"Some Comments on Printing Grade Plastic Papers"

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The Paper discusses four different printing grade plastic papers. The optical and physical strength properties of these synthetic papers are compared with those of high grade cellulose fiber papers.

Due to the present high price of petro-chemicals, 100% synthetic papers will not be economical substitutes for cellulose papers. However, the unique properties of plastics can be combined in plastic-cellulose fiber combinations for speciality papers.

The application of plastics in packaging has been well established. The use of polyethylene film for breadwrap is a common phenomenon. The interest in total synthetic substitutes for high quality printing papers is of more recent origin. In Japan, which lacks forest resources, considerable interest was focussed on synthetic papers. In America and Europe, where wood fiber is much cheaper, interest in synthetic paper is based more on the special properties of these products.

Synthetic Papers :

The discussion in the present article covers synthetic papers having good printability. The relatively popular products consist of either a polyolefin or polystyrene base material. These include Q-kote, Q-Per, Poly-art, Acro-art and Tyvek.

Q-kote is obtained by pigment coating a plastic film—usually rubber modified polystyrene—to give a printing surface equivalent to that of high grade enamel papers. The base film thickness is about 75 microns, whereas the coating thickness is around 20 microns each side.

Q-Per is Produced from oriented polystyrene film by treating the surface with a partial solvent to produce a matte finish. The micro-voids in the surface diffract visible light which gives the film opacity and an appearance of whiteness. These microvoids also provide a certain degree of ink absorption.

Polyart as well as Acroart essentially consist of linear polyethylene blended with pigments and minor amounts of other resins, The required degree of opaqueness is achieved by pigmentation of the base film rather than through the application of a pigmented surface coating.

Tyvek is manufactured from spun bonded polyethylene filaments whlch are randomly oriented and bonded together by heat treatment. This type of structure is similar to that of cellulose fiber paper. No doubt, uncoated Tyvek can be printed but coatings are applied for more exacting reproduction of graphics, for example, class room maps.

Table 1 lists the products, the suppliers, base films, etc. for four different plastic papers.

A comparison of the properties of pigment coated cellulosic fiber papers with uncoated and pigment coated plastic films is given in Table 2.

Optical Properties:

Brightness and opacity are a function of the type of pigment in the coating and the amount of coating applied to the substrate surface. With cellulose fiber papers and other fibrous structures such as (of) Tyvek, optical properties are also influenced by the light scattering characteristics of the fiber mat.

The results in Table 2 show that the opticals of enamel paper and the pigmented coated plastic film are quite similar. The opticals of the uncoated plastic film indicate that the latter con-

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TABLE 1

Plastic Paper Grades

Product	*Supplier*	*Base Film*	*Pigmented*	*Coated*
Q-Kote	Japan Synthetic Paper	Rubber Modified Polystyrene	No	Yes
Q-Per	,,	,,	No	No (Solvent Etched)
Polyart	Bakelite Xylonite Ltd.	High Density Polyethylene	Yes	No
Acroart	Mead	,,	Yes	No
Tyvek	Dupont/Appleton Coated Paper Co.	Polyethylene	No	No/Yes

TABLE 2

Physical and Optical Properties of Enamel Papers and Plastic Fibers (all foreign samples)

	High grade Off-set enamel (Sample No. 1)		*High grade Off-set enamel (Sample No. 2)*		*Uncoated High Impact Polystyrene*		*Uncoated Medium Impact Polystyrene*	
	MD	*CD*	*MD*	*CD*	*MD*	*CD*	*MD*	*CD*
1. Basis weight, gm/m^2	91		111		91		65	
2. Caliper, Microns	74		79		81		61	
3. Tensile, kgs/15 mm	7.5	4.6	8.0	—	4.0	2.9	6.00	5.6
4. Elongation, %	4.4	2.8	—	2.7	51.5	42.9	7.27	6.70
5. Burst factor	21.6		17.0		33.4		54.0	
6. Tear factor	61.6	44.0	50.5	32.5	33.0	22.0	21.06	21.6
7. Folding Endurance	150	82	—	—	6125	1700	200	194
8. Stiffness, $gm/m^2 \times 10^7$	12.6	9.4	—	—	2.54	2.26	3.56	4.0
9. Brightness (GE)	83.3		86.2		81.4		—	
10. Tappi opacity	93.8		95.5		71.9		—	
11. Printing opacity	94.0		96.2		73.1		—	

tributes very little to the final coated structure and that unlike cellulose fiber paper, all of the optical properties must come from the coating.

Physical Properties :

Physical strength properties are a function of polymer composition, i.e. amount of rubber modification and the degree of orientation. The bursting and tearing strengths of the synthetic structures are comparable to those of cellulose paper. Folding endurance is at least as good as or better, depending upon the degree of orientation. The stiffness of plastic structures is approximately 25-30% of that cellulose paper. The tensile strength values of the former are slightly lower than in the latter.

