Sterling Fibers
Guidelines for Processing
CFF® Fibrillated Fibers

For Use in Wet-Laid Specialty Papers, Filtration Media and Nonwovens

Technical Fibers Report
TF-2004-1

TABLE OF CONTENTS

1.0 ***INTRODUCTION***

CFF® fibrillated fiber is a high efficiency binder used in making improved performance specialty and technical papers, nonwovens, filtration media and pulp molded products. The acrylic fiber is composed of greater than ninety percent polyacrylonitrile (PAN), with a small amount of copolymer. Typical properties are shown in Table 1.

TABLE I CFF ACRYLIC PULP PROPERTIES	
TYPICAL PHYSICAL PROPERTIES	
Property	**Value**
Density, g/cm^3	1.17
Tensile Strength, MPa	450
Modulus, GPa	6.0
Elongation, %	15
Typical Fiber Length, mm	3.5-6.5
Canadian Standard Freeness, ml	35-700
BET Surface Area, m^2/g	50
Moisture Regain, %	<2.0
Surface Charge	Anionic
Surface Finish / Sizing	None
Appearance	Fine White Pulp

CFF acrylic pulp has a very high degree of fibrillation for mechanical interlocking combined with long fiber length for good tensile strength. As shown in Figure 1, CFF fibrillated fiber has a treelike structure with a main trunk fiber and various size limbs and branches attached to this main stock. The trunk fiber is about 20 microns in diameter with smaller macro fibrils and fibrils ranging down to a few microns. Very fine micro fibrils, which are near one micron in size, can be created with sufficient processing which results in a highly fibrillated pulp.

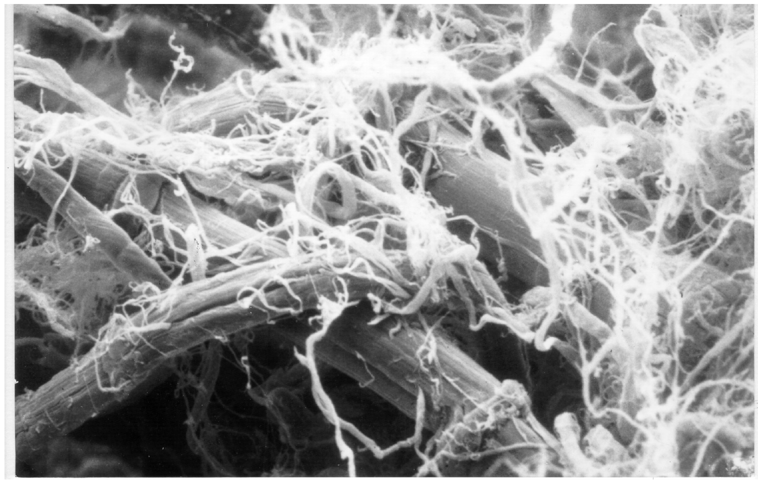

Figure 1 – CFF Fibrillated Fiber

This acrylic pulp is used in various types of high-performance applications such as air and water filter media, sorptive filter media, non-asbestos gaskets, transmission papers, combustible shell casings, analytical paper and speaker cones. Constructions based upon CFF have several special features, as listed below:

- High efficiency binding with good mechanical strength
- The wide range of fiber lengths and freenesses available
- Higher retention efficiencies than achievable with alternative synthetic fibers
- Environmental/solvent resistance
- Temperature resistance and char yield
- Improved homogeneity of media
- Increased performance in nonwovens
- Excellent fiber to resin adhesion in resin impregnated papers

CFF pulp for wet laid applications can be supplied to specific Canadian Standard Freenesses (CSF) ranging from 700 ml to less than 50 ml. Properties of the four most commonly used pulp grades are shown in Table II. In addition, customer defined freenesses can also be supplied.

