

# The Handsheet Making Manual Pulp and Paper Centre, UBC

by

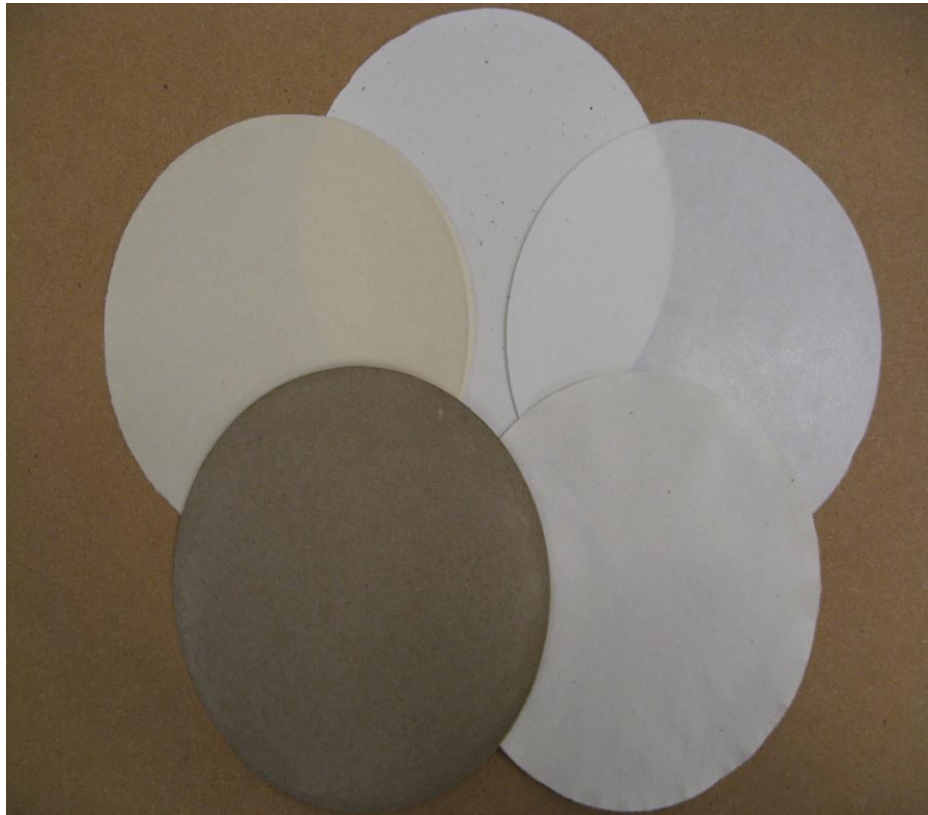
**George Soong**

E-mail: [gsoong@mail.ubc.ca](mailto:gsoong@mail.ubc.ca)

Phone: 604-822-2530, 778-835-2298

Office: 321 at PPC

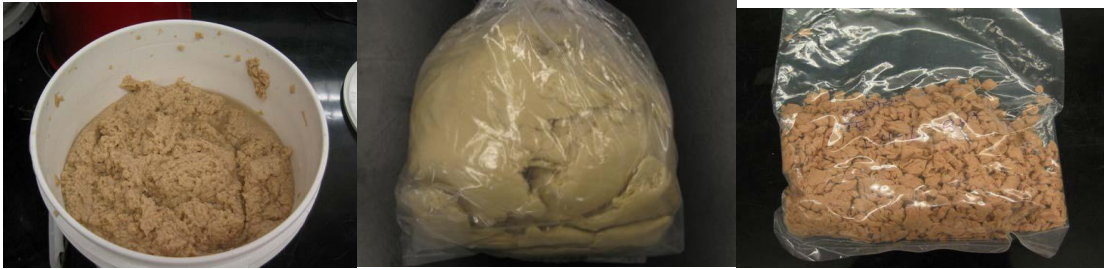
Rev 2 Updated May 8, 2012 by Nici Darychuk



<b>Pulp Consistency Determination:</b> .....	2
<b>Preparing the Pulp Suspension for the Handsheets:</b> .....	5
<b>Freeness Determination:</b> .....	9
<b>Making the Handsheets:</b> .....	13
<b>Pressing the Handsheets:</b> .....	18
<b>Drying the Handsheets:</b> .....	20
<b>Fiber Quality Analysis:</b> .....	21
<b>Fiber Fractionation:</b> .....	22

## Pulp Consistency Determination:

- 1) Mix the pulp sample thoroughly either in slurry form or shredded pulp cake (see figures 1 and 2). If it is a slurry form, use a plastic beaker or a wide spatula to mix it thoroughly ensuring homogeneity. It settles quickly, therefore it is essential that you mix often before and while taking your sample. If it is a vacuum de-watered pulp cake, either use a machine such as a pulp shredder or Hobart Blender or tear it by hands to small pieces (see figure 1). Never grab a big chunk from the de-watered cake as your testing sample. **Note: After you mix the slurry, it quickly becomes inhomogeneous again, evident from the pools of supernatant that form rapidly after mixing (see figure 2).**



**Figure 1:** The bucket on the left contains 4.5% pulp in slurry form. The pulp on the right is in shredded cake form which is at a consistency of ~20%.



**Figure 2:** A few minutes later after mixing. Notice how the water emerges in the right-hand picture while pulp is settling. Mix thoroughly often to ensure you collect homogenous and representative samples.