The density and caliper of coated plastic film are about equal to that of the coated cellulose fibre paper. Hence, yield or printing surface area per kilogram of product should be about the same. It is quite unlikely that much lower caliper plastic film can be utilised without a serious drop in physical strength and stiffness properties.

Table 3 gives the properties of Acroart, Q-kote and a pigment coated cellulose fiber paper. The data show that the optical properties of all the three structures are quite similar.

Both Acroart and Q-kote are somewhat higher in bursting strength than cellulose paper. Acroart is the highest in tearing strength. As regards folding endurance, the plastic papers are outstandingly superior to cellu-

TABLE 3

Physical Andoptical Properties of Enamel Papers and Plastic Fibers (all foreign samples)

	Enamel Paper		*Q-kote (Sample A)*		*Q-kote (Sample B)*		*Acroart*	
	MD	*CD*	*MD*	*CD*	*MD*	*CD*	*MD*	*CD*
1. Basis weight gm/m²	121.0		117		140		150	
2. Caliper Microns	94.0		96		111		127	
3. Tensile kgs/15 mm	9.0	6.0	5.3	4.6	5.8	5.0	4.2	3.9
4. Elongation %	1.9	5.5	55.6	44.4	11.0	36.0	Over 200%	
5. Burst factor	18.6		31.8		27.5		21.2	
6. Tear factor	51.0	51.0	63.2	41.0	30.0	44.0	460	225
7. Folding Endurance	55	66	13,700	—	13,140	—	Over 30,000	
8. Taber stiffness, gm/cm	2.0	3.3	4.08	3.27	1.9	1.7	1.5	1.6
9. Brightness (GE)	84.2		86.6		86.2		91.1	
10. Tappi Opacity	95.4		92.4		95.6		94.7	
11. Printing Opacity	95.6		92.6		95.7		93.1	

lose paper. However, both the plastic papers are somewhat lower in tensile and stiffness. The plastic papers are somewhat higher in percent elongation but slightly lower in density than the cellulose paper.

Pigment Coated Plastic Film vs Cellulose Fiber Paper :

Table 4 compares the over-all performance and functional utility of plastic paper with cellulose fiber paper.

The above comparison is based primarily on the pigment coated plastic film. Most of the comments would however, be equally applicable to the pigment loaded plastic paper.

Advantages of Plastic Paper:

Since plastic paper is a totally synthetic product, properties can be controlled by polymer type and resin composition. Variations in quality of the raw materials can be much-more closely controlled than in a natural product like wood fiber.

The capital investment required for the initial production of plastic paper will be much lower than that required for cellulose fiber paper. Additional extruders can be installed as the market grows for these papers. In contrast to this, the initial capital investment for cellulose fiber papermaking facilities is extremely high. Besides, the manufacture of cellulose paper requires a tremendous amount of water unlike in plastic paper which can be produced anywhere without significant stream pollution.

Plastic paper, unlike cellulose fiber paper, is non-hydroscopic and dimensionally stable—a distinct advantage in case of recording charts and off-set papers.

The strength of plastic paper structure is unaffected by water. Plastic paper, for all practical purposes, is a water proof struc-

TABLE 4

Comparison of Pigmented Coated Plastic Film Vs Enamel Paper

	Plastic	*Enamel*
Synthetic product	Yes	No
Initial Equipment investment	Low	High
Dimensional Stability	Excellent	Poor
Water-proofness	Yes	No
Mouldproofness	Yes	No
Acid & Alkali Resistance	Yes	No
Oil & Grease Resistance	Yes	No
Water Vapor Transmission Rate	Good	Poor
Surface smoothness	Good	Fair
Heat Resistance	Fair	Good
Base Stock Opacity	Poor	Good
Broke Recovery	Poor	Good
Water conservation	Good	Poor
Printability	Good	Good

ture, which property makes this paper ideal for labels, outdoor posters and other applications requiring high water resistance. In case of cellulose paper, unless reinforced with wet strength resin it is sensitive to moisture and loses strength when wet.

Plastic paper does not contain any ingradients which will support mould or bacterial growth. This will make it especially suitable for soap wrapper stock. Plastic paper will have significantly better Water Vapor Transmission Rate (WVTR) than cellulose fiber paper. Oil and grease resistance is also considerably higher. A number of packaging applications such as oil can labels, frozen food packages, etc. could utilise these functionalities.

The inherent smooth surface of a plastic film results in excellent half tone dot reproduction. Print quality will be hence sharper in plastic papers than in cellulose papers.

Drawbacks of Plastic Papers

The printability of the pigment coated plastic film should be about the same as that of a pigment coated cellulose fiber because the coating compositions in both are quite similar. Ink setting and ink drying times should be comparable. No special inks are required. Internally pigmented plastic paper generally requires specific inks.

The heat distortion temperature of oriented rubber modified polystyrene film is in the neighbourhood of 170°-190° F. Although considerably higher air temperatures can be utilised, this might place a limitation on the drying conditions used during the application of the aqueous pigmented coating. It could also have a bearing on the utility of plastic paper in web printing presses with drying ovens.