TABLE II
CFF Fibrillated Fibers for
Wet Laid Applications

CFF Fibrillated Fiber Type	Product Form	Nominal Solids, %	Max./Typical Fiber Length, Millimeters	Nominal Degree of Fibrillation, CSF Milliliters
106-3	Wet crumb	30	8.0/6.5	600
111-3	Wet crumb	30	8.0/6.5	250
114-3	Wet crumb	30	6.0/4.3	50
125-2	Wet lap	50	4.0/3.5	400

When using CFF 114-3 pulp with a freeness of about 60 milliliters CSF, as little as 5% binder fiber will interlock other fibers without the need for resinous binders. Commonly, 10-15% binder is used to provide good handling strength. CFF 111-3 pulp with a freeness of about 250 milliliters CSF requires only about 40-50% acrylic pulp to entrap and hold particles while maintaining good strength. One hundred percent acrylic paper can be prepared using either the pulp itself or pulp in combination with chopped acrylic fiber. CFF 106-3 pulp with high freeness (600 milliliters CSF) will provide good wet web formation and also results in a more porous sheet. CFF 125-2 pulp is used where a shorter pulp is desired because of the dispersion limitations of the hydropulpers or other paper making equipment used.

The use of dry versions of CFF pulps, such as CFF 110-1 and CFF 125-1, is generally not recommended because it is more difficult to disperse, and because the resulting paper will be weaker than when wet pulps are used. During drying, there is some shrinkage of the wet pulp that helps to "lock" the fibrils together. Some exceptions would be to reduce paper shrinkage, to increase porosity, or to increase paper bulk.

For the same weight sheet, the thickness of papers made from CFF fibrillated fiber will be greater than paper made from cellulose or most other synthetic fibers due to the relatively low density of CFF acrylic pulp. Acrylic fiber has a specific gravity of 1.17. Conversely, if papers are made of the same thickness, longer web length will be obtained with the acrylic pulp of equal weight.

The zeta potential can be used to monitor wet end chemistry and to optimize processing parameters. The zeta potential of CFF acrylic pulp is compared with aramid and cellulose pulps in Table III. Note that the values given for cellulose are representative, since the actual zeta potential is strongly dependent on the source of cellulose and the processing used. All values in Table III were calculated using a ZETA-METER (Zeta Meter, Inc., Staunton VA) on dilute pulps in pH 7 deionized water. The similarity in zeta potentials means that the same processing used for cellulose and aramid can be used for CFF pulp without major changes.

TABLE III – ZETA POTENTIAL COMPARISON

PULP	**ZETA POTENTIAL (Millivolt at pH 7)**
CFF Acrylic Pulp	-31
Aramid Pulp	-50 to -60
Cellulose Pulp -Unbleached Kraft - Bleached Kraft	 -23.5 to -33.7 -17.0 to -32.9

The effect of pH on the zeta potential of CFF acrylic pulp is shown in Table IV.

TABLE IV- Effect of pH on Zeta Potential

pH Level	CFF Zeta Potential
3.0	-34.4
4.0	-32.0
5.0	-28.2
6.0	-30.2
7.0	-31.0
8.0	-30.6
9.0	-33.3
10.0	-37.2
11.0	-42.5

Regardless of the type and concentration of CFF pulp used, specific sheet quality can be affected by several factors including the degree of fibrillation, dispersion, and the use of retention or dispersion aids. CFF pulp can be readily dispersed and formed in sheet making equipment using recommended procedures. **The key to successful performance of CFF pulp is good dispersion and formation. It is recommended that these guidelines presented in the following sections be reviewed prior to beginning development efforts.**

2.0 PULP PACKAGING AND STORAGE

CFF acrylic pulp is supplied as a wet crumb containing about 30% solids packaged in plastic lined boxes, with the exception of CFF 125-2, which is supplied as a wet lap roll with about 50% solids. It is very important not to allow the wet pulp to dry out since this makes redispersion into a slurry difficult and can reduce ultimate web strength. Open boxes or rolls should be kept sealed when not in use. When the pulp is properly sealed, it can be stored indefinitely at ambient conditions. The wet pulp will not rot and is insensitive to mildew. As discussed in Section 1, the use of dry pulp is not recommended for wet laid processes.