- 2) Pre-dry some filter papers that will fit your Büchner funnel. Dry them in the speed dryer and obtain their oven dried (OD) weight. Write this weight on the back of the filter paper. **Note: Pre-dried tared filter papers should already be near the speed dryer.** Before you deplete that supply, pre-dry more, keep at least half a box full for future use.
- 3) When taking your sample, take from different parts of the container or bag, e.g. from the left, top, bottom, right, middle such that you get a representative sample. For the sake of time, it is best to keep the amount of pulp low, such that ultimately, you will have less than 3 g of oven dried (OD) pulp. The pulp cakes

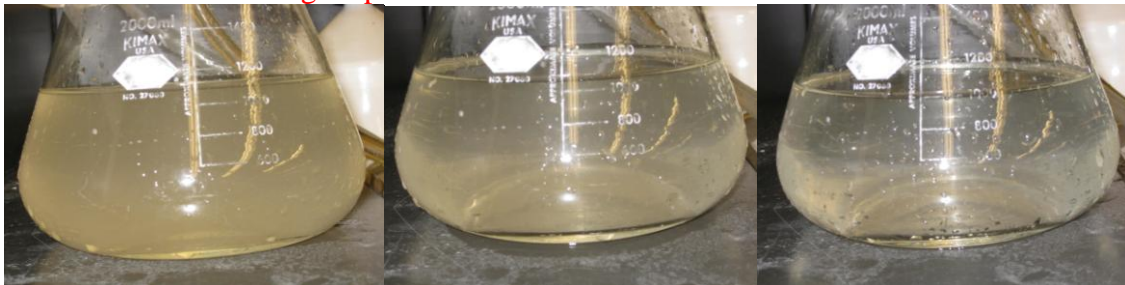
have a higher consistency than the slurries. The slurries from the low consistency refiners (LCR) are at ~ 4% consistency. This means that there are 4 g of OD pulp for every 96 g of water, total 100 g of slurry. We would target for 2-3 g of OD pulp. Let's say we want 3 g of OD pulp, therefore the amount of 4% wet pulp needed is:

$$\frac{3 \text{ g of OD pulp}}{0.04 \text{ g of OD pulp / 1 g of slurry}} = 75 \text{ g of slurry}$$

Aim for around  $75 \pm 5$  g of slurry as the slurries will vary in consistency and you don't actually know the consistency just yet. It is strongly recommended to take at least two samples for consistency determination. Remember to immediately seal and put the sample back to the refrigerator after taking some for testing. This prevents changes in consistency and rotting of your sample.

- 4) After you have weighed out the slurry into a tared beaker, add some water (~300 ml) to disperse the sample. Hook up the vacuum apparatus, place your filter paper in the funnel with your writing (weight and sample name) facing the porous bottom of the funnel. Use squirt bottle to pre-wet the filter then apply vacuum slightly to pull it against the porous bottom. Pour the suspension in slowly. Remember to quantitatively transfer your sample!
- 5) Depending on the type of pulp used, the filtrate that seeps through contains plenty of fines and DCS (dissolved and colloidal substances), which make up approximately 25 to 30% of the OD weight of TMP (see figure 3). Release the vacuum and pour the filtrate to the beaker. Take the filtrate and re-filter it through the pulp pad. Repeat another two times for a total of three times. Once this is done, remove pulp pad together with filter paper on the bottom side of the pad, and rub the bottom and inside wall of the funnel with your finger to pick up any pulp left behind. Transfer these fibres from fingers onto the pulp pad. Fold the pulp pad inside filter paper in half and dry using the speed dryer (see figure 4).

**Note:** Re-filtering helps reduce the loss of fines.



**Figure 3:** On the left, is the initial filtrate. The cloudiness comes from the many fines and DCS in the suspension; in the middle, is the second pass of filtrate that has been re-filtered through pulp pad; on the right, the third time filtrate has been re-filtered through the pulp pad. Notice the increase in transparency signifying that fines are being retained.

- 6) Check the weight one hour later until constant weight is reached. Once the sample is completely dried, weigh it, being careful to record the weight right when it comes out of the dryer. Wait for it to stabilize (two seconds is good, don't wait long because the pad rapidly absorbs moisture) and record the weight.



**Figure 4:** Semi-circle pulp pads being dried at speed dryer for consistency determination.

- 7) To find the consistency, divide the OD weight (subtract the filter paper weight first) by the wet pulp weight, that gives a fraction, multiply by 100 to get %. For example, original pulp slurry is 76.45 g; filter paper is 1.23 g; total weight of dried pulp pad with filter paper is 4.35 g.

$$4.352 \text{ g of dry pad} - 1.232 \text{ g of filter paper} = 3.12 \text{ g of OD pulp}$$

$$\frac{3.12 \text{ g of OD pulp}}{76.45 \text{ g of pulp slurry}} \times 100\% = 4.08\% \text{ of slurry consistency}$$

- 8) Perform this entire process at least twice and average your results to finalize the consistency determination of the bulk pulp sample.

### Preparing the Pulp Suspension for the Handsheets:

- 1) Now that the consistency of the pulp sample is known, the goal now is to get 30 g OD pulp from your bulk pulp sample. To do that, e. g., if your pulp consistency is 4.08%, the weight of wet pulp you need is 735.29 g. Remember to tare and receive your pulp slurry in two 2000 ml glass beaker evenly, i.e. ~367.65 g each.

$$\frac{30 \text{ g of OD pulp}}{0.0408 \text{ g of OD pulp / 1 g of slurry}} = 735.29 \text{ g of slurry}$$

- 2) Take the beakers and pulp and fill them up to the 1500 ml mark with distilled water (see figure 5).