The fibrous nature of cellulose paper provides a fair degree of capacity. A plastic film coating base, unless pigmented, is at least only translucent. Therefore, it may be necessary to use more expensive pigments such as titanium dioxide in the coating and/or much heavier coating weights to achieve the required opacity.

Broke recovery in the paper Industry denotes recycling uncoated or coated paper through the papermaking operations. Internally pigmented film, if uncoated, will have similar recycle possibilities as in cellulose papers. However, surface coated film will have virtually no recycle capabilities because of possible non-homogenicity. Since the amount of scrap generated during coating, finishing and trimming is around 15% lack of, recycling possibilities can have a significant effect on the over-all economics in plastic paper manufacture.

End Uses of Plastic Papers:

The best competitive position for plastic paper can perhaps be achieved by capitalizing on the functional properties of the plastic base along with the printability properties. Table 5 lists some potential plastic paper end uses. There are undoubtedly additional applications for plastic paper where functionality coupled with good printability are highly desirable. The rigidity characteristics of paper boards could be advantageously combined with the vapour and liquid impermeability characteristics of plastics.

Economics:

The four-fold increase in fuel oil price in the last five years somewhat pushed back the emergence of synthetic substitutes for high grade printing papers. Furthermore, printing grade plastic paper must meet stringent specifications on caliper variation, opacity, brightness and stiffness. These manufacturing restraints further add to plastic paper prices.

In Japan, before the fuel oil price hike the forecast for synthetic paper production in 1978 was of the order of 400,000 Metric Tonnes. It is now doubtful, however, if this production level could be reached barring new developments leading to the availability of cheaper petrochemicals or the availability of plastic films from other sources at comparable prices.

In the long run, synthetic paper which may be improved considerably from the technological viewpoint, could prove to be more advantageous to Japan than natural paper in the light of its scanty wood resources.

Present Status of Plastic Papers:

There are at present five manufactures of synthetic pulp with semi-commercial plants of 5000-10,000 tonnes/year capacity.

Synthetic pulp is now more or less accepted as a valuable addi-

TABLE 5

Plastic Paper—End Uses

Labels	Code
Jar & Bottle—G,O,W	(Resistance)
Detergent Bottle—A,W	A — Alkali
Oil Can—O	C — Chemical
Aersol Can—C,M	G — Grease
Mailing—S,W	H — Heat sealable
Phonograph records—H	
Meat—G,W	
Laminates:	
Set up Boxes—S,W	M — Mold
Place mats—G,W	O — Oil
Plates—G,O,W	S — Scuff
Pouches—C,G,H,O,W	T — Tear
	W — Water
Books:	
Children's—S,T,W	D — Dimensional Stab
Service manuels—G,O,S,T,W	L — Lightweight
Cook—G,T,W	
Covers & Jackets—S,W	
Telephone (Q-Per)—L,T,W	
Catalogues (Q-Per)—L,T	
Other:	
Maps—D,M,S,T,W	
Graphs & Charts—D,W	
Baggage Tags—S,T,W	
Seed Packets—H,W	
Envelopes—S,W	
Menu—G,S,T,W	
Soap wrapper—A,M	
Banding—S,T,W	
Posters & Pennants—S,T,W	

tive to the furnish of conventional paper pulp to give enhanced properties (brightness, dimensional stability, bulkiness, opacity and resistance to chemicals) and also to achieve a higher drainage rate (as the water is only physically retained in the synthetic pulp). Therefore, market assessment for synthetic pulp is presently going on in various applications in paper and board mills. The response appears to be somewhat encouraging, particularly in the field of wall papers, tea bag papers, battery separators, etc. Furthermore, synthetic pulp seems to have a potential market as a binder in the production of non-wovens and in various other applications out-side the paper industry. It may be mentioned that non woven producers prefer a longer, fast draining synthetic pulp fiber as against a slower draining fiber (for better sheet formation) desired by speciality paper manufacturers.

Due to the prevailing high price of petro-chemicals, synthetic pulp manufacturers have been active in developing second generation materials, which should improve their marketability.

Indian Scene:

The Union Ministry of Petroleum estimates that India will not only be self-sufficient but have a surplus of oil resources in the decade of 1980. Based on this premise, it may be meaningful to forward plan product development for the next decade in terms of synthetic substitutes for cellulose paper. A part of the quality production could also be planned for export.

In the meanwhile, development work could be started in paper industry research laboratories for plastic cellulose paper combinations for speciality purposes.

Acknowledgement:

Most of the information in the paper is taken from the bulletin distributed at a seminar in 1969 at the State University College of Forestry, Syracuse, New York, U.S.A. The bulletin was entitled "Plastic Paper" and contributed by Mr. J. Eichhorn and Mr. E.J. Heiser of Dow chemical company, Midland, Michigan, U.S.A.