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FOR THE PAPER INDUSTRY

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FILLERS – DON'T JUST "FILL"

Introduction:

Fillers can be defined as water-insoluble, particulate substances in the size range of about 0.1 to 10 μm that are added to slurries of cellulosic fibers before the formation of paper. In terms of the amounts used, fillers rank second only to fibers themselves as an ingredient of paper. In addition to having a huge economic impact, fillers also provide a fascinating field for scientific and technological investigation.

Main Classes of Fillers for Paper making

The most widely used fillers for papermaking can be described as inorganic, particulate materials. As shown in Table 1, it is possible to divide these materials into two main classes, natural and synthetic. Some minerals, such as calcium carbonate, are available as fillers in both natural and synthetic forms. Other minerals, such as talc and titanium dioxide, are mainly restricted to either the natural or the synthetic category of fillers, respectively

Mineral Composition	Natural products	Synthetic products
$CaCO_3$	Ground Limestone (GCC)	Precipitated Calcium Carbonate (PCC)
	Chalk (ground)	
Al_2O_3-$2SiO_2$-$2H_2O$)	Clay (Hydrous Kaolinite)	Precipitated Aluminum Silicate
TiO_2		Titanium Dioxide (rutile and anatase form)
$Mg_3Si_4O_{10}(OH)_2$	Talc	
$CaSO_42H_2O$		Gypsum

Fillers Don't Just "FILL"

Despite their somewhat humble name, fillers do much more than just occupy space within paper. Fillers affect paper's structure, appearance, and many measurable properties that determine paper's end-use performance in different applications. If one "fills a hole," one adds something to occupy an existing void volume. But in the case of papermaking, what we call fillers are added before the structure of paper yet exists. As will be discussed, because of the way paper is formed, fillers can profoundly affect the thickness of the resulting product. By partly interrupting the bonded area between fibers, most fillers tend to decrease the strength properties of paper. In some cases filler use increases the fraction of void volume of paper, especially if the caliper is measured before the paper is calendered. The proportion and dimensions of empty spaces within the sheet have a large impact on optical properties, in addition to the paper's permeability and interaction with inks.

Most papermaking fillers have maximum dimensions in the range of about 0.2 to 4 m. To put this size range into perspective, the diameter of a typical filler particle is only about 1/1000 of the length of a typical papermaking fiber, which usually is about 1 to 3 mm.

Though it is possible to see individual filler particles under a high-power optical microscope, their presence is more often made apparent by indirect tests, including ash analysis of paper samples, measurements of paper properties, and the light scattering characteristics of mineral suspensions. Because typical papermaking fillers are so small, their retention during the paper forming process presents technical challenges, and these will be considered later in this article.

Main Benefits of Filler Use:

As summarized in below Table, there are a variety of benefits that papermakers and their customers can derive from the use of fillers in paper. While not all of these benefits may be important for a particular type of paper, fillers offer the manufacturer of paper products a variety of ways to meet customer needs and improve profitability. Depending on the type of paper being made, the product attributes most likely to benefit the most from filler use are brightness, opacity, smoothness, dimensional stability, print quality, and the overall cost of materials. The selection of what type of filler to use, and also the amounts added, will depend on which of these attributes are critical to the paper's end use,

Benefits of Filler used	Ways to Maximize the benefits
Cost reduction	Increased filler contents, using low-cost fillers
Brightness	Increased filler contents, using bright-fillers
Opacity	Increased filler contents, especially using fillers with optimum size of the primary particles. Best results with high refractive index filler
Reduced energy of drying the paper	Increased filler content
Friction – to increase the paper-to-paper coefficient	Composite structure of filler. E.g. calcinied clay, scalenohydral PCC
Friction – t decrease the paper-to-paper coefficient	Platy filler with easy delamination. E.g. talc
Control of pore size e.g. for filter papers	Selection of size and particle shape of filler
Controlled burn rate, e.g. for cigarette paper	Use of aluminum unhydrate (ATH)

and in what proportions.