**Figure 5:** On the left, weigh pulp slurry in beakers; on the right, diluted suspensions are heated in microwave oven.

- 3) Next, if the suspension is a mechanical pulp, take these two beakers of pulp suspension and cook them in the microwave oven for 22 minutes, or until the suspension heats up to ~85-90 °C (see figure 6). This step helps to remove the latency of the mechanical pulp fibres; straightening out the fibres for handsheet making.



**Figure 6:** The suspension has been heated and is at ~85-90°C.

- 4) Using heat-proof gloves, take the heated suspension (or room temperature suspension for chemical pulp) and pour one beaker into the stainless steel vessel

in each of the two disintegrators. Load the vessel back into the disintegrator and push it back to ensure contact with the sensor button mounted on the disintegrator. **Note:** The contact between the vessel and sensor is required for the disintegrator to work (see figure 7).



**Figure 7:** On the left, the heated pulp being poured into disintegrator apparatus; on the right, the vessel must touch the sensor stub in order for the disintegrator to operate.

- 5) Depress and hold on the red button. Push the black buttons to change revolution counts. Each count on the console equals 25 revolutions. The pulp needs to undergo minimum 7500 to 25 000 revolutions to be fully disintegrated. Set the button console to 300 to run 7 500 revolutions, 600 (usually recommended) to run 15 000 revolutions or 1000 for 25 000 revolutions (see figure 8). The disintegrator is set to run at 3 000 rpm, and it should take 8-9 minutes for the disintegration process. Depress yellow button to start the disintegrator. Repeat the same procedure to disintegrate the other pulp suspension. During this time, turn on the speed dryer and ensure it is set to 113°C. Make sure you have filter papers with OD weights recorded on them.



**Figure 8:** On the left, the button pad on the disintegrator; on the right, depress and hold the red button then push the black buttons to reset the revolution counts, which is required before you can disintegrate. **Note:** Each count equals 25 revolutions.

6) Once disintegration is finished, you may wait for another three minutes to let it cool down further. The pulp is still very hot. Wear woven gloves to hold the handles. At first open the lid slightly in case the pulp suspension bursts because pressure buildup in the vessel. **Note: It is prohibited to disintegrate pulp at extremely high temperature (over 95 °C) in PPC.** You should use the pressurized disintegrator in Canfor R&D or Paprican to carry out high temperature disintegration. Quantitatively transfer the contents from the vessel. Always have a squirt bottle handy to wash the pulp stuck at the top of the disintegrator lid, the shaft, and propeller (see figure 9). Transfer all of the disintegrated pulp suspension to a white 12 L bucket or a grey 12 L graduated pail (see figure 10) that has been tared.



**Figure 9:** Pulp suspension after 7500 revolutions in the disintegrator. Squirt bottle is used to wash fibres off shaft and propeller.

7) Place the bucket on the Mettler balance (max 32.1 kg). The goal is to dilute the suspension to 10 kg at 20 °C. Take cold distilled water from cold room, and, for hot pulp, use it to dilute the suspension to 9 kg. Check the temperature, either use ice, cold or room temperature distilled water to bring it as close to 20 °C as possible (see figure 10). **Note: The ice in lab 308 is made by filtered tap water. If you use ice, you must pre-make some ice with distilled water.** For room temperature pulp, add some cold distilled water to get it to 20 °C, then prepare and add large beakers of 20 °C water using a mixture of piped and cold distilled water. As soon as the dilution to 10 kg is completed, record the exact temperature. Proceed to the next test, either consistency determination or freeness test. Mix the suspension well before you do anything, as the pulp quickly becomes inhomogeneous.



**Figure 10:** On the left, the disintegrated pulp has been diluted to 10 kg. **Remember to measure sample amounts in weight, as volume is temperature dependent.** On the right, the graduations are on the inside wall, 10 kg is at 11 L mark. This inaccuracy would cause serious problems in the following tests.

- 8) Next, if freeness has already been determined or given, is the consistency determination of the diluted suspension. **If freeness is to be measured, skip ahead to the Freeness Determination step now, as consistency will be measured using the freeness sample.**
- 9) Weigh out ~400 g of suspension and use vacuum to filter it through filter papers of known weight. Recycle/re-filter the filtrate 3 times to retain fines. Take the pulp pad and speed dry it. Repeat once. **Note: Fines make up a significant portion of TMP.**
- 10) Once the weights of the OD pulp pads are constant, record them and average the two readings. The OD weight subtracts the filter paper weight, divided by the weight of the solution (~400 g) times 100% gives you the consistency in percentage. The target consistency is 0.3% (0.003 g pulp to 1 g suspension).

