**OPTIONAL QUIZ QUESTIONS for Course 2: “Paper Sizing & Resistance to Fluids”**

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Session 1: Water-loving nature of fibers

1A – What kind of “bonding”, involving a water molecule and the surface of a cellulose fiber, helps to explain why untreated cellulosic fibers are easily wetted by water?

* Covalent bonding
* Polar bonding
* Hydrogen bonding
* Hydrolysis

1B – Three of the following items are names of sizing tests for paper. Which of the items is not a sizing test for paper?

* Cobb sizing (a weight-gain method)
* Gurley Densometer (seconds per 100 cm3)
* HST (a penetration-time test)
* Rapid penetration test (using microwave transmission evaluation)

1C – In what way can hydrophobic sizing of the paper (i.e. “internal sizing”) affect the results of surface sizing (i.e. application of starch solution at a size press)?

* It tends to draw the size-press starch into the interior of the sheet.
* It completely prevents the size-press solution from wetting the paper.
* It has absolutely no effect, since these items are added at different places.
* It tends to hold the size-press starch out near the surface of the paper.

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Session 2: Rosin soap sizing

2A – The sizing invention patented in 1807 by Moritz F. Illig involved what two materials?

* Fumeric acid and abietic acid (fortification)
* Rosin soap and aluminum ions (aluminum sulfate)
* Rosin soap and calcium ions (water hardness)
* Rosin emulsion and aluminum ions (PAC)

2B – What reaction makes rosin more storage-stable and improves its ability to interact with alum?

* Epichlorohydrin and levopimeric acid (stabilization)
* Detergent and rosin acid (saponification)
* Fumeric acid and abietic acid (fortification)
* Micro-cellulose and resin acids (mycellization)

2C – How do papermakers achieve effective rosin soap sizing in cases where the process water has a fairly high level of calcium ions (water hardness)?

* By adding the rosin to the system before the alum (reverse sizing)
* By adding the rosin early to the wet-end process (saturation)
* By treating the rosin soap with sodium hydroxide (alkaline papermaking)
* By adding the alum to the system before the rosin (reverse sizing)

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Session 3: Rosin emulsion sizing

3A – What prevents typical formulated rosin emulsion particles from coming together and agglomerating with each other?

* Negative charges (charge-charge repulsion) due to some saponification of the rosin
* A layer of water-loving cationic polymer such as cationic starch or a synthetic cationic polymer
* Hydrogen bonding of the adjacent water molecules with the surface of rosin particles
* The “Teflon effect” due to the low surface energy of the rosin material

3B – What critical step in rosin emulsion sizing happens in the dryer section of the paper machine?

* Bonding is formed between rosin and aluminum species at the surface of the paper.
* Aluminum compounds present in the process water become deposited on fiber surfaces.
* Aluminum abietate present in the process water become deposited on fiber surfaces.
* Aluminum ions interact with the carboxylate groups of the rosin (which is often fortified).

3C - Why is alum (aluminum sulfate) not able to interact well with rosin if the pH is too high (e.g. pH 7 or 8)?

* At that pH most of the alum will be present as oligomers (e.g. valence 7+).
* At that pH most of the alum will be present as Al3+ (trivalent aluminum).
* At that pH most of the alum will be present as aluminate (negatively charged ion).
* At that pH most of the alum will be present as neutral floc, Al(OH)3.

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Session 4: ASA sizing

4A - What kind of mineral filler has provided the main motivation for papermakers to form paper in the pH range of about 7 to 9.5?.

* Clay
* Calcium carbonate
* Talc
* Titanium dioxide

4B - Alkenyl succinic anhydride (ASA) can undergo two reactions, one favorable and one unfavorable. What type of chemical structure is formed during the favorable reaction of ASA with a fiber surface?

* An anhydride bond
* A hydrogen bond
* An ester bond
* A hydrolysate bond

4C - Why do typical ASA emulsion droplets ordinarily cling with high efficiency to surfaces of cellulose (fines and fibers) in the wet end of a paper machine?

* The hydrophobic nature of ASA oil makes it want to come out of the solution phase onto a surface.
* Covalent bonding develops between the ASA and fiber surfaces in the wet end of the machine.
* Alum in the wet end of most paper machines will “set” the size, even under alkaline conditions.
* They are stabilized by cationic polymer, so there is a charge attraction to negative fiber surfaces.

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Session 5: Troubleshooting of ASA sizing

5A – Why do increasing proportions of mineral fillers within the paper furnish typically increase the amounts of sizing agent required?

* Calcium carbonate filler will tend to increase the pH, and progressively higher pH becomes less and less favorable for hydrophobic sizing systems.
* The filler surfaces act as an effective catalyst, causing the ASA to more rapidly react with water (formation of hydrolysate).
* Mineral fillers typically have higher surface area than typical cellulosic pulp, so there is more surface area that needs to be covered when the filler level is increased.
* The filler surfaces are highly wettable, to they provide an alternative pathway by which the water is able to pass through the paper.