3.0 DISPERSION / PROCESSING

Wet crumb and wet lap can be dispersed in water and used with various wet lay paper machines to obtain specialty nonwovens or papers. Pulps can be successfully processed on cylinder, rotoformer, and fourdrinier paper machines. Normally, the pulp is dispersed in a hydropulper (or a Waring-type blender for laboratory evaluation) to break up any entangled fibers prior to the addition of other components. In general, the CFF pulp is somewhat harder to disperse than cellulose or unfibrillated fiber because of its longer length and higher degree of fibrillation, and the operator should not expect the dispersion to look like wood pulp. However, uniform distribution is possible so that good formation will result for basis weights of 30 g/m² and greater. Guidelines for dispersing and processing CFF pulps for a range of typical processing conditions are presented in Section 5. Protrusions in chests, piping or the headbox itself can "spin" long fibers into strings. Therefore, long periods of agitation in hydropulpers or chests, pumping through barely opened valves, and butterfly valves should be avoided. Such strings can be the source of nonuniformities in paper.

The amount of dewatering and compaction in CFF pulps has been selected to permit good dispersion in typical production hydropulpers. Two simple test procedures may be useful to check dispersion and opening of the pulp. A simple graduated cylinder visual inspection, as presented in Section 8, has proven very useful. Preparation of a sheet on the handsheet mold may provide another quick assessment of adequate mixing. Another simple way to check dispersion is to prepare a blend of CFF pulp and cellulose using cellulose pulp that has been dyed. The addition of about 90% cellulose produces a good contrast with the white CFF pulp and provides a quick visual check of dispersion. A recommended procedure is presented in Section 8. When initially working with CFF acrylic pulps, it is also highly recommended that the dispersion be checked using the mixing and dispersion procedures employed in your laboratory and pilot machines.

4.0 DISPERSION / PROCESSING AIDS

Good quality paper and nonwovens can be produced without the use of any chemical additives. However, a dispersion aid can be used to improve the uniformity (i.e., fiber retention and formation) of the acrylic pulp sheet. The acrylic fibers in water possess a negative (anionic) charge. Neutralization of the fibers negative charge with a positive (cationic) charge allows the fibers to agglomerate into "flocs" which will not repel each other but come together forming a sheet with greater uniformity. The "flocking" of fibers also prevents loss of fines. A low molecular weight cationic polymer attaches cationic "patches" onto the anionic fibers. Once the cationic patches are established, agglomeration of fibers occurs via association of anionic and cationic sites on adjacent particles.

Since the advent of neutral/alkaline pH papermaking, cationic polymers are used in conjunction with high molecular weight polyacrylamides to "floc" the charge neutralized particles together more efficiently. The high molecular weight anionic polyacrylamide establishes a bridge between the small particle agglomerates via "loops" which extend from its surface (much like casting a fishing net). The dual polymers work in synergy by first dispersing and then controlled flocking of the fibers together.

Cypro 515, manufactured by Ciba, is a medium molecular weight cationic polyamine polymer supplied as a 50% solids solution. It is used to neutralize the CFF fiber's anionic charge. The Cypro 515 is diluted with water to 1% solids before use.

Magnafloc E38 (previously called Percol E 38) is a high molecular weight, high charge density, anionic polymer supplied as a 36% solids emulsion. Before using, the Magnafloc E38 is diluted to a 1% solids solution in water (with a low speed stirrer or paddles) and aged 30 minutes prior to use.

Approximately 0.05 to 0.5% per ton of fiber is a typical dosage for the Cypro 515. The Magnafloc E38 is used at 0.025 to 0.15% (polymer as received) per ton of fiber. It is likely that there are many other dispersion aids that will give positive results. Preparation of these Ciba retention aids (Cypro 515 and Magnafloc E38) is discussed in Section 7. Other processing aids are also listed in Section 7.

5.0 TYPICAL PROCESSING CONDITIONS

The following procedures have been used for preparing laboratory handsheets and pilot machine quantities of paper. In addition to the processing conditions used for preparing laboratory handsheets and pilot machine runs of paper from one hundred percent CFF acrylic pulp, procedures are presented for making one hundred percent acrylic paper containing a blend of acrylic pulp and staple. A procedure is also presented for making powder loaded papers where the CFF fibrillated fiber serves as the mechanical binder.