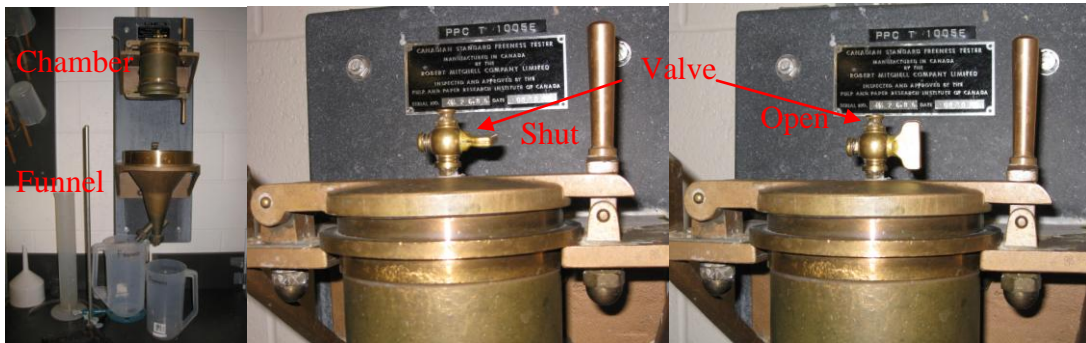
$$2.455 \text{ g of dry pad} - 1.224 \text{ g of filter paper} = 1.231 \text{ g of OD pulp}$$

$$\frac{1.231 \text{ g of OD pulp}}{400.62 \text{ g of pulp suspension}} \times 100\% = 0.307\% \text{ of suspension consistency}$$



## Freeness Determination:

- 1) The freeness test is based on **Tappi Method T 227**.
- 2) The freeness tester (see figure 11) must be cleaned and calibrated before use. The chamber and funnel are gently brushed with soap and rinsed with distilled water thoroughly. Check that all surfaces and orifices are free of fibres to prevent any disruption of flow. Check inside the funnel to ensure the spreader cone is firmly in position. Let tester drip for thirty seconds then close the bottom lid. Two freeness beakers are also cleaned and one is placed right below the bottom orifice of the funnel. The other one is tared on top of the Mettler balance.



**Figure 11:** On the left, freeness tester and accessories; in the middle, the valve is shut after water or pulp suspension is poured in; on the right, the valve is open to release the suspension.

- 3) Prepare ~3 L of 20 °C distilled water in a 4 L plastic beaker. Weigh exactly 1000 g of 20 °C distilled water to the tared 2 L freeness beaker. Pour the water to the chamber and place the beaker in position to receive the water from side orifice. Close the top lid and shut the vent valve (or cover hole with finger) and open the bottom lid gently (see figure 12). Open the vent valve quickly (or lift finger from hole) to release the water. Wait until dripping stops. Weigh the beaker that receives water from side orifice. It must fall between 880-890 g to verify the accuracy of the tester. Repeat procedure to carry out second blank check. If it is off from the required range, check the water temperature, adjust it if necessary, and check the tare of the beaker. Repeat again until it hits the targeted range. If it is still off, contact the Lab Technician for troubleshooting because the entire freeness tester may need to be taken down and thoroughly inspected.
- 4) If you wish, you may use a 1000 ml plastic graduated cylinder to replace the 2 L beaker (see figure 13). The accuracy of the graduated cylinder can be verified by checking whether 1000 g of 20 °C water matches the 1000 mL mark or not. You then fill up the cylinder with 20 °C distilled water to the 1000 mL mark and pour it to the tester. The other steps are identical except using graduated cylinder instead of beaker. **Note: Always use weighing to verify amounts for calibration regardless of whether a beaker or graduated cylinder is used.**

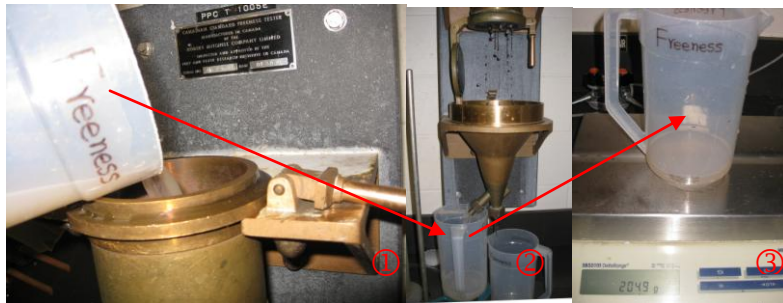


**Figure 12:** Sequence of using Freeness beakers to carry out calibration. 1: Weigh 1000 g of 20 °C distilled water; 2: Pour the water into the chamber; 3: Open the valve and bottom lid to release water; 4: Receiving water from side orifice.



**Figure 13:** Sequence of using 1000 mL graduated cylinder to carry out calibration.

- 5) Once the calibration of the freeness tester is verified, carry out the tests for the pulp suspension immediately. Check the temperature of suspension again; normally it remains the same within 10 minutes after it is prepared. Or, calibrate the freeness tester before you prepare the pulp suspension.
- 6) The testing procedure (see figure 14) of pulp suspension is identical to the calibration procedure. Tare the freeness beaker. Agitate the pulp suspension vigorously with a plastic 500 mL beaker and take samples to the freeness beaker. Weigh to 1000 g precisely. Pour the suspension to the tester as soon as 1000 g is reached, close the lid and shut the valve. Place the freeness beaker to the side orifice and open the bottom lid carefully, open the valve to release the suspension. When dripping stops, check the weight of water received from side orifice (beaker remains tared). Record the weight and temperature to the filter paper and your lab book.



**Figure 14:** Sequence of freeness test of pulp suspension. 1: Pulp suspension is poured to chamber; 2: Collection of filtrates; 3: Weigh the filtrate collected from the side orifice.

