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SYNTHETIC AND PLASTICS PAPERS

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As THIS symposium is held in Cambridge, it seems appropriate to speak on semantics, particularly on the terminology of synthetic and plastics papers. Confusion about it prevails in both the paper and plastics industries. It is necessary to emphasis that the synthetic polymers and conventional paper and board industries in some cases compete and in other cases co-operate closely in order to achieve products with required functional properties by making them from materials of both industries, properties that cannot be achieved in products made from materials supplied by one industry only. The consumption of polyethylene for coating paper and board is increasing.

It is significant that Dr Robertson describes in his paper the modification of the mechanical properties of paper by the addition of synthetic polymers and mentions the encouraging possibilities of the continuing development of products based on the combination of synthetic polymers and paper.

Nobody would describe these products as synthetic paper or products. The same applies to special grades of paper (for example, for making teabags or vacuum cleaner bags) that embody a small amount of rayon and/or synthetic fibres. Only when the content of synthetic fibres and/or plastics reaches a certain level (not yet defined) does one speak of synthetic papers.

In addition to the three groups referred to by Prof. Rånby, there are also synthetic papers that consist of synthetic fibres *and* conventional pulp, supplied for making geographical maps, drivers' licences, inoculation certificates and other specialised applications, particularly for outdoor use.

Prof. Rånby has referred to spunbonded materials. The material based on high density polyethylene *Tyvek* is of interest to the graphic industry, whereas *Nomex* paper based on polyamide finds applications in the electrical industry. Tyvek is a spunbonded sheet of 100 per cent high density polyethylene (HDPE), produced by bonding under heating and pressure a web of continuous fibres ranging from less than 0·5 microns to about 10 microns in thickness and without any external binder. The very small diameter of the fibres results in a high opacity and whiteness of the material.

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There are two different kinds of bonding in this case—over the entire area and that confined to discrete spots separated from one another by unbonded fibres. Tyvek coated on one side or on both sides finds application in the graphic industry. I cannot provide all the technical details in the short time available to me, but I will be quite happy to do so if asked.

On synthetic papers based on plastics films, I would like to make the following observations—

1. Most of these synthetic papers can be described as first generation products. Discussions with manufacturers indicate very clearly that they are working on second generation products.
2. Unlike synthetic papers based on one-layer film, the Yupo FP synthetic paper produced by Oji-Yuka Company, is a multi-layer, filled polypropylene film product, based on a modified tenter biaxial orientation continuous process. This paper has a number of characteristics that have led some experts to call it a second generation product. In fact, only recently, a leading American papermaker has acquired a licence for manufacturing this product in the United States. It is noteworthy that Oji-Yuka is a joint company of a polymer manufacturer (Mitsubishi Petrochemicals) and of Oji Paper Company—another indication that the synthetic paper industry of the future will consist of joint enterprises of the conventional paper and polymer industries' firms.
3. The European developments should not be underestimated. It is true that numerically there has been a superiority of developments in Japan, but numbers alone—in this connection—are not decisive. Although I am not very keen on mentioning names of manufacturers at a technical symposium, one has to realise that just talking about products without giving their names tells only half the story. Among products that have come from Europe are *Polyart*, *Arathene* and *Phoenix-artplast*.

   Polyart (a BXL, England product) is an oriented, filled, modified HDPE film, which is not coated, but contains some additives. It is noteworthy that Mitsubishi Rayon of Japan have started manufacturing Polyart under licence from BXL.

   Arathene (a UCB-Sidac, Belgium product) is a blown extruded film made from a blend of thermoplastics (mainly HDPE) and some additives. (German Patent 2 132 510, published 5th January 1972.)

The German papermaking company Scheufelen has introduced Phoenix-artplast, which has a polystyrene film base. This product is based on BASF development.

For synthetic pulp, one point cannot be strongly enough emphasised: the specific weight of high density polyethylene is approximately 0·96 and that of polypropylene is approximately 0·91, both considerably lower than that of cellulose fibres. Prof. Rånby in his preprint has given some technical details of two different types of synthetic pulp. An advanced stage in development of synthetic pulp has been also reached by Solvay. Their continuous process from ethylene to pulp made of microfine HDPE fibres (not above 1 micron thickness and controlled in length) is applicable for wet processing the pulp on conventional papermachines. The non-polar characteristics of polyethylene can be modified to make it wettable.

This Solvay process can, with modifications, be applied to propylene or to ethylene plus propylene as feedstock to produce pulp grades with properties for particular applications. Solvay's Italian pilot plant of 6 000 t/a output is to start operating this year and arrangements have been made with more than fifteen papermaking firms that are evaluating this synthetic pulp for their specific requirements.

Research work on synthetic pulp and its properties by more than ten leading polymer firms, in some cases with papermaking concerns, has been published. Toray-Kanzaki have developed a process for making pulp from polypropylene or acrylics. Sumitomo Chemicals use their TPS polyolefin fibrous material (fibres 1–15 mm long and 0·005–0·1 mm wide) for papermaking on its own or with conventional pulp. Mitsubishi Rayon has developed a process of 'polyolefin microflake aggregation and paper-like polyolefin sheet obtainable therefrom' (British Patent 1 262 531, published 2ndFebruary 1972), which ejects a polyolefin solution through a slit to form a paper-like sheet. A process by Toray using a similar principle with polyolefins and styrene has been described in British Patent specification 1 323 174, published 11th July 1973.

