Application Techniques for Maximising Softness in Tissue Manufacturing & Converting

By: Philip George Bunce, Product Manager

INTRODUCTION

Many mills do not pay sufficient attention to the conditions on the machine and during converting to maximise softness. Firstly, the ability to produce soft tissue begins with the furnish blend and the amount of strength required to meet the end users need. Specifications can often be set too high to produce a bulky soft sheet and although the softness can be enhanced by chemical treatment at the wet end, creping and conversion, it is often masked by other effects from "external forces", which have a negative effect on the overall softness. This paper covers the main criteria to make the softest product within the limits of the manufacturing process.

FINDING A COMPROMISE

Many Tissue mills are faced with reaching a compromise based on costs, strength, bulk and softness. The use of pulps with low coarseness such as eucalyptus and acacia will improve the fibre flexibility and therefore the bulk softness which is the term given for the ability of the sheet to be crumpled or draped. The long fibre softwood to short fibre hardwood ratio can be changed, but the complication arises when the sheet needs to meet a certain strength specification based on refining which increases the machine direction and cross direction tensile strength but reduces the softness. In addition, wet strength and dry strength additives will also play a part in increasing the strength and they too will reduce softness. Using a de-bonder will reduce the cross direction tensile and increase bulk softness, but if used with strength additives and high levels of refining will have very little impact on softness even at high addition rates and will cause release problems during creping. This is why we often hear that "the softener did not work". The secret is to keep all wet end variations to a minimum, optimise strength additives if they must be used and operate with the right creping chemistry will also increase the sheet breakdown for bulky soft tissue. This is because generating a good base sheet is very important to maximise softness during conversion.

GENERATING A GOOD BASE SHEET

The importance of operating the right creping chemistry is essential because most of the sheet breakdown and hence strength loss, occurs at the creping blade, which generates surface softness by the increased "Z" direction of the fibres. A coarse crepe produces a coarse sheet therefore the doctor blade type and thickness, plays an important role in producing a fine crepe. A more flexible blade will give increased tendency to alter the crepe structure, cause "chatter" and give softness and quality variations. Similarly, if the blades "stick out" and doctor blade pressure is too high, it changes the effective creping

Good sheet breakdown at the doctor blade increases the fibres in the "Z" direction and improves the hand feel.

angle under pressure. If the blade bevel is increased from a square blade, to a higher bevel blade, then the higher the angle the more micro and macro folds are generated in the tissue increasing the bulk and surface softness. The effective shelf angle # is reduced.

 # The angle between the tangent and perpendicular to the Yankee surface

So changing the bevel has more impact on the effective shelf angle than changing the holder angle. Softness is increased when the effective shelf angle is lowered and in Fig 1 we see that it can be negative. A holder set at 18 degrees with a 10-degree bevel, will give an effective shelf angle of 8 degrees.

So we can see by choosing the right creping geometry we can have an impact on the surface softness, however we need to increase the coating adhesive to keep the Yankee protected as more coating is removed with a beveled doctor blade.

Holder	Angle of bevel	16	18	20	22
Square	0	16	18	20	22
	5	11	13	15	17
	10	6	8	10	12
	15	1	3	5	7
	20	-4	-2	0	2

Figure 1: Changing the bevel angle has more impact than changing the holder angle

A good spray pattern is essential for an even coating to produce an even fine crepe structure.

CHOOSING THE RIGHT SOFTENER

Applying a softener to the wet end will improve both the bulk and surface softness, while a de-bonder will give strength loss to create drape other softeners give minimal strength loss but impart hand feel. The effect of any softener addition must be controlled with increased adhesion to maintain the sheet breakdown discussed above, therefore selection of the correct creping adhesive is important as this may increase softness on its own merits by applying a softer even coating. Increasing the coating thickness (add on mg/m2) is particularly important for Yankee protection when using beveled blades and when spraying a softener to the wet web to improve the surface softness. As discussed previously, increasing the bevel angle will increase the sheet breakdown in the "Z" direction and reducing the stick out to 12-15mm will improve the number of crepes per inch, it should also be noted therefore that drying the sheet more on the Yankee rather than in the hood reduces energy consumption and increases the sheet breakdown at the creping blade all three factors combined contribute to better surface softness or hand feel.

MAINTAINING AND IMPROVING THE SOFTNESS

Now that we have produced a nice soft base sheet with the above conditions it is important to maintain the sheet characteristics. Applying a lotion or balm to a good base sheet will improve the softness of the final sheet above that achievable on the machine. However, it is well known that excessive rewinding and calendering will reduce the bulk and softness considerably, but only improve smoothness. Moreover, embossing will reduce the surface softness although the bulk is increased and any moisture applied to the sheet will cause the flexibility of the sheet to be lost on re-drying the fibres.

