

## *Prepared contribution*

---

### **Dr F. L. Hudson, College of Science and Technology, Manchester**

THE author suggests that wet strength resins are retained in the first place by an adsorption mechanism, possibly followed by hydrogen bonding that approximates ultimately to bonds approaching in strength those of primary valency. Whatever the mechanism of retention, the resin must be very loosely held by the wet pulp in the first place, as there is evidence <sup>(1)</sup> that it redissolves and may migrate as the paper is dried. Under laboratory conditions, it is easy to force and demonstrate this migration during drying either by radioactive tracers or by using dyes that are substantive to resin but not to cellulose. There is evidence to suggest that chemical reaction between cellulose and urea is possible. It is well known that lower alcohols will easily etherify urea resins and butanol ethers have been commercial products for many years. Dialdehyde oxycelluloses, themselves forming part of the fibres, will give wet strength. <sup>(2, 3)</sup> They can react only with other fibres and cannot form a resin. Substituted chloro-triazine derivatives, of the kind first developed for dyes capable of chemical fixation, but incapable of forming resins, will give wet strength. <sup>(4, 5)</sup> They too must react with fibres.

### **References**

1. Hudson, F. L., James, H. and Putman, J. L., *Tappi*, 1955, **38(a)**, 166A
2. Schur, M. O. and Levy, R. M., *Tech. Assoc. Papers*, 1947, **30**, 203
3. Zeronian, S. H., Hudson, F. L. and Peters, R. H., *Tappi*, 1964, **47** (9), 557
4. A. J. Hinton and Imperial Chemical Industries Ltd., B.P. 875 229 (published 16.8.1961)
5. J. Corser, Ph.D. Thesis, University of Manchester, 1965

## Transcription of Discussion

### *Discussion*

---

**Mr J. W. Swanson**—Thank you for bringing out these points. I apologise for not having included them in the paper, because they form an important contribution.

There remains the question, however, whether or not sufficiently fractionated resins were used in the study and whether or not the low molecular weight materials that contribute nothing to wet strength and are only partly absorbed were the migrating molecules.

We have done little work on the formation of chemical bonds in the wet strengthening process ourselves, but merely quoted the work of Stannett and co-workers. Their work indicated that very few chemical bonds were formed, though, it will be recalled, quantitative yields of their model products were not obtained. The recovery of, say, the glucoside products was only 95 per cent and the wet strengthening mechanism may not require a large amount of chemical bond formation. I think the work Back has done on high temperature treatment of paperboard indicates quite clearly that chemical bonds are formed and there is little reason to doubt that some chemical bond formation may occur during the development of wet strength.

**Dr F. L. Hudson**—On the point about fractionation, the resins were ordinary commercial materials and not fractionated. Nevertheless, it was possible to confirm the migration effects indirectly by strength tests, when drying conditions were adjusted to reduce migration.

**Miss S. Schmidt**—With reference to this paper, the Editor of *Wochenblatt für Papierfabrikation*, Dr. Ulrich Kirchner would like to advise that his doctoral thesis, prepared under the guidance of Prof. W. Brecht, was 'The air content in paper stock suspensions'. They published their results in *Wochbl. Papierfabr.*, 1959, **89** (8), 295–305 and *Das Papier*, 1961, **15** (10a), 625–634.

In November 1964, a round table discussion exclusively concerned with the significance of the air content of paper stock suspensions took place at the Institut für Papierfabrikation of the Technische Hochschule, Darmstadt, organised by the Akademische Papieringenieurverein, of which a detailed report was published in *Wochbl. Papierfabr.*, 1965, **93** (1), 1–22.

**Prof. B. G. Rånby**—I find it highly commendable to take a positive attitude towards papermaking additives that are being developed by the chemical industry. I agree with Swanson that the paper industry as a whole would benefit by taking advantage of this offer from the chemical industry. In our laboratories, we have studied a few aspects of the large problem of chemical additives, in particular the addition of latices and dry strength resins to papermaking fibre slurries. You cannot expect effects on the paper properties from fine chemicals that are not retained in the papers. Therefore, we have studied retention in detail with many unexpected findings as a result.

When alum is used as a retention aid, it is not only a question of the slurry's pH value, it is also a question how the alumina flocs formed interact with the fibres and the additives (such as the latex particles or the polymer molecules). We have found that there were extremely narrow pH intervals in some cases that gave a retention approaching 100 per cent. In other cases, one could hardly find such an area of high retention, apparently because there is a delicate balance of the pH value affecting the alum in solution *and* the charge of the fibres and the latex particles. The success or failure of using additives may depend upon the retention. These problems can also be so difficult to resolve that they need special studies. Along these lines, you may explain many of the disappointing results with chemical additives.

**Mr W. F. Reynolds**—Where the use of hydrophilic polymers as fibre defloculants is discussed in Swanson's paper, it may be of some interest to note that it is now possible by the use of a small amount of polymer to control the drainage rate of unbeaten pulp to any degree desired.

**Chairman**—Time has expired with many questions left unanswered; however, Swanson's slide on the effect of mannogalactans on papermachine formation show clearly that the formation of the machine-made sheet can be influenced chemically.