5.1 Preparation of Laboratory Handsheets Containing CFF® Fibrillated Fiber

In the laboratory preparation of handsheets, the following procedure is recommended to make a nominal 100 g/m² sheet measuring 30 x 30 cm:

5.1.1 Disperse wet CFF acrylic pulp in a Waring type commercial blender (Waring Blender CB-6 Model 34BLL22 is recommended) for 30-40 seconds in about 3 liters of water.

Note**:** The blades of the Waring blender should be installed upside down so that the blunt edge impacts the pulp and cutting is minimized.

5.1.2 Add other fibers, powders, etc. and blend for 15 seconds.

Note**:** Total weight (dry weight basis) of components from 1 and 2 should be 10 grams.

5.1.3 Transfer slurry to headbox of handsheet machine and dilute to 11 liters. Hand mix using 8-10 vertical strokes with the mixing paddle.

5.1.4 Gravity drain to form sheet. Use vacuum to remove excess water retained in sheet after sheet formation.

5.1.5 Place wet sheet between blotters and pass one time between pinch rollers.

5.1.6 Place sheet on drum dryer at 115ºC (240ºF) (3-4 passes).

Note: Increasing the dryer can temperatures will increase the shrinkage of the CFF pulp. This will increase the tensile strength but decrease sheet porosity.

5.1.7 Condition 24 hours prior to testing.

5.2 Typical Batch Preparation for the Production of Paper Made From 100% CFF Acrylic Pulp

5.2.1 Add about 25 pounds (11.4 kilograms) of CFF pulp (dry weight basis) for each 400 gallons (1514 liters) of water to obtain about 0.75% consistency slurry.

5.2.2 Run hydropulper for a minimum of one minute.

5.2.3 Add 457 milliliters of diluted, premixed, Magnafloc E38 into hydropulper, for each 25 pounds of acrylic fiber. Run hydropulper one minute for each 25 pounds of acrylic fiber.

5.2.4 Add 1133 milliliters of diluted, premixed, Cypro 515 into hydropulper, for each 25 pounds of acrylic fiber. Run hydropulper one minute for each 25 pounds of acrylic fiber.

Note: See Section 7 for polymer mixing details.

5.2.5 Check dispersion of pulp.

***Note*:** A quick technique is to place a small amount of slurry in a one liter cylinder, dilute with water to one liter. Shake. Observe pulp uniformity (cloudiness/lack of dense spots) by holding cylinder in front of light. Very high dilutions such as 50-1 are most useful.

5.2.6 If good dispersion is not obtained, run hydropulper for an additional 30 to 60 seconds and recheck dispersion.

***Note*:** Because of the length of CFF acrylic pulp, roping can occur if pulp is overmixed.

5.2.7 Dilute pulp in hydropulper by increasing water to about 1500 gallons (5678 liters) for each 25 pounds (11.4 kilograms) of pulp to obtain a consistency of about 0.20%.

5.2.8 Pump to headbox at a constant feed rate and feed in make-up water to maintain consistency of about 0.10%.

5.2.9 Typical paper machine conditions (wet end) for a 100g/m² sheet:

- The more highly fibrillated CFF pulps, i.e. CSF 60, will drain more slowly. Typically, machines are run with the dandy roll down.

5.2.10 Typical drum temperatures:

- First Section – 245-250ºF (118-121ºC)
- Remaining Sections – 255-265ºF (124-129ºC)

5.3 Typical Batch Preparation for Production of Paper Made from 75% CFF Acrylic Pulp/25% Acrylic Fiber

5.3.1 Add about 18.75 pounds (8.51 kilograms) of CFF pulp (dry weight basis) for each 400 gallons (1514 liters) of water to obtain about a 0.55% consistency slurry.

5.3.2 Run hydropulper for one minute.

5.3.3 Add 6.25 pounds (2.84 kilograms) of acrylic staple (dry weight basis) to bring consistency to about 0.75%.

5.3.4 Add 357 milliliters of diluted, premixed, Magifloc E 38 into hydropulper for each 25 pounds of acrylic fiber. Run hydropulper one minute for each 25 pounds of acrylic fiber.

5.3.5 Add 1133 milliliters of diluted, premixed, Cypro 515 into hydropulper, for each 15 pounds of acrylic fiber. Run hydropulper one minute for each 25 pounds of acrylic fiber.