Plastics paper (paper-like high density polyethylene film) does not require a post-extrusion treatment and finds an increasing market in wrapping (low molecular weight grades of HDPE are used) and bag-making (high molecular weight grades of HDPE being used).

It is significant that the latest developments in the field of plastics paper aim at products for the printing industry. HDPE extruded together with up to 30 per cent kaolin (Hoechst development) and films extruded (or calendered) from HDPE and polystyrene compounds (Huels development) show promising results. The extruded films (whether described as plastics or synthetic papers) have characteristics of good printability and, in thicknesses of over 100 microns, they offer new products that compete against other synthetic papers and traditional paper in certain applications.

Transcription of Discussion

Discussion

Dr K. Ebeling I would like to draw attention to two points—stress relaxation and change of modulus. I used dry paper in my study of moisture content (determined by Karl Fischer titration below 0·25 per cent). I did not observe the Kubát behaviour; there was no clear break point when plotting the relaxation speed against the unrelaxed load. The behaviour that I observed was similar to that in your Fig. 9 for the 4 per cent curve.

The other point is that the apparent initial straining modulus decreased after cycling that involved apparent plastic deformation. Only during cycling with relatively high average load did one observe that the slope of the load elongation curve was higher than the initial slope starting from zero load.

Mr A. A. Robertson We clearly have differences between us to resolve. We, too, have carried out these tests under completely dry conditions (at least as dry as anhydrous calcium sulphate can provide) and obtained the Kubát curves for a wide variety of papers. We have been able to relate the local modulus (which we measure after stress relaxation) to a local cycling modulus that also has been determined. We have found the local cycling modulus anywhere along the stress/strain curve to be higher than the initial modulus and very close numerically to that measured after stress relaxation. So our results are in direct contrast to your own.

Dr A. de Ruvo I think that Dr Robertson touched upon very important matters—what is the mechanical effectiveness of the latex in the paper structure and how do different ways of polymer deposition in the paper influence the mechanical effectiveness of the polymer? In our studies, we have worked with a torsional pendulum to measure the amount of polymer that is effective by following the damping curve with temperature. At the glass temperature, the polymer displays a damping peak, which is proportional to the amount of polymer present and mechanically active in the system. Of course, there are different ways in which the polymer can be deposited in the paper. One way is that it is between the fibres, where it constitutes the fibre bond; this is the

Under the chairmanship of Prof. V. T. Stannett most effective way if you want to use the polymer properties. The other way is on a free segment, where it is not taking any mechanical action at all; this is a very poor way of using the polymer. For Fig. G, where we have plotted the area of damping against the amount of binder, we used two different ways of putting the polymer into the system—spray bonding and beater addition. The curve shows that spray bonding is much more effective as indicated by the much higher increase in the area of the damping peak at specific loading levels.

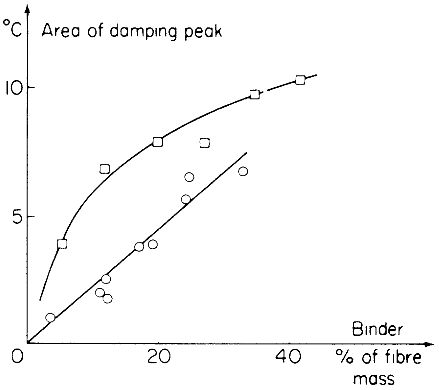

Fig. G

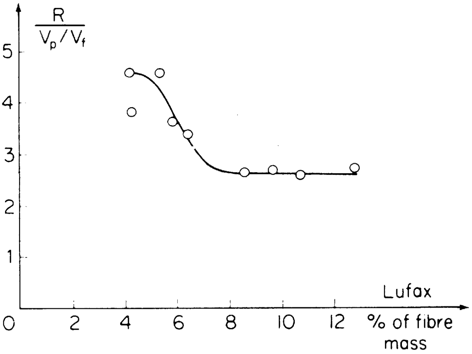

Fig. H

The same situation is shown for a more practical property—strain. Spray bonding is again the effective process for putting the polymers into the sheet.

A small comment about the colloidal system. Of course, when you are using better deposition, you have to have a colloidal system and use a retention agent. In Fig. H, we have plotted binder retention against the percentage of the retention agent (Lufax, in this case). As expected, if we overdose the system, the binder retention falls. What is important is that, exactly at the point where the retention falls, the mechanical effectiveness (that is, the damping area) also falls. This means that the mechanical effectiveness of the latex is reduced by changes in the colloidal system. Besides this, of course, the reduction of retention means that an excess of latex exists in the papermachine system, which can be rather difficult.

Discussion

Mr L. M. Lyne With the increasing limitation of petroleum in the world, do you see a limitation in the development of polymer papers over the next 25 years?

Prof. B. G. Rånby No, I don't see that, because it is a very small fraction of the petroleum that goes into the preparation of polymers. It is at present only about 5 per cent, but the burning of petroleum is 85–90 per cent, so it is in this that restrictions in petroleum usage must first apply.