7 The practical application of wet-strength resins

F. LINHART

7.1 Introduction

Wet-strength resins are an important group of papermaking chemicals. Their mode of action is unusual in that they cause an irreversible change in a characteristic physical property of paper – its strength in the dry state and its tendency to disintegrate when wet – rather than merely improving paper quality. They are therefore only used for a fraction of the total paper production, but this still amounts to 4–5% of all paper produced or 10 million tonnes per year. World-wide consumption of wet-strength resins is estimated at 400,000–500,000 tonnes per year with a value of around US$470 million.

A great deal of work has been published on the history of wet-strength resins, their chemical composition, the processes by which they are produced, their different effects, the relationship between their chemical structure and their mode of action, and test methods for wet-strength grades of paper.\textsuperscript{1–3} Only passing reference will be made to these topics in this chapter. The main emphasis here is on the practical application of wet-strength resins in the paper mill, with the aim of assisting papermakers – who are not usually trained chemists and not particularly interested in chemistry – to get the best practical results from this class of products.

There are many reasons why more work has been published on the physics and chemistry of wet-strength resins than on their practical aspects. One of the reasons is that many stages of the processes in which they are applied are taken for granted or considered so straightforward or unscientific that nobody has taken the trouble to write about them. Another reason is that many technicians working for manufacturers of wet-strength resins have built up their own special expertise with these products in a mill environment, and they are unwilling to pass it on. Another factor is that, in papermaking, there are many practical phenomena for which there is a logical explanation, but for which no scientific evidence can be put forward.

7.2 Areas of application

Wet-strength papers can generally be classified as having a wet breaking length of at least 30% of their dry breaking length. However, many grades of paper, such as hygiene papers, would have virtually no wet strength at all if they did not contain wet-strength resins, and so these papers are classed as
wet-strength papers if their wet breaking length is at least 10–20% of their dry breaking length. Also, the aim is not always to obtain the highest possible wet strength, because papers have to be able to be repulped. The required wet strength depends on the applications to which papers are put.

The most important area of application for wet-strength resins is in the production of hygiene papers. These include hand towels, serviettes, cleaning cloths and facial tissue. Although wet-strength resins are used in the production of toilet tissue to coat the crêping cylinder (see below), papers of this type are not true wet-strength grades, because they have to be able to disintegrate easily in order to avoid blocking the sewage pipes.

Packaging papers are another important area of application for wet-strength resins. These include paper sacks, carrier bags, milk cartons, deep-freeze packaging, meat wrappers and fruit trays.

Wet-strength resins are also used for a variety of speciality papers such as poster paper, labels, overlay paper, wallpaper, abrasive paper, map paper, filter paper, electrical insulating paper, photographic paper, banknote paper and other grades that are required to retain a certain level of strength when moistened.

The reservations concerning plastics packaging that have been expressed in the public debate on the environment are an argument in favour of using wet-strength paper packaging. However, this is only true as long as the paper can be considered capable of being easily repulped and recycled.

7.3 Types of wet-strength resins

Nowadays, the wet-strength resins used in the paper industry usually belong to two main groups: formaldehyde resins, which can be divided into urea-formaldehyde and melamine-formaldehyde resins, and polyamidoamine-epichlorohydrin resins.

Polyethylenimine, dialdehyde starch, polyacrylamides with glyoxal substituents and other substances are employed in special cases. Glyoxal is also used, but it is never applied at the wet-end.

The characteristics common to the main classes of wet-strength resins and the differences between them are summarized below:

- All wet-strength resins cause an increase in dry strength
- The paper has to be left to cure before its wet strength reaches the maximum
- Wet-strength resins themselves do not impair absorbency
- Liquid products have a restricted shelf life
- Urea-formaldehyde resins and melamine-formaldehyde resins are most effective in acid conditions
- All formaldehyde resins contain free formaldehyde, formaldehyde is released during processing and from freshly made paper