



Blotting Paper for Bench Type Testing - A 48-inch Pilot Paper Machine Production Run

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Author's contribution

The sole author designed, analysed, interpreted and prepared the manuscript.

Article Information

DOI: 10.9734/JERR/2021/v21i1117507

Open Peer Review History:

This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: <https://www.sdiarticle5.com/review-history/83398>

Original Research Article

Received 20 October 2021
Accepted 26 December 2021
Published 28 December 2021

ABSTRACT

Paper manufacturing originated in China in 105 BC and has come a long way. Countless different paper grades have been developed and are being used all over the world today. One of these paper grades is blotting paper, first recognized in 1465 and machine manufactured in the 1800's. Today, one of the blotting paper applications is to absorb water during handsheet forming for paper testing.

Blotting paper product with an oven dry basis weight of 269.8 g/m² and 322.6 g/m², a thickness of 484 µm and 566 µm, respectively was manufactured on a 48-inch small commercial Fourdrinier paper machine.

The wet tensile index and stretch was 0.9 Nm/g and 3.54% and 0.94 and 4.04% for the lower and higher bases weight. Water absorbance achieved values of 44.42 mL/s for the top side and 25.43 mL/s for the wire side for the 269.8 g/m² blotting paper and 27.91 for the top side and 20.55 mL/s for wire side of the 322.6 g/m² blotting paper. The minimum total absorbency requirements of 500 ± 50 g/m² was achieved for both basis weights.

Optical properties measured included Opacity at 99.98%, brightness at 86.89%, whiteness at 76.04% and color of 96.43% for the L* value, -0.93 for the a* value, and 3.33 for the b* value.

The manufactured blotting paper has been successfully used producing handsheets with basis weights between 20 g/m² and 300 g/m² utilizing virgin and recycled fiber material.

Keywords: Blotting paper; handsheet making; papermaking; paper machine; paper testing.

1. INTRODUCTION

Since the invention of paper by Cai Lun during the Eastern Han dynasty at 105 CE in ancient China [1-4], countless different paper grades have been developed all over the world. For example, in Germany over 3000 different paper grades are produced today [5]. Based on the European forest industry, paper is classified in four major categories, which are: (i) printing and writing papers, (ii) paperboard, (iii) tissue, and (iv) specialty papers [6]. All manufactured paper can be characterized by its grade specific mechanical, optical and physical properties. In general, paper is considered to have a basis weight of up to 150 g/m², board between 150 g/m² to 600 g/m², and tissue between 10 g/m² to 60 g/m². However, the basis weight boundaries are not fixed and allow some flexibility for the manufacturers and individual product specifications. Specialty paper for instance can be found in all basis weight ranges and represent paper grades that are not considered commodity grades [6]. These papers are produced in quantities from a few sheets, for handmade paper [7] to lot sizes of over 10,000 lb (4,535 kg) for machine made paper [8].

Today's modern 600 m long modern paper machines that produce paper sheets at a speed of 2,000 m/min at a width of 11.5 m at a production rate of 4,500 metric-tons per day [8,9]. Due to the small lot sizes, specialty paper machines are a fraction of the size of today's modern paper machines and operate at much lower speeds. This allows the economic production small lots sizes of paper products in a wide range of basis weights. An example might be the 48-inch (1,219 mm) wide paper machine installed at the Chemical Engineering Department's pilot plant at the State University of New York (SUNY), College of Environmental Science and Forestry (ESF). Decades ago, this machine was a commercial paper machine similar in size to today's small specialty paper machines utilized for the production of specialty paper products. At SUNY-ESF it is used to educate future paper engineers as well as run research and pilot trials for customers from the paper and affiliated industries.

Paper for instance is considered a specialty paper, produced in small lot sizes of 2000 lb (907 kg) to 10,000 lb (4,535 kg) and a basis weight roughly between 100 g/m² to 500 g/m² based on specification by the end user [10].

Blotting paper according to Dard Hunter first was recognized in 1465 [11] and was invented and

first machine made in the early 1800's by William Smart Slade who recognized that broke who unsized paper absorbed ink, and that he just made absorbent paper [12].

Blotting paper as we know them today, are used to absorb the excess of a liquid substance from a surface.

Some applications are: (i) the removal of excessive ink left by a fountain pen on the writing paper surface, (ii) as coasters to protect the table surface from liquid damage [1], and (iii) removal of excessive cosmetics oil from the human face. Blotting paper has an application as art paper as an aquarelle painting surface, because it absorbs the suspended pigments in the water-based solution better than standard painting papers. Technical applications include diagnostic paper for analytical testing, filter paper, chromatography, electrophoresis, gravimetric analyses, and absorbent pads for shipping sensitive materials, as well as for pulp and paper testing [13].