5B – Why is it often recommended to acidify and cool starch solution that is about to be used for emulsification of ASA sizing agent?

* Those measures will decrease the amount of hydrolysis of the ASA during the preparation and transportation of the emulsion.
* Those measures will increase the efficiency of retention of the ASA in the paper during its formation.
* Those measures will decrease the particle size of the ASA emulsion droplets due to higher fluid viscosity and increased positive charge at the lower pH.
* Those measures will convert much of the ASA to its more effective “hydrolysate” form.

5C – Why do some papermakers add a small amount of aluminum compound (alum or PAC) when using an ASA sizing system?

* The alum reacts directly with ASA, converting it is an alum-ASA complex.
* The alum, even in tiny amounts, converts the wet end to an acidic condition (pH lower than 5).
* The alum floc, which forms at the paper surface, is hydrophobic and resists water.
* The alum can help detackify the ASA hydrolysate and can make the sizing more effective.

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Session 6: AKD sizing

6A – Where does the emulsification of alkylketene dimer sizing agent usually take place?

* Adjacent to the paper machine in a high-shear unit
* In a “satellite plant” adjacent to the paper mill
* The emulsification is actually installed within the paper machine itself.
* At a factory owned by the chemical supplier

6B – What is the potential advantage of injecting AKD at the stuff-box or “drop-leg before the stock valve” before the fan pump?

* The most important benefit of such a practice is the good mixing of the stock in the fan pump.
* Because AKD is slower to react, it is important to add it earlier to the wet end system.
* By adding AKD to the thick stock, a larger amount can be accommodated onto the surface of solid materials.
* Such a practice favors attachment to surface of fibers, which are retained at high efficiency during paper formation.

6C – Why do papermakers often take some AKD-size paper from the reel of a paper machine, put it in an oven for a specific time period, then measure the sizing?

* They want to determine whether the paper has a sufficient resistance to water so that it can make it through a size press with high efficiency.
* They want to estimate the level of sizing that will be present once the paper reaches the customer.
* This is part of the standard procedure to determine the basis weight of paper.
* The heating is supposed to promote the “molecular overturn” of the sizing agent, and this is a means of determining if it was well-attached in the first place.

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Session 7: Hydrophobic surface size additives

7A – Why are there typically a lot fewer web breaks when starch solution is being applied by a “film press” rather than the more traditional “pond” type of size press?

* The film press holds the paper together tighter, keeping it from breaking.
* The starch film solidifies on the applicator rolls before transfer to the paper.
* The paper is exposed to less of the hot starch solution for a shorter period of time.
* In a film press the starch is not forced into the core of the paper, whereas a pond-type size press pushes the starch into the paper directly.

7B – What benefit is often achieved by surface sizing that is not achieved by adding a sizing agent to the paper furnish (“internal sizing”)?

* Surface sizing typically increases paper’s resistance to wetting.
* Surface sizing typically makes the paper more hydrophobic.
* Surface sizing typically decreases the apparent density of the paper.
* Surface sizing typically increases paper strength.

7C – During the drying of a mixture of starch solution and a hydrophobic copolymer such as styrene maleic anhydride (SMA), how does the orientation of the copolymer often change?

* The hydrophobic groups (maleic anhydride) become orientated outwards at the surface of the dried paper.
* The hydrophobic groups (styrene) become orientated outwards at the surface of the dried paper.
* The hydrophilic groups (styrene) become orientated outwards at the surface of the dried paper.
* The hydrophilic groups (maleic anhydride) become orientated outwards at the surface of the dried paper.

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Session 8: Super-hydrophobic systems

8A – Which of the following statements is correct?

* A wettable surface has a contact angle of greater than 90 degrees.
* A wettable surface has a contact angle of no greater than zero degrees.
* A wettable surface has a content angle between 150 and 180 degrees.
* A wettable surface has a contact angle of less than 90 degrees.

8B – Contact angle hysteresis (a difference between advancing and receding contact angles) can be caused by several features or actions. Which of the following is NOT one of them?

* Very fine-scale roughness (less than 10 nm in scale)
* Relatively large-scale roughness (bigger than about 100 nm)
* Pores in the surface (as explained by the equation of Cassie and Baxter)
* Adding or removing liquid from a droplet attached to a surface

8C – Two features need to be present in order to achieve super-hydrophobic character of a surface. Which of the following is a correct listing of these two features?

* Very low surface area at the nano-scale and a low-energy surface treatment
* Very low surface area at the nano-scale and a high-energy surface treatment
* Very high surface area at the nano-scale and a high-energy surface treatment
* Very high surface area at the nano-scale and a low-energy surface treatment

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