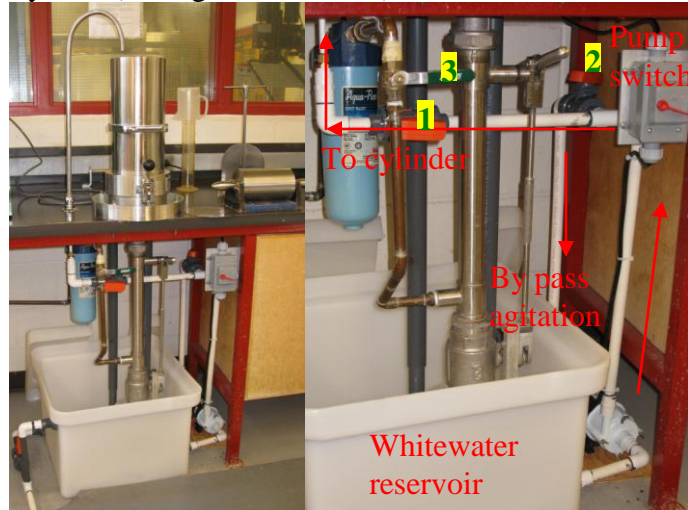
- 7) Pour the remaining pulp suspension in the chamber to the side orifice beaker. Use filtrate from the bottom orifice beaker and distilled water to flush the chamber and pour it to the side orifice beaker. Filter the whole suspension in the Buchner funnel using the same procedure as for consistency determination. The filtrate must be re-circulated three times or until it turns clear (see figure 3). Dry the pad in speed dryer for at least an hour or until constant weight is reached (see figure 15). Subtract the filter paper weight and you have the OD pulp weight from 1000 g of suspension. For example,  $4.834 - 1.895 \text{ g}/1000\text{g} \times 100\% = 0.294\%$ . Repeat the same test for the second sample to get the average. In this way you also get your consistency value. Use the Freeness Correction Tables to calculate the final freeness.



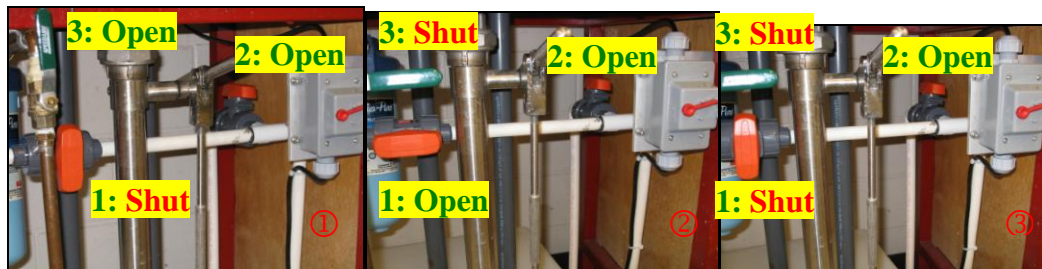
**Figure 15:** On the left, suspension is being poured to Buchner funnel with a tared filter paper; on the middle, pad is dried in a speed dryer; on the right, check the OD weight of pad.

## Making the Handsheets:

- 1) This handsheet making procedure is based on **Tappi Method T 205**.
- 2) The handsheets which will eventually be tested require minimal fines loss. This is an issue especially when using TMP and CTMP, as well as HW pulps. Hence the handsheets are made on a handsheet maker equipped with a whitewater recirculation system (see figure 16 and 17).



**Figure 16:** On the left, the entire handsheet maker in PPC; on the right, the whitewater recirculation system. Valve **1**: whitewater to refill cylinder; Valve **2**: whitewater bypass for agitation in the reservoir; Valve **3**: fresh water to refill cylinder or prime the funnel under the screen.



**Figure 17:** Directions of water flows of the whitewater recirculation loop. ①: Using fresh water to fill up the cylinder while producing whitewater from the first three handsheets; ②: Using whitewater to fill up cylinder to make correction (three) and testing (ten) handsheets; ③: ready to drain cylinder to form handsheet or while idling, keep the bypass on all the time to agitate whitewater in reservoir.

- 3) Ensure that the lower runoff valve of reservoir is closed and the whole handsheet maker is clean. Fill the cylinder on the handsheet maker to about a quarter of the way up with fresh water and then quantitatively transfer the suspension (~ 400 g) into the cylinder. Fill the cylinder to the engraved line. Take a piece of blotting paper and wet it completely with a squirt bottle. This piece will be used for the handsheet making process for your entire sample.

- 4) Place the perforated plunger into the cylinder (see figure 18) and make sure the bottom multi-holed plate is submerged. Hold the handles for guidance but let gravity pull the plunger. The plunger can only go down to a certain extent and when it reaches that limit, pull it up at the same speed gravity was pulling it down. Avoid bubble formation by not letting the bottom of the 4 fins leave the water. Definitely do not let the bottom multi-holed plate leave the water. Repeat this down and up motion another 4 times, the 5 repetitions should take around  $5 \pm 1$ s for each movement.



**Figure 18:** On the left, insert the plunger into the cylinder slowly; on the middle, the lower position of the plunger; on the right, the higher position of plunger.

