**OPTIONAL QUIZ QUESTIONS for Course 10: “Mineral Fillers for Paper”**

Session 1: Introduction: Why fill paper?

1A – Approximately how much smaller are typical filler particles compared to the lengths of typical papermaking fibers?

* About 100 times
* About 1000 times
* About 100,000 times
* About 1,000,000 times

1B – Which of the following situations typically leads to increased density of a paper sheet?

* Filler particles creating debonded areas between fibers
* Decreased content of a fillers, due to their low inherent density
* Increased refining of kraft fibers
* A change from a platy filler to a rosette shape at the same level

1C – What type of mineral filler is known to dissolve in the presence of acidity?

* Kaolin clay
* Calcium carbonate
* Titanium dioxide
* None of the commonly used fillers

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Session 2: Filler types, composition, preparation

2A – What type of filler particle is often specified to have a rosette-type shape?

* Chalk (coccolith type)
* Hydrous kaolinite (but the shape is transformed in calcined clay)
* Titanium dioxide (both rutile and anatase crystal types)
* Precipitated calcium carbonate (scalenohedral)

2B – Which of the following is a reliable method to evaluate the particle size of filler particles, especially if the particles are approximately spherical in shape?

* X-ray diffraction (XRD) analysis with backscatter
* Angular dependence of the intensity of forward-scattered laser light
* Refractive index measurements, suspending the particles in a set of liquids of differing refractive index
* Raman scattering analysis with attenuated total reflectance (ATR)

2C – Which of the following is a dispersant that can be used to stabilize a suspension of mineral particles in water?

* Sodium hexametaphosphate
* Sodium montmorillonite
* Aluminum trihydrate (ATH)
* Sodium silicoaluminate

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Session 3: Paper strength & physical properties

3A – Why does ground limestone (the most common form of GCC) typically have a highly negative surface charge when it is delivered to paper mills?

* That is the inherent charge of the pure mineral (calcite).
* Dispersants are added during the grinding process.
* Protons dissociate from the silanol groups at the particle surfaces.
* Agitation during rail or truck transport affects the particle surfaces.

3B – What type of mineral fillers tend to have the largest negative effect on paper strength?

* Small filler particles
* Large filler particles
* Medium-sized filler particles
* Particles attached to fibrils

3C – What type of filler particle is likely to contribute to the lowest air permeability through paper?

* Precipitated calcium carbonate (rosettes)
* Ground calcium carbonate (blocky)
* Kaolin clay (platy)
* Synthetic silicate (high surface area)

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Session 4: Paper optical properties & minerals

4A – What do the equations of Kubelka and Munk involve?

* Angular dependence of scattered light
* Predicting the refractive index of minerals
* Light scattering and light absorption
* Estimation of paper gloss based on smoothness

4B – Which of the following minerals has the highest refractive index?

* Kaolinite clay
* Calcite calcium carbonate
* Calcined clay (metakaolin)
* Rutile titanium dioxide

4C – Study results showed that paper opacity was positively correlated with what attribute of filler products?

* Platy shape of the filler
* Increasing diameter of the filler
* Increasing apparent density of the filled paper
* Surface area per unit mass of the filler

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Session 5: Feeding and retention of fillers

5A – What type of rail car is used to transport the dry powder form of a mineral filler?

* Tank car
* Tank engine
* Hopper car
* Container car

5B – What type of pump can meter the flow, with only a small dependency on the back-pressure?

* Kinetic pump
* Fan pump
* Cavitation pump
* Positive displacement pump

5C – Under what circumstance is it common for papermakers to add the same mineral product at two different points in the process (split addition)?

* When practicing automated control of the filler content
* When using a retention aid to retain the filler
* When the filler has been dispersed by means of an eductor
* When the delivery pump to add the major amount is not quite adequate

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Session 6: Filler distribution in the sheet

6A – What mechanism of retention tends to yield paper in which more of the mineral product is near to the “wire side” of the paper made on a Fourdrinier paper machine?

* Washing
* Thickening
* Bridging
* Filtration

6B – What kind of chemical additive works by a bridging mechanism, making it very effective, working independently, in developing strong attachments between particles and fibers in a suspension of cellulosic fibers and mineral fillers?

* Very high charge cationic polyamine such as polyDADMAC
* Very high mass cationic acrylamide copolymer
* Colloidal silica or sodium montmorillonite (bentonite)
* Sodium hexametaphosphate

6C – Which of the following practices can be expected to give a discrete distribution of mineral particles within paper?

* Adding the mineral to a fiber suspension that has been polymer-treated to impart the opposite sign of charge
* Failure to adequately disperse the mineral product, such as by use of an eductor system
* Treatment of the mineral slurry with a small amount of cationic starch before its addition to the process
* Addition of very-high-mass cationic acrylamide copolymer (retention aid) to the white water silo

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Session 7: High-filler strategies

7A – What is the expected result if the filler product is agglomerated together (by use of a cationic polymer such as cationic starch) before its addition to the papermaking furnish?

* Higher scattering of light compared to the default process
* Higher paper strength compared to the default process
* Lower first-pass retention compared to the default process
* Lower apparent density of the paper compared to the default process

7B – Pre-agglomeration of mineral particles makes them less effective for scattering light. Why is this generally not a problem with respect to achieving paper opacity goals?

* It is common to add titanium dioxide along with pre-agglomerated filler.
* The filler level can be increased due to the pre-agglomeration.
* The refining of the fibers is increased in order to maintain opacity.
* Most of the agglomerated filler will be present within the lumens of fibers.

7C – What unit operation of paper is often very effective for increasing paper stiffness and decreasing the dustiness of paper, especially when a filler is being used?

* Wet-pressing of the paper with an extended-nip press
* Soft-nip calendering
* Size press application of starch
* Twin-wire (gap former) forming

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Session 8: Minerals at the size press and coater

8A – Film splitting in the course of applying a starch solution to the paper surface at a size press can impart what type of effect to the paper?

* Nano-structure, often leading to super-hydrophobicity
* An orange peel effect
* High smoothness, compared to coating
* High color density after offset lithography printing

8B – Addition of what to a size press formulation has been shown to be effective for increasing the sharpness of ink-jet images, when using conventional aqueous ink-jet inks?

* Precipitated calcium carbonate
* Starch insolubilizer, *e.g.* ammonium zirconium carbonate
* Gelatin
* Starch by itself

8C – What is composed of pigments, binders, and additives?

* A conventional size press formulation
* Pre-agglomerated filler
* Conventional wet-end addition of filler
* A coating formulation

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ANSWERS TO QUIZ QUESTIONS, COURSE 11

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2A: What type of filler particle is often specified to have a rosette-type shape? Precipitated calcium carbonate (scalenohedral)

2B: Which of the following is a reliable method to evaluate the particle size of filler particles, especially if the particles are approximately spherical in shape? Angular dependence of the intensity of forward-scattered laser light

2C: Which of the following is a dispersant that can be used to stabilize a suspension of mineral particles in water? Sodium hexametaphosphate

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4B: Which of the following minerals has the highest refractive index? Rutile titanium dioxide

4C: Study results showed that paper opacity was positively correlated with what attribute of filler products? Surface area per unit mass of the filler

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5B: What type of pump can meter the flow, with only a small dependency on the back-pressure? Positive displacement pump

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7C: What unit operation of paper is often very effective for increasing paper stiffness and decreasing the dustiness of paper, especially when a filler is being used? Size press application of starch

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