**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

SCROLL DOWN TO THE BOTTOM TO SEE ANSWERS

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

SCROLL DOWN TO THE BOTTOM TO SEE ANSWERS

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)

SCROLL DOWN TO THE BOTTOM TO SEE ANSWERS

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

SCROLL DOWN TO THE BOTTOM TO SEE ANSWERS

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

SCROLL DOWN TO THE BOTTOM TO SEE ANSWERS

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

SCROLL DOWN TO THE BOTTOM TO SEE ANSWERS

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

SCROLL DOWN TO THE BOTTOM TO SEE ANSWERS

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

SCROLL DOWN TO THE BOTTOM TO SEE ANSWERS

 |

 |

 |

 |

 |

V

 |

 |

 |

 |

 |

V

 |

 |

 |

 |

 |

V

ANSWERS TO QUIZ QUESTIONS, COURSE 11

1A: Approximately how much smaller are typical filler particles compared to the lengths of typical papermaking fibers? About 1000 times

1B: Which of the following situations typically leads to increased density of a paper sheet? Increased refining of kraft fibers

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

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

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? Dispersants are added during the grinding process.

3B: What type of mineral fillers tend to have the largest negative effect on paper strength? Small filler particles

3C: What type of filler particle is likely to contribute to the lowest air permeability through paper? Kaolin clay (platy)

4A: What do the equations of Kubelka and Munk involve? Light scattering and light absorption

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

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

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

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? 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 mass cationic acrylamide copolymer

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

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 paper strength 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? The filler level can be increased due to the pre-agglomeration.

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

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? An orange peel effect

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

8C: What is composed of pigments, binders, and additives? A coating formulation