilic virgin fiber. As a result of these changes in the fiber, the papermaker experiences problems with drainage and wet web strength.

Factors to consider regarding recycled content:

The problems of **excessive curl and contamination** are quality issues related to the paper manufacturing process. Recycled papers, just like virgin papers, vary from high- to low-quality in terms of print quality and runnability. Producing a quality paper requires strict performance specifications and to control the variability of the papermaking process to meet these specifications consistently. Recycled paper - a mix of fibers from many different sources, is inherently more variable than a virgin sheet made from a more limited number of fiber types. This variability in recycled paper makes it more challenging for a papermaker to control the paper's curl.

Another important factor is the "drainage" on the paper machine. The ability to uniformly control drainage is important for making a consistently high-quality, low-curl paper - recycled or virgin.

A specific problem unique to recycled paper are the "stickies" (adhesive and plastics) which can build up on the paper-making machines (causing holes and inclusions in the paper, degrading its quality) and on copying/printing equipment (causing spots on the photoreceptor, which in turn causes poor print quality). The higher dirt level in recycled paper may also be objectionable to customers seeking premium image quality.

Remedial action:

Deposit control

In the paper making process, other than slimy deposition caused by accumulation of biological phenomenon, non-biological deposition is another major production problem affecting yield and quality of paper. As cellulose papers are made from wood, they have a myriad of organic and inorganic substances either intra-cellular or extra-cellular which are instinct to all plant products. These materials include both water-soluble and nonwater solubles. Water soluble plant substances are lignin, tannins, flavoroids and phenolics; while the water insoluble are fatty acids,

terpenes, rosin, glycerides and esters.

Typical inorganic materials are calcium, silica, barium, sulphates, oxalates and carbonates. Much of these unwanted contaminants are removed during pulping, washing and refining processes by either physical or chemical means, however there are still culpable residue accumulated to cause significant damage to machine run-ability and paper quality. There are 3 types of deposit in pulp and paper making namely, i) Pitch, ii) Inorganic and iii) Stickie.

Pitch control

Earlier practice of Pitch control is with the use of Alum. Since alum is cationic, it is capable of coagulating the colloidal pitch particles and attaching it to the anionic cellulose fiber of Paper. However there is pH limitation for this pitch control approach as Alum does not ionize well under high pH condition. Fixative or fixing agents have been successfully used to solve Pitch problem. These are usually cationic polymer capable of attaching the culpable particles to the final paper sheet. Hydrophobic micro-adsorbents like talc and bentonite are also used to prevent large scale agglomeration of pitch. Non-ionic polymers have also recorded success in some cases for mechanical pulp. The control principal is encapsulations.

Inorganic Deposit Control

There are various methods to confirm whether the deposition problem is Microbiological, Pitch, Inorganic or Stickie. These methods involved the use of IR (Infrared) GC (Gas Chromatography), TLC (Thin Layer Chromatography), EDX (Energy Dispersive X-ray) and AAS (Atomic Absorption Spectroscopy).A typical inorganic deposit would exhibit high inorganic metallic components in AAS.

Upon its confirmation, the use of cheaper inorganic treatment program is warranted. In this program, since almost all deposits are caused by insoluble salts which have high solubility under lower pH, sometimes by re-locating the feed points of Alum will eliminate the problem. In situations where pH needs to be high and cannot be altered, like in the pulping of Newsprint, the next viable step is to use Chelating agent to lower the electro-kinetic surface charge of the culpable particles to avert precipitations.

Stickie Control

Adsorbent technology developed some 3 decades ago is still being used today as one of the commonest chemical used in stickie control of Recycled fibre. Its advantage over other technology is that it is cheap; however its down side is that it is a powder and need to be properly dispersed before it can be used. In dispersion, surfactants are needed and they will affect wet-end chemistry of Paper making. Thus evolved is other technology which uses liquid for detackification by encapsulations of stickie particles. Initially ionic polymers were developed and used for stickie control with some degree of success.

Again these cationic or anionic polymers with strong charges can influence water chemistry to the extent that the usage of other functional additives escalates. Non-ionic polymer has emerged in the last decade or so to replace the ionic type. It is proven to be a good agent for stickie control but it has its short-fall too. Its dissolution and reaction are slow and that treatment cost is un-competitive. The latest technology for stickie control uses enzymes and hydrolysable non-ionic Polymer for dispersion and encapsulations. Enzyme acts to catalyze the dispersion of ink from fibre while the encapsulation process is still dependant on non-ionic polymer.

Deinking Of Recycled Pulp

The use of secondary fiber in the manufacture of paper is becoming increasingly important as the practice of recycling staple materials grows. The greater percentage of natural cellulose fiber available for recycling is from post consumer waste sources. Repulping - Printer's ink, plastic coatings, adhesives and similar contaminants are generally removed by repulping. This process generally comprises the steps of combining post consumer waste paper with water in a large vessel having a powered agitation rotor driven about a vertical axis passing through the vessel center from the bottom thereof. The mechanically induced hydraulic turbulence of a pulper rehydrate the fiber to induce separation from the contaminants.

After a period of blending, the mixture is discharged from the vessel and processed through a series of screens and centrifugal separators to finish the segregation process.

This procedure is reasonably effective upon larger contamination particles. However, small particles of solidified ink have proven to be extremely elusive and difficult to isolate from the rehydrated fibers. Laser and non-impact printed ink has been especially difficult to remove. To improve the process, deinking chemicals have been developed to induce agglomeration of the minute ink particles into larger particles that are more responsive to the separation devices.

Drying imrovement on paper machine

The application of cellulases on pulp for the purpose of enhancing the freeness has been researched and patented by several research groups.Cellulase together with a polymer treatment enhanced the freeness of OCC and linerboard/newspaper furnishes without a significant loss in tensile or burst strength. Bhat et al. had similar results with bleached and unbleached recycled softwood pulp. Stork et al. explained that the draingae enhancement by cellulase action was a result of the hydrolysis of amorphous cellulose on the surface of the fibers, and not a selective hydrolysis pf the fines.

Conclusion:

The essence of a successful secondary fiber recycling scheme is simple - to collect together a sufficient quantity of a particular type of waste material, and find an appropriate RCF processing technology. However, in practice there are often problems to be overcome, and advance planning is essential, to ensure a smooth functioning right from the source selection, correct waste paper identification and quality check at every stage of processing. As recycled paper uses much less total energy than producing virgin paper, require less water, generate less solid waste and minimum pollution load, more and more recycling of secondary fiber will ensure the clean and safe environment.

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