Specialty paper chemicals: an overview

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Some of the chemicals used today as functional or processing aids have a dual purpose and could be classified under either category.

Specialty paper chemicals can be categorized as being functional in nature or as processing aids. The functional specialty paper chemicals impart some property to the sheet of paper or paperboard, such as water resistance, wet strength, or flame retardancy. Processing aids such as pitch control agents, defoamers, cleaners, and biocides are used to assist the papermaker in processing the paper or paperboard.

Let's discuss the main categories of functional and processing aids.

Functional chemicals

Sizing agents

Internal sizing. Internal sizing agents can be broken down into acid rosin sizes consisting of 70% soap paste, 50% fluid water-soluble sizes, and 35% dispersed free-rosin emulsion sizes. All of these rosin-based sizes are used at an acid pH, with alum in a pH range of 4.5 to 6.2. Dispersed-size emulsions are the most widely used of the rosin-based sizes today and are used at the higher acidic pH levels.

Neutral and alkaline rosin sizes are generally dispersed free-rosin size emulsions (both anionic and cationic in nature) and are designed to be used at neutral and alkaline pH in conjunction with alum or polyhydroxyaluminum chloride, cationic starch, and cationic or anionic polymers. Point-of-addition and application technique is extremely important using these free-rosin emulsions at pHs of 6.5 to 8.5. Some companies have patents on composition of matter and end use. Many companies have developed their own technique for addition of the size, with special application and retention techniques to achieve sizing.

The main reason for the increased use of neutral sizing is the growing use of recycled fiber containing higher and higher amounts of calcium carbonate filler.

The other main internal sizing agent is alkaline sizing with alkyl ketene dimer (AKD) and alkenyl succinic anhydride (ASA). This market segment continues to grow throughout the world. The conversion to alkaline sizing is mainly due to the substitution of lower-priced calcium carbonate fillers for high-priced clays, titanium dioxide, and cellulose, which produces a product with higher strength at lower cost, reduces corrosion, increases paper permanency, and creates a cleaner wet-end system.

The main benefits of AKD sizing are its ready-to-use, stable emulsion and ease of wet-end addition, while ASA is generally cheaper and imparts on-machine sizing due to its faster reaction with cellulose. The disadvantages of AKD are its higher cost and the level of slip developed due to the wax-like nature of the dimer when reacted with cellulose. The main disadvantages of ASA are the need for the papermaker to prepare a stable emulsion and the rapid-reaction response, which sometimes results in the hydrolyzation of the ASA and thus potentially creates machine deposits.

Surface sizing agents. These are mainly styrene maleic anhydrides. Surface sizing agents are used, and are often necessary, with neutral and alkaline rosin sizing. They are also often used in conjunction with AKD and ASA to help achieve sizing through the reduction of internal size at the wet end to reduce slip and improve ink-jet printability.

Wet-strength resins

Wet-strength resins are used to impart wet strength to paper and paperboard and are widely used in tissue and toweling, corrugating medium, wet-strength liner, parchment paper, and various specialty wet-strength paper grades. There are several types of wet-strength resins such as polyamide epichlorohydrin, glyoxal, polyamine, epoxide, melamine, and urea formaldehyde. The most widely used wet-strength resin is the polyamide epichlorohydrin resin, which was originally designed for neutral-to-alkaline pH systems. Polyamide epichlorohydrin resins are now replacing urea formaldehyde-type resins at acid pH levels, mostly because of the environmental considerations related to formaldehyde. There is now a worldwide trend to reduce the level of epichlorohydrin and chlori-

nated by-products (AOX) in the polyamide resins, and new, low-AOX resins have been developed to meet these needs.

Dry-strength resins

Dry strength is a property constantly sought by the papermaker, and, when it cannot be achieved by fiber furnish or complemented by refining, it is necessary to obtain added strength through the use of chemicals. The major specialty chemicals utilized for dry strength are the polyacrylamide resins, water-soluble polymers such as guar gum, polyvinyl alcohol, and CMC, along with cationic starches and starch–polyacrylamide blends.

Retention aids

Retention aids were once considered processing aids, but because of the new sizing systems and the need to close up the wet end, retention aids have become more functional in nature and have developed from simple papermakers alum to complicated two- and three-component systems that not only improve retention but also drainage, strength, and formation.

The major retention aids employed by the papermaker today are anionic and cationic polyelectrolytes, mostly of the polyacrylamide type, used either singly or as dual-polymer systems, microparticle systems such as bentonite and cationic polymers, colloidal silica and cationic starch, polyethylene oxide with various dispersants such as phenolic formaldehyde resin and naphthalene sulfonate, and polyaluminum silicate sulfate, an inorganic cationic polymer.

Coatings

Coatings are not wet-end chemicals but are included in this overview since they are so important and widely used in coated grades of paper and paperboard.

Many millions of pounds of chemicals and fillers are used in coating formulations in the manufacture of coated paper and paperboard, varying from simple clay, starch, and water coatings to more sophisticated formulations containing titanium dioxide, clay, calcium carbonate, styrene–butadiene rubber, ethylene vinyl acetate, ethylene vinyl chloride, synthetic hollow spheres, surface sizing agents, polyvinyl alcohol, starches, CMC, sodium alginate, protein products, structural pigments, and a variety of other specialty chemicals including defoamers, levelling agents, optical brighteners, grease-resistant agents, biocides, and lubricants to assist the papermaker in developing a suitable coating for gloss, brightness, smoothness, and printability.