Blotting Paper for pulp and paper testing applications is specified by testing methods of the Technical Association of the Pulp and Paper Industry (TAPPI) testing standards TAPPI T205 sp-06, "Forming handsheets for physical tests of pulp" [14], and TAPPI T432 cm-99, "Water absorbency of bibulous papers" [15].

The following manuscript describes the manufacturing of a heavier grade blotting paper for use in laboratory bench scale paper testing, utilizing their 48-inch (1219 mm) wide pilot paper machine located and installed at the Chemical Engineering Departments pilot plant at SUNY-ESF.

2. MATERIALS AND METHODS

The following materials and methods were used for the blotting paper manufacturing using a 48-inch wide Small Commercial Fourdrinier Paper Machine (SCFPM).

2.1 Materials

For the blotting paper production, a mixture of Northern Bleached Maple Hardwood Kraft (NBHK) pulp, Sulfite Softwood pulp (SS), Northern Bleached Softwood Kraft (NBSK) pulp and Cotton pulp (C) were used. No additional chemicals were added to the pulp suspension prior to papermaking.

2.2 Testing Methods

For this research project the following testing methods of the Technical Association of the Pulp and Paper Industry (TAPPI) and International Organization for Standardization (ISO) were used:

TAPPI T 205 sp-12, "Forming handsheets for physical tests of pulp" [16] was used as a guideline for the production of blottingpaper. Physical testing of handsheets was performed in accordance with T 220 sp-06, "Physical testing of pulp handsheets" [17]. Freeness of pulp was measured as Canadian Standard Freeness (CSF) according to T 227 om-09 "Freeness of pulp (Canadian standard method)" [18]. Consistency of the pulp suspensions was measured with TAPPI T 240 om-07 "Consistency (concentration) of pulp suspensions" [19].

Conditioning of the paper samples was done according to T402 sp-08, "Standard conditioning and testing atmospheres for paper, board, pulp handsheets, and related products" [20]. Basis weight was measured with T 410 om-08. "Grammage of Paper and Paperboard (weight per unit area)" [21]. Thickness of the paper was measured with TAPPI T 411 om-10. "Thickness (caliper) of paper, paperboard, and combined board" [22].

Moisture content of pulp was determined by T 412 om-06 "Moisture in pulp, paper and paperboard" [23]. Water absorbency was measured using TAPPI method T 441 om-04 "Water absorptiveness of sized (non-bibulous) paper, paperboard, and corrugated fiberboard (Cobb test)" [15]. Wet tensile breaking strength was measured according to TAPPI T456 om-03 "Tensile breaking strength of water-saturated paper and paperboard ("wet tensile strength")" [24]. Tensile strength was evaluated using TAPPI method T 494 om-06 "Tensile properties of paper and paperboard (using constant rate of elongation apparatus)" [25]. Surface roughness of the paper product was measured with TAPPI method T 538 om-08. "Roughness of Paper and Paperboard (Sheffield method)" [26]. The air permeance of the paper product was measured with TAPPI T547 om-07 "Air permeance of paper and paperboard (Sheffield method)" [27]. Brightness was measured according to ISO 2470 "Paper, board and pulps - Measurement of diffuse blue reflectance factor - Part 1: Indoor daylight conditions (ISO Brightness)" [28]. Opacity was determined according to ISO

2471:2008 "Paper and Board: Determination of Opacity (Paper Backing) - Diffuse Reflectance Method" [29]. Whiteness/Color was measured according to ISO 11476:2016 "Paper and Board - determination of CIE Whiteness, C/2° (Indoor Illumination Conditions)" [30].