Fillers have played an especially prominent role in the manufacture of paper products intended for printing. Although bleached kraft fibers have

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achieved a position of dominance for high-end printing papers, the fibers themselves do not contribute sufficient interaction with light to meet customer requirements for opacity in typical grades of printing papers. The translucent nature of paper made from bleached kraft fibers only tends to increase when the papermaker applies mechanical action to the fibers, i.e. refining, to enhance inter-fiber bonding and increase the apparent density of the paper.

Key problems associated with Filler use:

As shown in below table, some common effects of using fillers are generally regarded as unfavorable. However, as indicated by the entries in the second column of the table, suppliers and users of papermaking fillers have developed various ways to minimize various undesired effects..

Filler related Problem	Strategy to Minimize Probled
Strength decrease, higher frequency of web breaks	Larger particle sizes, cationic starch, increased pulp refining
Increased apparent density of the paper	Use of bulky fillers, fiber optimization
Low first-pass retention, two-sidedness of paper sheet	Effective retention aid use
Abrasion of forming fabrics, slitter knives, die-cutters	Acoidance of quartz impurities, fine particle size
Dusting, contamination of printing presses, copiers	Surface-applied starch
Increased demand for sizing agents, etc.	Increased chemical dosages, reduced filler content, larger particle size

Some of the most important characteristics of fillers can be anticipated from the composition and crystalline nature of the materials. Though papermakers themselves seldom carry out the analyses needed to determine filler's composition or crystalline nature, knowledge of these factors can be helpful in making decisions regarding filler use. For instance, it may be possible for the supplier of the filler material to substitute a different grade of mineral that better meets the papermaker's needs.

In yet other cases the papermakers can choose among several different potential filler materials in order to meet customer objectives at minimum cost.

Some factors about Fillers:

- Some of the most important characteristics of fillers are, Hardness, Refractive Index, Solubility, Wettability and Crystal Structure.
- Some filler properties controlled by suppliers are, Brightness, Determination of filler particle shape and Particle size.
- Ground calcium carbonate (GCC), Chalk, Kaolin clay, Calcined clay, Chemically-structured Kaolin, Talc, Mica, Zeolites are few examples of Natural, mined filler products.

Synthetic, precipitated filler products are Precipitated Calcium Carbonate (PCC), Aragonite, Acid-Tolerant PCC, Titanium Dioxide, Aluminum Trihydroxide, Amorphous Silica Fillers, Amorphous Silicate Fillers, Calcium Silicate, Synthetic Gypsum, Urea-Formaldehyde Pigment – A non-mineral filler.

QUOTABLE QUOTE

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SCRABBLE
email answers by 25th Oct' 23

Form TWO word :

CAR LIT POLOR LAP

First correct answer will win a gift from Wires & Fabriks (S.A.) Ltd. (Maximum two prizes for one person in a year)

WINNER
SEPTEMBER 2023

Mr. Babu Kambadkone, Production Manager, M//s Gayatri Paper Mills, South Africa

Answer : PRIMARY HEADBOX

?QUIZ
email answers by 25th Oct' 23

QUIZ: The use of a long press nip with one roll at 175-400°Celcius to remove water from the web's called as _____ .
(a) Yankee drying (b) Reel '(c) Dryer Hood (d) Impulse drying

WINNER
SEPTEMBER 2023

Quiz: _____ are relatively inexpensive polymers that are easily devised to high molecular weights on the order of several million (g/mol).
(a) Poly electrolytes (b) Charge Density '(c) Carboxylate (d) Polyacrylamides

Mr. Prasad Reddy Bora, Sr Manager (Quality), M//s Andhra Paper Mills, Rajahmundry, Andhra Pradesh.

Answer : (d) Polyacrylamides

Prizes

Best / first correct answer received will win one-year subscription to **IPPTA Journal** *(Maximum one prize for one person in a year).*

Teaser

***Laughter* is the best medicine, but if you laugh for no reason, you need *medicine*.**

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