- 5) Now repeat the motion one final time, but this time take 6 seconds. Slowly remove the plunger without rotation. Wait 5 seconds, then push down the lever to drain the cylinder through the mesh at the bottom.
- 6) The moment the handsheet on the bottom breaks the surface of the water, pull up the lever to stop the suction. **Note: The over-aspirated TMP handsheets are difficult to be lifted and may have lower fines content.** Place a new, dry piece of blotter on top of the handsheet gently, making sure that the handsheet is centered (see figure 19, do this visually before you drop the blotter onto the handsheet). **Note: The moment the pulp touches the blotting paper, you must let go, and make no further adjustments.**
- 7) Place the wet blotter on top of the dry blotter. Place the metal couching disc on the blotter (centered over the handsheet, see figure 19). Take the coucher, the big metal rolling pin, and carefully place it in the middle of the couching disc (figure 20). Do not drop or apply extra pressure downwards on the pin. A barely visible indentation across the handsheet is created if you drop the pin. This over-pressed area (it is still difficult to identify it while performing Handsheet Inspections) will eventually cause low strength of the defected handsheet. The handsheets must be couching with a specific force, which is precisely supplied through the weight of the rolling pin. **Note: the couching disc is larger than the pressing disc.**

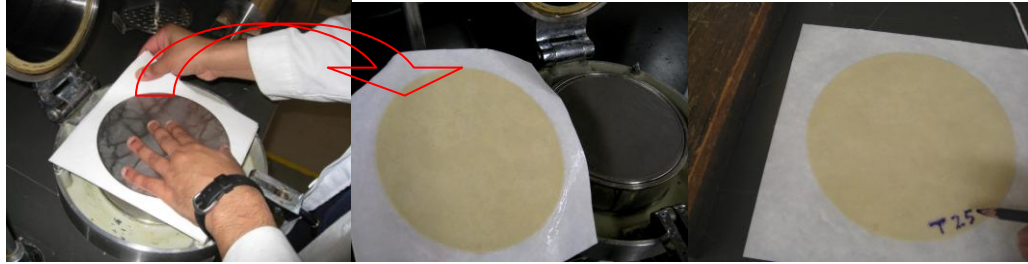


**Figure 19:** On the left, handsheet is formed; in the middle, place the first dry blotter on top of handsheet; on the right, well centered blotters and couching disc on top of handsheet.



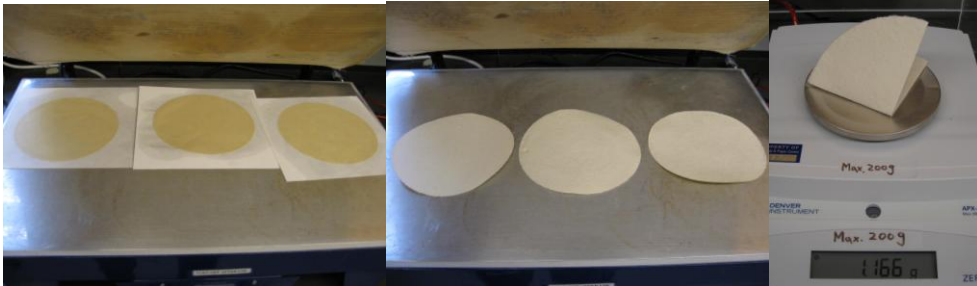
**Figure 20:** On the left, the couching pin is gently placed at the middle of couching disc; in the middle, rolling couching pin with palms up; or, on the right, rolling couching pin with circles formed by thumb and index fingers.

- 8) Let the pin roll freely on your palms or finger circles while pushing the pin back and forth. Roll the pin 5 times: First roll starts from the middle, up to the top, down to past middle to the bottom, and up to the middle again. Apply five rolls to couching disk. **Note: Do not let the pin roll on or off the edge of the disc, keep the pin a minimum of 1" away from the edge while rolling (see middle picture of figure 20).**
- 9) Take away the pin, and hold the corner of the blotting papers. Turn it quickly like turning the page of a book. This will lift the handsheet off the mesh. The handsheet should be uniform, have no deformations and be very smooth (see figure 21). There should be minimal material left on the mesh.
- 10) Peel off the wet blotter and the couching disc. Take the handsheet and blotter and carefully label the actual handsheet with the special indelible pencil. It is ideal to label on the edge of the handsheet. If the handsheet has a very slight deformation near the edge, you can still use it, just label on or near the deformed spot. Gently rub off the fibers with water that are left on the 200 mesh. Close the cylinder. The first few handsheets are not valid for testing. They can be tested for gaining practice, however.



**Figure 21:** On the left, ready to lift the handsheet; in the middle, handsheet is lifted with no defect visible; on the right, use indelible pencil to mark the handsheet.

- 11) Repeat the procedure three times to collect whitewater to reservoir, and discard these blotters and handsheets at this stage.
- 12) Turn pump on and open valves **1** and **2** to refill the cylinder and agitate the reservoir. Repeat the same handsheet making procedure as described from step 4) to 9) to make three basis weight correction handsheets. Put these three handsheets with blotters to speed dryer. Peel handsheets off the blotters ten minutes later and leave the handsheets in the dryer until constant weight is reached (see figure 22).



**Figure 22:** Basis weight correction handsheets are being dried in speed dryer.

- 13) The target weight for a handsheet is  $1.20 \pm 0.4$  g (OD). You need to calculate how much suspension equates to 1.20 g of OD weight pulp. The consistency of the handsheet making suspension has been determined from the freeness test.

$$\frac{1.20 \text{ g of OD pulp}}{X \text{ g of suspension}} = \frac{\text{wt. of OD pulp}}{\text{wt. of suspension}} = \frac{\text{Consistency}(\%)}{100}$$

$$\text{Re-arrange} \Rightarrow X \text{ g of suspension} = \frac{1.20 \text{ g of OD pulp} \times 100}{\text{Consistency}(\%)}$$

The “X g” suspension tells you the ideal weight of suspension you must add to get 1.20 g of OD pulp. But never make handsheets simply based on this ideal number since there will be a lot of fines loss that renders the basis weight drifts away significantly. For example, the consistency in freeness test is 0.294% of suspension; the result of calculation of X is 408.16 g.