***Note*:** See Section 7 for polymer mixing details.

5.3.6 Check dispersion of pulp.

5.3.7 If good dispersion is not obtained, run hydropulper for additional 30 to 60 second periods and recheck dispersion.

***Note*:** The tendency for roping will be much greater with chopped fiber in the slurry.

5.3.8 Dilute pulp in hydropulper by increasing water to about 1500 gallons (5678 liters) for each 25 pounds (11.4 kilograms) of pulp to obtain a consistency of about 0.20%.

5.3.9 Pump to headbox at a constant feed rate and feed in make-up water to maintain consistency of about 0.10%

5.3.10 Typical paper machine conditions (wet end) for a 100g/m² sheet:
- Use standard operating procedures.

5.3.11 Typical drum temperatures:
- First Section – 245-250ºF (118-121ºC)
- Remaining Sections – 255-265º (124-129º)

5.4 <u>Typical Batch Preparation for Production of Paper Made from 50% CFF Acrylic Pulp/50% Carbon Powder</u>

5.4.1 Add about 12.5 pounds (5.7 kilograms) of CFF pulp (dry weight basis) for each 400 gallons (1514 liters) of water to obtain about a 0.38% consistency slurry.

5.4.2 Run hydropulper for one minute.

5.4.3 Add 457 milliliters of diluted, premixed, Percol E38 into the hydropulper, for each 25 pounds of acrylic fiber. Run the hydropulper one minute for each 25 pounds of acrylic fiber.

***Note*:** See Section 7 for polymer mixing details.

5.4.4 Check dispersion of pulp.

5.4.5 If good dispersion is not obtained run hydropulper for additional 30 to 60 second periods and recheck dispersion.

5.4.6 Add 12.5 pounds (5.7 kilograms) of carbon powder to bring consistency to about 0.75% and run hydropulper for two minutes.

5.4.7 Dilute pulp in hydropulper by increasing water to about 1500 gallons (5678 liters) for each 25 pounds (11.4 kilograms) of pulp plus powder to obtain a consistency of about 0.20%.

5.4.8 Pump to headbox at a constant feed rate and feed in make-up water to maintain consistency of about 0.10%

5.4.9 Add 1133 milliliters of diluted, premixed, Cypro 515 into the hydopulper, for each 25 pounds of acrylic fiber. Run the hydropulper one minute for each 25 pounds of acrylic fiber.

5.4.10 Typical paper machine conditions (wet end) for a 100g/m² sheet:
- Use standard operating procedures.

5.4.11 Typical drum temperatures:

- First Section – 245-250ºF (118-121ºC).
- Remaining Sections – 255-265ºF (124-129ºC).

6.0 CALENDERING

Papers containing CFF acrylic pulp can be calendered to improve surface smoothness, increase strength, and reduce porosity. For initial calendaring experiments, a surface temperature of about 290-310ºF (143-154ºC) at a pressure of 400-500 pounds/linear inch (70-80 kN/m) is recommended. Such conditions have been run on calendaring rolls at speeds of 75-500 feet/minute (23-152 m/min). These conditions should provide a good baseline that can be adjusted to meet specific requirements.

7.0 PREPARATION OF CIBA RETENTION AIDS FOR DISPERSING AND FLOCCING CFF ACRYLIC PULP

The three major retention systems used in papermaking include: 1) alum; 2) dual polymers; and 3) microparticles, such as colloidal silica. The dual polymer system offers an ideal combination of cost, performance, and versatility.

Dual polymer retention systems were the first developed specifically for neutral/alkaline pH papermaking. The first component is a low to medium molecular weight highly charged cationic polymer. The second component is a high molecular weight anionic polyacrylamide. The first polymer neutralizes the anionic charge of the CFF fiber. The second polymer flocs the neutralized particles together. This dual action offers good balance of retention, formation, and drainage.

Dual polymers are the retention aid system of choice for the CFF fibers. Two Ciba products (Cypro 515 and Magnafloc E38) are respectively a cationic polyamine (50% solids) and an anionic polyacrylamide (36% solids). Both are former Cytec products previously known as Cypro 517 and Accurac 171RS. Ciba's phone is 1-800-322-3885.

