

Technical advancements in manufacturing of packaging grades of paper as a substitute to plastic films in flexible packaging

Abstract: *The flexible packaging films today have a good surface to print and can form to a thin substrate with the best barrier properties and machinability. The purpose of this article is to analyse the properties required on paper as an alternative to plastic films in flexible packaging. Paper being a renewable source and an eco-friendly substrate has lot of challenges in meeting the specific requirements of the packaging applications which require long shelf life especially in food packaging. An attempt is made here to find a solution within the realms of the new technologies of papermaking, coatings, barrier chemistries and the challenges thereof. With the current technologies available it looks like there is a possibility to find answers to most of the problems when substituting paper with films. Though these technologies are existing in isolation we can combine them all to develop a renewable substrate meeting the requirements of flexible packaging. It requires the will and risk-taking ability of the paper manufactures to venture into this development and offer a solution to mankind.*



Key Words: *Printability, curtain coatings, clupack technology, tensile energy absorption, extensible sack kraft, lamination, biopolymers, oxygen transmission rate, water vapour transmission rate.*

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Introduction

The excessive use of the plastics in packaging and especially for disposable and single use has created problems of litter in the land and in marine. This has impacted climate change and it started showing its effect in the environment and society. With a clamour all over to ban single use plastic and also to reduce, recycle and reuse plastics it is imperative for the paper industry to find suitable alternative. This is a big challenge and an opportunity to the scientific community in the packaging industry.

Though plastic is a good substrate for packaging it has its limitations in getting composted and there are researches is going on to recycle, reuse and reduce. The biggest problem in plastics is that it takes hundreds of years to biodegrade and compost. If a suitable biodegradable and compostable alternative is developed it will be a disruptive innovation which may completely change and challenge the industry. Globally lot of alternatives have been tried and paper industry offers the best and a viable alternative.

Let us look at the challenges to paper as a substitute to plastics in flexible packaging. Flexible packaging is prevalent in all types of products ranging from food items to personal care products. The physical state of the product ranges from liquid to solids. The complications of packaging such products poses

challenges right from filling to the end use. Multilayer plastics provides the best solution to different requirements right from printing, pack formation, barrier to the product inside, ease of usage, shelf space and appeal etc. In the retail, packaging attracts customers and acts as the last sales man to the consumer. Can the paper industry meet up all the above challenges?

The challenges to the paper as a substrate are as

1. Comparatively lower printability especially in gravure process
2. Lower tensile strength to run in high speed filling machine.
3. Lower tearing strength compared to plastics
4. Lack of barrier properties which is to be impregnated.

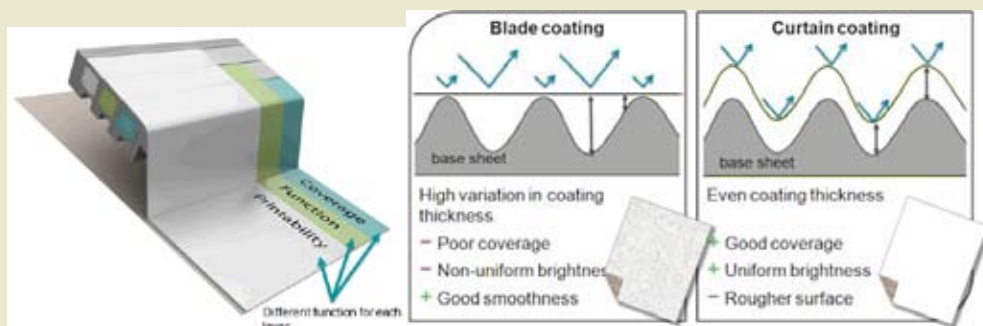
Technology advancements to improve Printing and Coating on paper

The first stage of a substrate in its packaging journey starts with printing. Most of the plastic films for flexible packaging are printed with multi-colour gravure or flexography printing processes. Modern machines run at very high speeds. Speeds as high as 300 - 600 m/min poses challenges in printability and maintain a tight register. The key to get good printability are smoothness targeting lower PPS, finish like gloss or matt, uniform ink absorption. The surface energy more than 40 dynes/sq. will provide anchorage to the ink and also for specialty coatings which can give both functional and aesthetic properties.

One of the recent developments to get the above properties on paper is through coating technologies like air knife, bar, blade coatings. However modern

technologies like curtain coatings offer various options to provide finishes, smoothness and other functional barriers.

Multilayer curtain coater applies coating thickness from extremely thin to thick and uniform layers simultaneously all within one coating station. It can be fixed in machines on a wide range of speeds and widths. The multilayer concept offers several advantages over single-layer curtain coating and other conventional coating methods. Further advancements in coating slide die has expandable designs which give possibility to upgrade by adding coating layers. The ability to coat with varying thicknesses of coating and of different formulations provides wide range of product developments to suit different applications.