$$X \text{ g of suspension} = \frac{1.20 \text{ g of OD pulp} \times 100}{0.294(\%)} = 408.16 \text{ g}$$



So for 408.16 g we must take at least three samples of 410.00 g to make handsheets and collect whitewaters into reservoir. These three handsheets will be discarded. Take three more samples of 410.00 g to make handsheets with whitewater recirculation. Their OD weights (use speed dryer) will be used to correct the yield loss hence to reach the targeted 1.2 g per handsheet.

$$\frac{1.20 \text{ g per handsheet}}{Y \text{ g of suspension after correction}} = \frac{\text{wt. of handsheet with WW recirculation}}{\text{wt. of suspension}}$$

The “Y g” suspension tells you the corrected weight of suspension you must add to get 1.20 g of OD pulp per handsheet. For example, the averaged weight of three handsheets (with whitewater recirculation) is 1.166 g (from 410 g of suspension). The result of Y is 421.96 g. We will take 422 g of suspension to make ten handsheets of 1.2 g per sheet (60 g/m<sup>2</sup> basis weight).

$$\frac{1.20 \text{ g per handsheet}}{Y \text{ g of suspension after correction}} = \frac{1.166 \text{ g per handsheet}}{410.00 \text{ g of suspension}}$$

$$Y = 421.96$$

- 14) The fines content in the handsheets normally stabilizes when there is about ~seven to eight handsheets worth of fines in the reservoir. You can observe the gradual increase of OD weight of handsheets from the first one onward, then it approaches a plateau at the seventh or eighth handsheet. But it still varies depends on the type of pulp. In other words, the machine needs you to run about 3000 g of suspension through the system first before you can make handsheets for valid testing. It is a time and material consuming procedure at this stage. We normally make three correction handsheets to save the time and materials, besides the suspension cannot sit still for longer than thirty minutes while waiting for the OD weight of correction handsheets. The averaged number is used to make the final ten handsheets following the same step by step procedure described above.

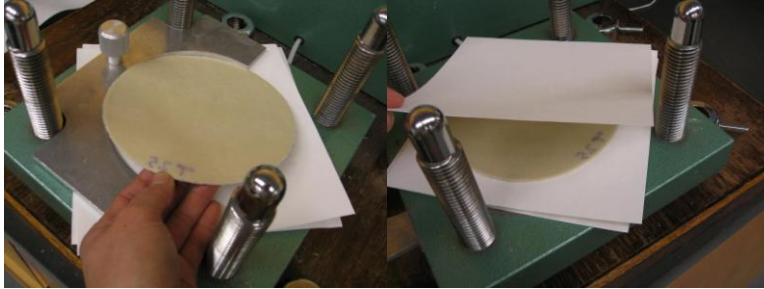
### Pressing the Handsheets:

- 1) Select a pressing disk for each handsheet, and polish the shiny side with a tiny amount of silicone spray and a paper towel.
- 2) Unload the handsheet presser, turn on the compressed air valve, turn on the machine, and place 2-3 sheets of blotting paper (new or used, your choice) on the circular piston base. Place the handsheet and attached blotter on the blotters and use the centering gauge to align the pad so that there is no white space between the handsheet and the inner curve of the centering tool. Place a pressing disc on top of the handsheet, shiny side faces down. Push the disc against the centering gauge with a shallow angle and drop it gently (see figure 23). **Note: Align carefully before dropping the disc; once you drop it, it is impossible to retrieve it without damaging the surface of the handsheet. Place a clean, unused piece of blotter on top of the pressing disc.**



**Figure 23:** On the left, centering the handsheet; in the middle, place the pressing disc with an angle on top handsheet then drop it gently; on the right, place a new blotter on top of pressing disc.

- 3) Load the handsheet to the press immediately after it is made. Do not leave them air dried outside the press.
- 4) Repeat the above steps for loading the handsheet presser until all handsheets have been loaded, or until there are 10 handsheets loaded. **Note: The maximum number of handsheets you should load into the presser is 10. Place the pressing weight (the heavy green square piece with 4 holes) on top of the stack of handsheets and secure well (finger tight only) with the 4 round nuts.**
- 5) Depress the yellow button to initiate the 1<sup>st</sup> press. It will put the handsheet stack under 50 psi. Observe the dials to see that the apparatus is in the 50 psi range. The 1<sup>st</sup> press will run for 5 minutes. Once this is done, remove the pressing weight and take your stack of handsheets out. Now the handsheets stick on pressing discs in the stack. Remove the top blotter and flip the pressing discs (handsheet now on top side, see figure 24) and place them into the press, aligning with centering gauge and placing a new blotter on top of each handsheet. Depress the yellow button to initiate the 2<sup>nd</sup> press, and it will press the stack for 2 minutes.



**Figure 24:** On the left, place in the disc with handsheet on top side; on the right, place a new blotter on top of handsheet.

- 6) Once the second press is done, remove the pressing weight, and take the stack carefully to the CTH Room.

### Drying the Handsheets:

- 1) Carefully peel the blotters from the pressing disc and handsheet. Place the pressing disc and handsheet into the drying ring with the metal surface facing the counter surface (figure 25). Do not worry if the edge of the handsheet spills out onto the rim of the drying ring. The goal is to keep the handsheet taut while air drying it.



**Figure 25:** These are the drying components. On the left, place the disc to the holed copper (or PVC) rings; on the middle, place another drying ring on top of the handsheet; on the right, the handled stainless slab is the weight put on top of the drying ring stack during drying.