SUBJECTIVE AND OBJECTIVE TESTING

The selection of wet end and surface sprayed softeners for facial and bathroom tissues can enhance the base sheet while further applications of softeners, lotions and balms can enhance the final quality of the sheet and provide:

- Improved "hand feel" and smoothness
- Flexibility and improved drape
- Bulk softness and pliability
- Silky and velvety surface

So how do we know how soft the sheet has become? The perceived softness of a substrate be it either the base sheet or the finished product is a combination of subjective properties felt by fingertip touch, and is a combination of severable measurable properties such as:

- Smoothness and sound
- Elasticity and bulkiness
- "Z" direction fibre orientation
- Micro and macro compressibility

During conversion fibres can become hardened due to re-orientation of the fibres or loss of chemical residues by them becoming absorbed into the sheet. So we need off machine objective testing which may be performed with softness analysers available on the market, or a panel test may be used which comprises of a fixed number of individuals who acquire the skills to differentiate many different levels of softness and softness types.

MECHANISMS FOR IMPROVED SOFTNESS

In Topical applications we are talking about the surface coating of individual fibres with softeners, which orientate themselves in the direction to give lubricity and softness depending on the type of softener and the hydrophobic or hydrophilic nature of the surface see fig 2. There is also a certain amount of Interference with fibre-fibre bonding so that fibres become more flexible because they are not so tightly bound to one another. In addition, there may be structural fibre changes by fibre wall penetration absorption as well as adsorption through topical applications with softener transfer such as lotions and balms to the end user when handling the final product from the packaging.

In selecting the topical application to give the desired properties, we must consider the compatible with other process chemical applications, such as fragrances, additives and antibacterial agents. They should be easy to handle with good environmental properties and toxicology, controllable effects and stable at high temperatures unless transfer is expected upon touch. In addition, they must have no effect on shade, odour and meet regulatory compliance, biodegradability, toxicity, etc.

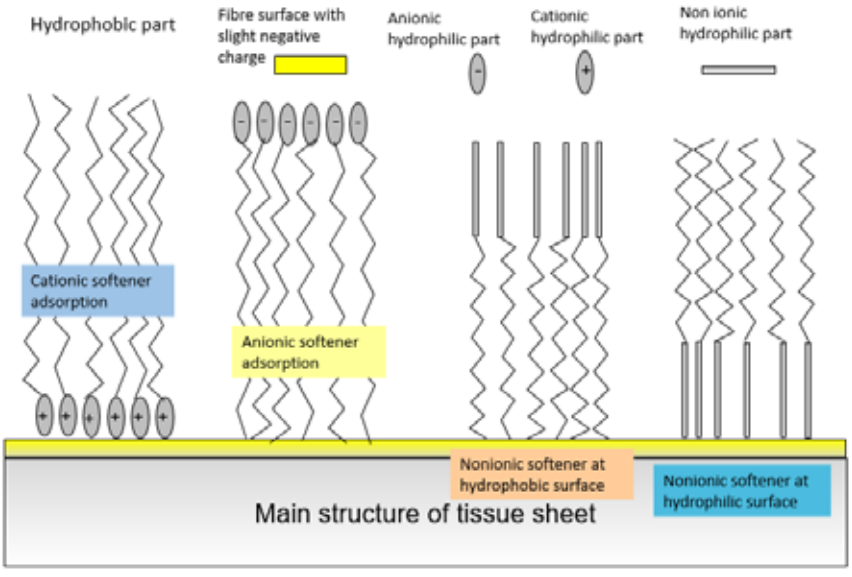

Figure 2: Schematic of softener applications

SELECTING THE RIGHT TYPE OF SOFTENER OR TOPICAL APPLICATION

There are many product types consisting of a hydrophilic and a hydrophobic part they are therefore classified as surfactants and may be cationic, anionic or non-ionic and comprise of:

- Oil in water emulsions
- Long Chain Alkyl group
- Polydimethylsiloxanes
- Silicone derivatives
- Paraffin's
- Polyethylene softeners

The products, which can be applied topically, have different properties; cationic softeners are the most substantive, whereas anionic softeners produce slick surface effects, hydrophilic softeners can appear to impart moist qualities. Softeners based on micro emulsions penetrate into the interior of the fibre so that a good core softness is achieved, while softeners of macro emulsion formulations accumulate more at the fibre surface and therefore soft, voluminous and smooth hand feel effects are obtained.

In summary generating a good base sheet is very important to producing a soft product while the selection and application of the softener can give additional properties towards the perceived final quality and acceptance of the product. It must be noted that much of the "good work" done by the paper maker may be undone during conversion. Softeners and debonders are often available commercially only as complex mixtures rather than as single compounds to utilise a number of effects and suitable softeners, debonders and surfactants will be readily apparent to the skilled worker and are widely reported in the literature.

Phil Bunce
Product Manager
Amazon Papyrus Chemicals
philip_bunce@amazon-papyrus.com
www.amazon-papyrus.com