Coating Blade Vs Curtain Coating

Image Courtesy: [www. Valmet.com](http://www.Valmet.com)

Other advantages of curtain coating includes cost reduction and strength improvement opportunities. The base paper can be made with strong brown unbleached fibers and covering it completely and aesthetics can be improved with the coating formulations. There are also no coating colour losses because of the dry-edge running mode and careful recovery of the coating color. Opti Coat from Valmet offers curtain coating stations which are very compact in size and can easily be fitted in most paper or board machines without much changes to the existing set up.

Further advancements to improve smoothness and gloss includes online soft nip calenders, brush

calenders in the paper machines without affecting the density of the paper. Apart from gloss of the substrate these advances also help in maintaining the bulk and also improve the ink and varnish hold outs.

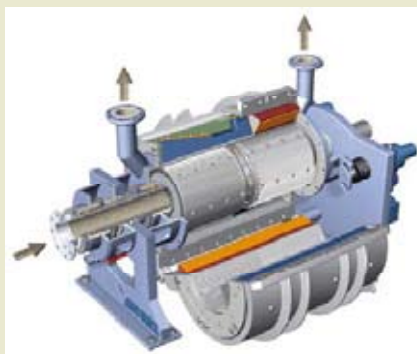
In the coating colour application and preparation recent technologies are modifying the rheological properties to improve smoothness by operating at higher solids maintaining lower viscosity. This again is helping better coverage and provide opportunity to use cheaper and stronger fibers. This can make it more environment friendly with reduced water and chemical consumption during manufacturing and recycling the same with better recovery.

Technical advancements to improve strength of the paper

Plastic films have superior tensile and tear strength to withstand supply chain stresses and paper need to meet these challenges. Advancements in improving strengths starts from the fibre characteristics and generally papers made with softwood gives good tensile and tearing strength. Other traditional strength improvement processes include refining. There are advancements of refining which includes high consistency refining, enzyme refining and under mechanical refining there are different methods. Andritz has introduced new cylindrical refining mechanism under Papiilon series.

The cylindrical refiner with extremely small diameter of refining area gives gentle refining of fibres with low energy but still gives the tensile and tear strength to the properties.

To further improve the strength properties required for paper in packaging there are options of using Clupak technology to improve tensile stretch and Tensile Energy absorption. Paper being anisotropic has differences in strength properties in both the MD and CD.

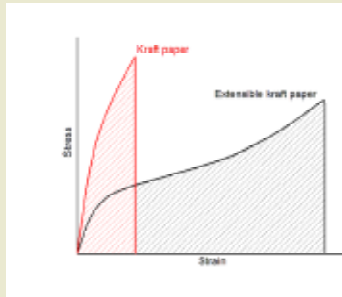


Cylindrical refining (image Courtesy www.andritz.com)



Schematic of Clupak (Image Courtesy www.mondi.com and www.cepi.org)

Rubber Recoiling 7 %

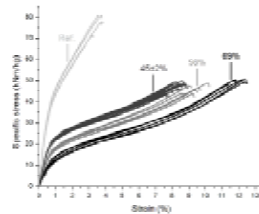


Stress-strain curve for extensible Kraft In Machine Direction

(Image Courtesy www.mondi.com and www.cepi.org)

Clupak technology creeps the paper using a rubber blanket which when passing through a nip imparts elasticity to the paper which improves its young modulus. Currently such papers like extensible sack Kraft papers are used for packing powdery materials like cement, rice flours etc.

Rubber Recoiling 14 %



Specific Stress strain curves for different rubber Recoiling percentages

Nano fibres also add to the strength of the paper. These Nano fibres are added in very minimal quantity to the conventional cellulosic fibres during paper making. Results have shown improvement in tensile strength, stretch and tear.

Technical advancement for Imparting Barrier on paper

Paper which is made of cellulosic fibres are generally porous in nature. Any porous substrate gives a poor barrier to moisture, oxygen, grease water etc. Shelf life is an important functional requirement of packaging and it varies from few hours to few years. Laminating a layer of polymers like LDPE, PET will provide the necessary barrier to the requirement. We can laminate the paper through adhesives, extrusion lamination, thermal lamination etc. However such laminates poses challenges of recycling and composting.

As a first step Industry is moving towards emulsion coatings which are heat sealable and offer oil, grease and water resistance. Such type of products are

replacing PE coated paper cups, tubs for short shelf life disposable products. These products are completely recyclable in the conventional recycling system. Industry also working on Biopolymer coated products for similar application and they offer compostability as the end of life option. These biopolymer coated boards are completely biodegradable and compostable in composting atmosphere. Some biopolymers are compostable in home composting environment too.

More developments are taking place in imparting barrier through nano material, ligno compounds and other specialty coatings to give barrier against oxygen transmission rate, water vapour transmission rate etc.

Conclusion

In this article we have tried to find theoretical solutions to the challenges which are likely to come in developing a paper-based substrate for flexible packaging. All these advancements may take some more time to get commercialised and provide a viable alternative to plastics in flexible packaging market. It is also heartening to note that many companies have made commitments to shift to eco friendly packaging with targets on time, quantity and reach. This gives encouragement to the paper industry to work with other businesses and industry to offer solutions.

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