- 2) Take another drying ring and stack it onto the previous drying ring with loaded handsheets and give it a light-to-medium slap until you hear a clicking or snapping sound. If the rings do not fit together properly, select another ring. Place the next handsheet on top of these two drying rings. Repeat until all handsheets are loaded.
- 3) Once all the handsheets have been mounted into the drying rings, place a metal weight on top of uppermost drying ring (see right picture of figure 25). The handsheets require at least 24 hours to air dry before they are ready for testing.

### Fiber Quality Analysis:

- 1) Fiber properties such as length, coarseness, curl index, kink and fines content can be analyzed by **Fiber Quality Analyzer** (FQA, see figure 26).



**Figure 26:** FQA, Fiber Quality Analyzer with a 600-ml sample beaker.

- 2) Take 200 ml of pulp suspension of 0.3% consistency for three tests of each pulp sample. Dry pulps must be soaked in water for several hours and then disintegrated thoroughly. Brit Jar with 200 mesh screen can be used to remove fines if only fibers are to be analyzed.
- 3) The pulp suspension has to be fully dispersed again by using a plunger (see figure 27) then diluted several times to prepare a sample with designated elapse per second (EPS). In general, run the FQA between 10 to 20 EPS if weighted length (LW) is longer than 1.3 mm; 20 to 40 EPS if LW is below 1.3 mm.
- 4) Please call lab technician to guide you through the program to set up your measurement parameters.



**Figure 27:** Plungers and 600-ml beakers for FQA.

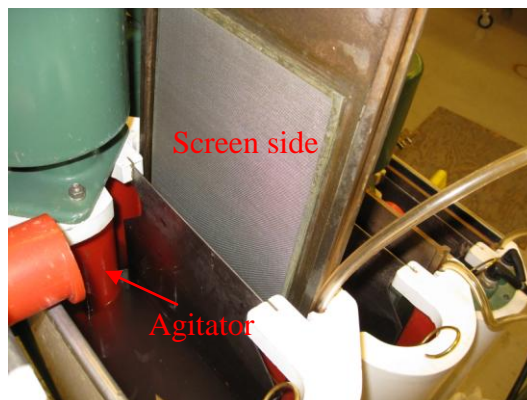
## Fiber Fractionation:

- 1) This test is based on **Tappi Method T-233**.
- 2) Fiber fractionation can be measured by the **Bauer McNett** (see figure 28). For TMPs, 14, 28, 48, 100 and 200 mesh screens will be used. It needs 10 g of OD weight pulp agitated with a 10 liter per minute flow for twenty minutes in one test. The sample is around 3333 ml of pulp suspension of 0.3% consistency, or a 1000 ml of suspension of 1% consistency.



**Figure 28:** Bauer McNett Fiber Fractionator.

- 3) Before using the Bauer McNett, check the cleanliness of all components including constant level tank, agitation vessels, screen plates and sample cups. Use brush and water jet to clean them if dirty, check all surfaces, vessels and screens for dried fibres.
- 4) Install the screens to the slots and hold them in position with the PE tubes. The screen side faces the agitator and the slotted plate side faces the overflow outlet (see figure 29). Plug drain holes and install sample cups with cloth secured by rubber O-rings.



**Figure 29:** The screen plate is installed by facing the screen towards agitator.

- 5) After all the screen plates are installed, turn on the compressed air to secure them. Fill up the vessels with 10 liters per minute flow rate. The flow rate is verified by using a graduated bucket and timer (see figure 30). Place the hose and lid back on the Constant Level Tank and increase the flow rate gradually until a slight overflow from its side.



**Figure 30:** On the left, valves for compressed air and water; on the right, verifying the flow rate with a graduated bucket.

- 6) When the last vessel (200 mesh) starts overflowing, turn on the power and check again to make sure the screen plates are firmly held and there is no leaking. Pour in pulp suspension carefully to the center of first vessel (14 mesh) and start a timer. Shut the water and power off exactly at twenty minutes. Unplug the holes when the overflowing stops and shower the vessels and screens thoroughly to wash out all of the fibers (see figure 31).



**Figure 31:** Collection of fibers. On the left, shower the screen to wash fibers off; in the middle, shower the vessel to wash out all of the fibers to sample cups; on the right, collecting fibers into sample cups.

- 7) When there is no more dripping, unscrew the sample cups, and carefully transport them to the sink in a bucket. Transfer the fibers using a beaker, or directly on to labeled and tared filter papers in Buchner funnel. Remove water using vacuum flask. Dry them in the speed dryer. This procedure is similar to the consistency determination (see figure 32). Note: If the 100 and 200 mesh sample cups drain too slowly at the very end, you can unscrew them carefully and use a vacuum flask to accelerate the water removal.



**Figure 32:** Procedure for fiber collection and drying. On the left, water removal is accelerated by using vacuum flask; in the middle, wash fibers to tared filter paper in funnel; on the right, dry the pulp pads in speed dryer.

- 8) Check the dried pads until constant weight is reached, the result is expressed by percentage. For example, the total dry weight of 14 mesh is 2.223 g and the filter paper is 1.245 g, the fiber fraction of 14 mesh is  $(2.223 \text{ g} - 1.245 \text{ g})/10 \text{ g} * 100\% = 9.78\%$ .
- 9) Place all of the screens and sample cups in and under the vessels and fill them up with water. Shut off compressed air and unplug the power. Scrape spilled water off of floor and place the yellow **wet floor safety sign** by the Bauer McNett to warn other lab users about the wet floor.



**\*\*\*End of Handsheet Making\*\*\***