The first step in the use of Cypro 515 and Magnafloc E38 is reduction with water to a 1% solids solution:

Cypro 515: Dilute to a 1% solution by utilizing a 50 to 1 dilution with fresh water, i.e., 50 milliliters water and one milliliter Cypro 515.

No prolonged hand or mechanical mixing other than immediate dispersion in water is required.

Magnafloc E38: Dilute to a 1% solution by utilizing a 36 to 1 dilution with fresh water, i.e. 36 milliliters water and one milliliter Magnafloc E38.

Mechanical mixing of 15 to 20 minutes is required (magnetic stirrer in lab or low speed stirrer, blade or paddle, in plant).

Let solution age 30 minutes prior to use (allows molecules to uncoil).

The second step is addition to the stock. The Cypro and Magnafloc are added after refining. Cypro and Magnafloc are added after all other chemical addition. The anionic polymer Magnafloc E38 is added first. The cationic polymer Cypro 515 is added last. Allow 5 minutes recirculation (not refining) after the addition of each component.

For making a 21 gram handsheet in the laboratory, the recommended dosages are as follows:

<u>Cypro 515</u>: 2.1 milliliters of a 1% solution
<u>Magnafloc E38</u>: 0.66 milliliters of a 1% solution

For making a 25 pound beater run in the plant, the dosages are as follows:

<u>Cypro 515</u>: 1133 milliliters of a 1% solution
<u>Magnafloc E38</u>: 357 milliliters of a 1% solution

The addition of small levels of alum (1-3 lb/ton) may improve the efficiency of neutral/alkaline retention aids. In the case of a 25 pound beater run, 17 grams of dry alum would be added immediately prior to the Cypro 515.

These above systems are presented as typical types of dispersants that can be used. Many other systems that would also be suitable include:

Alum and anionic polyacrylamide (A-PAM)
Alum and cationic polyacrylamide (C-PAM)
Cationic starch and A-PAM
Cationic starch and C-PAM
Polyaluminum chloride (PAC) and A-PAM
Polyaluminum chloride (PAC) and C-PAM
Polyamine and A-PAM
Polyamine and C-PAM
Poly-DADMAC and A-PAM
Poly-DADMAC and C-PAM
Polyethyleneimine (PEI) and A-PAM
Polyethyleneimine (PEI) and C-PAM

From Bayer Chemicals, the following products may be of use (terms high/medium/low refer to charge density) as retention aids:

Retaminol PLE 112L, low cationic polymer
Retaminol MCS 301X, high cationic polymer
Retaminol PLE 109H, high cationic polymer
Retaminol PCE 106M, medium cationic polymer
Retaminol C01, medium cationic polymer
Retaminol E, very high cationic polymer
Retaminol PAE 102M, medium anionic polymer
Retaminol PAE 301S, very low anionic polymer

8.0 DISPERSION TEST METHODS

8.1 Dispersion of Acrylic Pulp by Dilution in Water

8.1.1 Scope

This method is used to determine the dispersion of CFF acrylic pulp by dilution in water and observing for pills. It is useful as a process control procedure.

8.1.2 Terminology

Pills – a group of fibrillated fibers that are held together by mechanical entanglement that keeps them from separating.

8.1.3 Apparatus 1 liter glass graduated cylinder
1 quart Waring Blender

Note: The blades of the Waring Blender should be installed upside down so that the blunt edge impacts the pulp in order to minimize cutting.

8.1.4 Procedure for Inspecting Incoming Pulp

1. Weigh out 5.0 grams of pulp (dry weight basis).
2. Add to 1 quart Waring Blender containing 500 milliliters of room temperature water.
3. Blend at low speed for 30 seconds.
4. Pour contents into 1 liter graduated cylinder – leaving remaining fiber from blender cap to be washed out and discarded.
5. Dilute to 1 liter with tap water.
6. Invert and shake graduate cylinder approximately 5 to 6 times in order to ensure good mixing.
7. Pour out 500 milliliters of the mixture and redilute to 1 liter.
8. Continue Step 7 six times to achieve a very dilute fiber / water ratio and inspect for small undispersed fiber bundles, or pills using transmitted light.

