Unconventional strength additives

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SUMMARY: Unconventional additives for increasing the strength of never-dried wet webs, dry paper and rewetted paper were investigated. It was found that handsheets made from bisulphite pulps or kraft pulps can be reinforced by cationic aldehyde starch (CAS). The strength of TMP handsheets was increased with chitosan, but not with CAS. However, stronger handsheets were obtained from TMP pulp which was treated with a cationic zirconium oxychloride solution prior to CAS addition. Treating TMP pulp with zirconium compounds was identified as a new method for improving the strengthening performance of polymers.

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Numerous publications describe the effect of interfering anionic materials on strength and other properties of paper (Lindstrom et al. 1977; Worster et al. 1980; Brandal, Lindheim 1966). Other publications deal with the influence of polyelectrolyte retention aids, electrolytes (for references. see the foot-note[a]), and other furnish components (Bianchin et al. 1979) on pulp characteristics and product properties. Until recently, however, little was known about the effects of anionic furnish components and additives on the strength of never-dried wet webs.

Wearing et al. (1985) have reported that the strength of wet webs and dry sheets made from a newsprint furnish was reduced when handsheets were made using water which contained dissolved and colloidal wood components. Lignin, wood extractives and surface active materials were reported to interfere with the interfibre hydrogen bonding (Dixon 1940). On the other hand, dissolved wood polysaccharides act as bonding agents and increase the paper strength (Lindstrom et al. 1977; Laffend, Swenson 1968; Swanson 1961). Various cationic starches increased the fines retention and the surface tension of white water, but failed to improve the wet-web strength of newsprint handsheets (Laleg et al. 1991). A cationic aldehyde starch, which can form chemical bonds with cellulose, was found to increase the strength of wet webs, dry paper and rewetted paper made from kraft pulps, both in the presence and the absence of alum, size, filler and retention aids, but failed to increase the strength of handsheets made from mechanical pulp (Laleg et al. 1989; Laleg, Pikulik 1991).

Mechanical pulps are often blended with a portion of chemical pulps in order to improve both machine runnability and product quality. The chemical pulps increase the cost of furnish, especially if purchased as a dry product. Production costs could be reduced considerably if a portion of the chemical pulp were replaced by a suitable strength additive. This work explores the possibilities of replacing the chemical pulp portion of wood-containing papers with polymeric additives.

One possible way of increasing the strengthening effect of polymer additives is the application of surface modifier chemicals known as "coupling agents," to improve bonding between the polymer and fibres. Such chemicals are commonly used in the production of composite materials (Monte, Sugerman 1984; Cohen 1983), but have not been used in papermaking (Stewart, Wolstenholme 1975). However. it has been reported that reactive titanate chemicals can modify the surface of cellulose fibres, crosslink cellulose fibres, increase fixation of inorganic fillers to cellulose fibres, and improve paper properties (Lagally 1955; Varma et al. 1986). The use of zirconium chemicals was found to reduce the "stickies" problem in the pulp and paper industry (Brewis et al. 1988). Zirconium compounds are suggested as coagulants for treating waste water from chemical pulping and paper mills by removing suspended substances and colloidal dispersed particles (Ayukawa 1976). The papermaking potential of two zirconium compounds are described in this paper.

Experimental

The never-dried thermomechanical pulp (TMP), unbleached bisulphite (UBP), bleached bisulphite (BBP), and previously dried bleached kraft pulp (BKP) used in this study were all made of softwood, and originated from eastern Canadian mills. *Table* 1 shows the

Table 1. Properties of pulps.

Pulp		TMP	BKP	BBP	UBP
TDCS[a], mgll		141	15	30	93
UV lignin[a], mg/l		68	2	3	46
Freeness, CSF mL		97	592	588	621
pH of pulp suspension		5.2	5.6	7.2	4.9
DDJ retention, %		78	97	95	97
Drainage time[b]. sec.		51	4.2	4.4	4.8
Bauer McNett fraction, %	R 14	12.4	61.5	30.9	55.3
	14/28	21.1	17.3	38.0	24.3
	28148	18.5	9.1	11.4	9.9
	481100	11.3	4.5	5.3	4.0
	100/200	5.6	1.9	3.6	2.6
	P 200	31.1	5.7	10.8	3.9

TMP = Thermomechanical pulp;
BKP = Bleached softwood kraft pulp
BBP = Bleached bisulphite pulp
UBP = Unbleached bisulphite pulp
TDCS = Total dissolved and colloid solids
[a] In filtrate
[b] In handsheet machine

[a] Pelton et al. 1980; Strom et al. 1982; Alince 1987; Hagedorn 1988; Laffend, Swenson 1968; Linhart et al. 1987; Auhorn, Melzer 1979; Cohen et al. 1949, 1950: Doblins. Alexander 1977; Scallan, Grignon 1979.