The trend is to lighter coatings on lighter-weight grades being applied at higher speeds, which requires much improved coatings and more efficient systems.

Surface-treatment chemicals other than grease-resistant products consist of film formers such as CMC, polyvinyl alcohol, and sodium alginate, which improve liquid hold-out as well as smoothness and printability.

Creping aids

Creping aids consist of chemicals designed to permit the sheet of tissue and toweling to stick to the Yankee dryer surface and to aid in its release. The agents designed for adhesion mainly consist of polyamide-type resins. Some companies have developed technology application through the use of spray booms, where the adhesive and release agent are combined and sprayed directly onto the sheet or the Yankee surface. Creping aids can also be added internally to the stock system, often in conjunction with Yankee surface treatment. Release agents are mostly mineral oil or similar products.

Other specialty chemicals

Dyes and pigments, flame retardants, grease-resistant agents, softening agents, and optical brighteners constitute the other major category of functional chemicals and are self-explanatory.

Processing aids

Processing aids are specialty chemicals that help control sheet properties and assist the papermaker in producing a quality grade of paper and paperboard.

Let's take a look at the main processing aids.

Pitch dispersants

Pitch has been a major problem throughout the ages and papermakers alum has been the most effective agent to control pitch, mostly in groundwood and sulfite and in grades of paper utilizing pulp derived from pine trees in the kraft pulping process. The most economical and widely used pitch control agents are talc and other absorbents such as diatomaceous earths.

Many companies have developed specialty surfactants for pitch control, which are anionic or nonionic in nature. Some companies have developed chemicals for stickies control. Stickies are a growing problem, and their treatment falls in the same category as pitch control. Some stickie control agents are cationic resins, consisting mostly of polyamines sprayed on the top side of the wire before the breast roll. Many mills are now also using high charge, low-molecular-weight cationic polymers for pitch control and for neutralization of anionic trash. These stickies control agents have been most effective in recycled and deinked stock systems. Stickies consist mostly of tacky materials such as ethylene vinyl acetate, neoprene, wax, pitch, isoprene, acrylic latex, residual papermaking chemicals, and other tacky materials sometimes labeled "white pitch," which can cause numerous problems to the papermaker including machine deposits, plugged felts and wires, and holes in the sheet.

Defoamers

Defoamers are the most well-known processing aids and are used throughout the entire pulp and paper mill, including the brownstock washers, bleach plant, deckers, screen room, paper

machine, size press, coatings, and calender stack, as well as in effluent treatment.

Defoamers vary in composition from the conventional oil-based silica and EBS compositions used in brownstock washing to oil-based, water-based, and water-extended products used in all other applications. Because of environmental pressures and concerns about dioxins and furans, companies have developed new silicone emulsion-type pulp mill defoamers and water-based machine defoamers, even though oil companies have greatly improved the quality of carrier oil for oil-based and water-extended products. The use of defoamers will grow as long as air is entrained in stock systems, more recycled and deinking systems are expanded and developed, and mills increase closure.

Increased throughput always requires more defoamer.

Biocides

Biocides classified as bactericides, slimicides, fungicides, etc., are a necessity in the manufacture of paper and paperboard. There are many types of biocides used to combat different types of problems, from control of simple bacteria in starch solutions to iron-eating bugs in the headbox. Biocide companies have developed sophisticated products and have had to reformulate due to the continuing switch from acid to alkaline papermaking conditions, and recently due to the reduction and elimination of chlorine from pulp and papermaking systems to prevent the formation of dioxins and furans.

Cleaners

Cleaners, including boil-out chemicals, are growing in use, and companies have developed sophisticated systems with proprietary-type cleaning compounds delivered through state-of-the-art nozzle spray systems designed to keep felts and wires clean without shutting down and losing production. Cleaners vary in composition from simple, inorganic alkaline-based products to highly sophisticated surfactant-based cleaners with the incorporation of biodegradable, nonhazardous solvents such as citrus *d*-limonene and *n*-methyl pyrolidone.

Deinking chemicals

Deinking chemicals are growing in use because of the large expansion of deinking pulping facilities throughout the world. Basically, deinking chemicals have not changed, and they are used in both conventional washing and flotation deinking-type systems. The trend today is to combine systems, followed by new state-of-the-art pressure cleaning and mechanical screening equipment. New equipment has been necessary because of the introduction of laser jet and flexographic inks, which are difficult to remove through chemical treatment alone. The main deinking chemicals utilized are inorganic acids and alkalis, solvents, defoamers, dispersants, drainage aids, sodium silicate, hydrogen peroxide, chelants, flotation aids, and polymers. Some of the latest innovations in deinking chemicals have been in the collector area, with new surfactant-based dispersants that are multipurpose, highly efficient, and are known as displectors.

Other chemicals

Some of the other major processing aids are release agents, lubricants, wetting agents, repulping aids, anti-block agents, anti-static agents, and anti-slip agents.

Comments

Some of the chemicals used today as functional or processing aids have a dual purpose and could be classified under either category.

The pulp and paper industry continues to grow and change, with the constant need for new and more efficient specialty chemicals in both the processing and functional end-use applications. TP

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