1 Papermaking chemicals and their function

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1.1 Introduction

Modern papermaking has come a long way from the original handicraft. The early making of paper sheets by hand had little in common with today's highly computer-controlled processes and equipment. Large-scale paper production today takes place on machines producing more than 30 tonnes of paper each hour. The market and market demands have also developed considerably. Often the paper is produced, printed with four colours, read and thrown away within 24 h, which is comparable with the time it originally took to form, press, dry and cut handmade sheets.

However different in scale and efficiency the papermaking machinery is, paper is still formed mainly from wood fibres (even though these fibres may have been recycled) that are suspended in water. Development has been due not to any radical new solution to papermaking but more to the higher demands on effluent control, efficiency, cost reduction and last but not least paper quality and print quality. The response from the papermakers to these demands have been (i) to minimise the losses; (ii) reduce downtime and cleaning, (iii) introduce low cost fibre substitutes; and (iv) add other components that change the way that paper reacts when in contact with water and with different inks in printing or typing. In all these areas, the addition of different kinds of chemicals are the key to success when added in the proper way.

As a complement to the machinery, which has a major influence on productivity and paper quality, the addition of chemicals improves both performance in papermaking and paper quality. Chemicals hence lead to an improvement when the paper machine has good productivity and the paper quality is good. On the other hand, chemicals are not efficient if the papermaking machinery is malfunctioning or if the paper quality is not within the required limits. These problems must be solved by means other than by the addition of expensive chemicals.

Generally, the chemicals of interest in papermaking are retention aids. This is historically true since alum, as the first papermaking chemical, worked as a retention aid for fines and fillers and helped to reduce losses as well as acting as a part of a sizing system. Retention does not, however, have a unique meaning since it involves not only solids but colloidal and dissolved substances. Retention aids as such are important, but today they are only a part of the total...
quantity of papermaking chemicals being used. We therefore suggest other
wider definitions to divide the chemicals into two different areas:

1. *Performance chemicals* which change the properties of the paper in such a
   way that they improve runnability in printing presses and also improve the
   quality of the printed or typed product.

2. *Process efficiency improving chemicals* which improve the paper machine
efficiency and help to keep fibre, fines and filler losses at a low level.

### 1.2 Paper chemicals

#### 1.2.1 Performance chemicals

*Dry strength aids.* Dry strength additives have been traditionally used to
compensate for the decrease in paper strength resulting from the addition of
either fillers or lower grade cellulosic fibres, i.e. recycled fibres. It is very
unusual to find any application where tailor-made speciality additives have
been used to improve the quality of an existing paper quality. This is mostly
due to the large volumes needed in paper manufacture and to the demand for
good production economy for these commodity products.

Different kinds of starches have been used to improve the paper strength.
Native starch was at first used, but these starches show a low affinity for the
cellulosic fibres and hence contribute to an unacceptable increase in the BOD
load in the effluent waters. The introduction of cationic starches resulted in a
dramatic improvement in this respect and it was soon observed that their
addition had a positive effect on the first pass retention. Due to the common
use of cationic starches and the large amounts used, a fairly large research
effort has been devoted to a cost and quality optimisation of starch addition.\(^1\)
However, modern paper technology with its dramatically increased degree of
system closure and a greater use of recycled fibres has reduced the efficiency of
the cationic starches. This has been found empirically in industrial use, and
recently published work\(^2\)–\(^5\) has also shown that it is the higher concentration
of indifferent electrolytes, fines and dissolved and colloidal material, induced
by the greater degree of closure and greater use of recycled fibres that causes the
decrease in starch efficiency. There are at least five ways out of this apparent
*cul de sac* in the use of starch as a dry strength additive:

- An increase in charge density of the starch (although this will decrease the
  maximum amount that can be adsorbed onto the stock in question)
- An internal cleaning of the white water system of the paper machine. This
  must be conducted by the papermaker with new technology
- Size press addition of the starch. This will decrease both the effect per kg of
  the starch and the productivity of the paper machine
- An increase in charge of the fibres. This will be very hard to control for the
  papermaker