8.1.5 Procedure for Process Control

1. Remove container of dispersed CFF slurry from hydropulper or chest and pour 500 milliliters into a 1 liter glass cylinder.
2. Dilute to 1 liter with tap water.
3. Invert and shake graduate cylinder approximately 5 to 6 times in order to ensure good mixing.
4. Pour out 500 milliliters of the mixture and redilute to 1 liter.
5. Continue Step 7 six times to achieve a very dilute fiber / water ratio and inspect using transmitted light for small, undispersed fiber bundles, or pills.

8.2 Dispersion of Acrylic Pulp by Blending With Dyed Cellulose

8.2.1 Scope

This test is used to determine the level of undispersed pulp or clumps in fibrillated acrylic fibers.

8.2.2 Summary of Method

The acrylic pulp to be tested is dispersed in a slurry of dyed wood pulp, handsheets are formed and then examined for the presence of clumps. The number of pills/cm² are counted and used as an index of dispersion.

8.2.3 Significance

Undispersed, or tangled, fibrillated fibers (clumps) prevent full utilization of the binding capacity of acrylic pulp and can be unsightly from a cosmetic standpoint. This method is used to determine the presence of such pills in a standardized dispersion procedure.

8.2.4 Reagents

1. Poly Blue LA-22 dye obtainable from Poly/Sperse Corp., 250 Narragansett Park Drive, P.O. Box 16068, Rumford, RI 01916 or equivalent.

2. Alum Potassium U.S.P. Powder TAC (aluminum potassium sulfate) obtained from Baxter Scientific or equivalent.

8.2.5 Apparatus

1. Balance accurate to 0.0001 gram.
2. 1 quart Waring Blender. The blades of the Waring blender should be installed upside down so that the blunt edge impacts the pulp in order to minimize cutting.
3. Noble and Wood Sheet Forming Machine with drum dryer.
4. Valley Laboratory Beater.
5. Light box.
6. Disposable medicine dropper.

8.2.6 Safety Precautions:

1. Use normal care practiced in using laboratory equipment.

8.2.7 Conditioning:

None required.

8.2.8 Procedure:

1. Weigh out 120 ± 1 grams of softwood pulp.
2. With no load on the beater roll, defiber the softwood pulp for 20 ± 1 minutes in 22 liters of water supplied to the beater.
3. After defibering the woodpulp, weight out 11.33 ± 0.01grams of Poly Blue LA-22 dye in a tared aluminum weighing dish.
4. Add the Poly Blue LA-22 dye to the slurry in the beater and circulate for 7 ± 1 minutes.
5. Weight out 5 ± .01grams of 100% dry alum in a tared aluminum weighing dish, add it to the slurry in beater and circulate for 7 ± 1 minutes. This activates the dye to adhere to the fiber.
6. With the beater circulating, extract 400 milliliters of pulp slurry.
7. Add 2 grams of acrylic pulp (dry weight basis) to the pulp slurry.
8. Place the woodpulp slurry with added fiber in the container of the Waring blender and agitate at slow speed for 90 ± 1 seconds.
9. Form handsheets in the Noble & Wood Handsheet Mold. The sheet mold is filled with 10 ± 0.1 liters of water and the slurry is agitated with 10 complete strokes, 9 fast and the 10th slow to reduce swirling.
10. Dry handsheet in Drum Dryer or Ames Dryer.
11. View the handsheet formed in Step 10, rotating it slowly on the light table, counting and marking with a circle all pills observed on both sides of the handsheet and record the total.

8.2.9 Calculations and Interpretations:

Handsheet from Box Number	Pills
2101	3
2102	0
2103	2
2104	1
2105	5
Total	11

One handsheet is made from each box of pulp. The total number of pills on both sides of handsheets made from all the boxes sampled is calculated. It is desired to determine the lot average for pills per box. The formula is:

$$\text{Lot average pills/box} = \frac{\text{Total pills for all handsheets}}{\text{Number of boxes sampled}}$$

Example:

$$\text{Lot average pills/box} = \frac{11}{5} = 2.2$$

Report:
Report the average number of pills per box.