2.3 Blotting Paper Specification

Blotting paper as described by the TAPPI standard T205 sp-06 [16], is a 200 mm square paper sheets with a basis weight of 250 ± 10 g/m² Oven Dry (OD), and a thickness $508 \mu \pm 13$ μ m, that has a minimum rate of absorbency of 25 s/1.0 mL of water when tested in accordance with TAPPI T 432 "Water Absorbency of Bibulous Paper". The minimum total absorbency of the blotting paper shall be 500 ± 50 g/m². The wet stretch should not exceed 2.5% in the Cross-Direction (CD) of the paper machine, to not alter the dimensions and form of the handsheets produced with the blotting paper. The color of the blotting paper shall be white, which suggests, that no preference is given to the bleached fiber type used. In addition, blotting paper should be free of any additives, which means, that no additives should be used in the manufacturing process of the blotting paper, because embedded chemicals can alter the handsheet properties produced with the blotting paper. The blotting paper appearance should be uniform, flat, and free of wrinkles and dirt, because any imperfection in the appearance or possible dirt embedded in the blotting paper will impact the appearance of the TAPPI handsheet produced using the blotting paper. Based on the above amore heavier, sturdier grade blotting paper grade with a targeted bases weight of 270 g/m² and 320 g/m² is produced for laboratory testing applications of handsheets that exceed the standard TAPPI handsheet basis weight of 60g/m².

2.4 48-inch Small Commercial Fourdrinier Paper Machine System Operation

To production of approximately 1,100 lb. of blotting paper, a large scale, a 48-inch Small Commercial Fourdrinier Paper Machine (SCFPM) located at the pilot plant of the Chemical Engineering Department at SUNY-ESF is used for a 48-inch (1219.2 mm) wide continuous paper sheet that can be cut into all standard paper sizes. The setup of the blotting paper production run using the SCFPM run can be described as follows:

2.4.1 Stock preparation for the 48-inch small commercial fourdrinier paper machine

The stock preparation of the SCFPM, shown in Fig. 1., consists of a 50 hp (37.28 kW), 1800 gal (6,800 l) low consistency pulper, a 15 hp (11.12 kW) transfer pump, a 150 hp (111.86 kW) low consistency conical Jones-Bertram beater, and a storage chest with a usable volume of 15,000 gal. (56,780 l). The storage chest is agitated with a propeller 20 hp (14.91 kW) propeller agitator. Additives for papermaking can be added either in the pulper, the Jones-Bertram beater or the storage chest.

The blotting paper production on the 48-inch SCFPM was designed for a maximum of approximately 6.0 hours, using 2100 lb (952.5 kg) of the following virgin market pulp were used: (i) 1340 lb (607.8 kg) of NBHK pulp, (ii) 400 lb. (181.4 kg) SSP, (iii) 260 lb. (117.9 kg) NBSK pulp, and (iv) 100 lb (45.4 kg) of cotton pulp. Six hours of production will leave enough time to start-up the SCFPM, make needed adjustments to meet paper properties, and produce about 1,200 lb (350 kg) blotting paper at the targeted basis weight of 350 g/m².

To prepare the needed fiber for the 48-inch SCFPM run, three batches of 700 lb (317.5 kg) each were pulped using the 1,800 gal (6,800 l) low consistency pulper followed by refining in the 1,800 gal (6,800 l) Jones Bertram beater of the of the SCFPM stock preparation system.

The first pulping batch contained, 700 lb (317.5 kg) OD of NBHK. The second batch contained the remaining pulp of 640 lb (290.3 kg) of NBHK fibers, 60 lb (27.2 kg) of NBSK fibers. The third

batch contained 100 lb (45.4 kg) of cotton pulp, 400 lb. (181.4 kg) SSP, 200 lb. (90.7 kg) NBSK pulp.

All three batches were pulped at a consistency of 5.3% based on OD fiber content by adding 1,400 gal (5,299.7 l). Each pulping batch consisted then of approximately 1,585 gal (5,990 l) of fiber slurry. After pulping the fiber slurry from each pulping batch was transferred into the 1,800 gal (6,800 l) Jones Bertram beater of the of the SCFPM stock preparation system.

For the beating operation in the Jones Bertram beater the stock was slightly diluted to 5% OD fiber content by adding 95 gal (360 l) of water resulting in 1,680 gal (6,350 l) of fiber suspension in the Jones Bertram beater.

The three pulped fiber slurries were beaten with a load of 4,000 lb (1,814.3 kg) added to the Jones Bertram beater wheel using a beating time of 10 minutes.

For the first fiber slurry an Ampere (A) beating load of 81 A was used, resulting in a 52.03 kW beating net power for the first and second pulped fiber slurry. The applied energy into the fiber slurries was 23.61 kWh/US ton (26.02 kWh/metric ton) of OD fiber, which lead to a reduction of the CSF of the fiber slurries from 500 mL to 448 mL.

A refining load of 90 A was used for the second pulped fiber slurry, resulting in an 57.82 kW power consumption. The applied energy into the fiber slurries was 27.53 kWh/US ton (30.35 kWh/metric ton) of OD fiber, which lead to a reduction of the CSF of the fiber slurries from 534 mL to 494 mL.

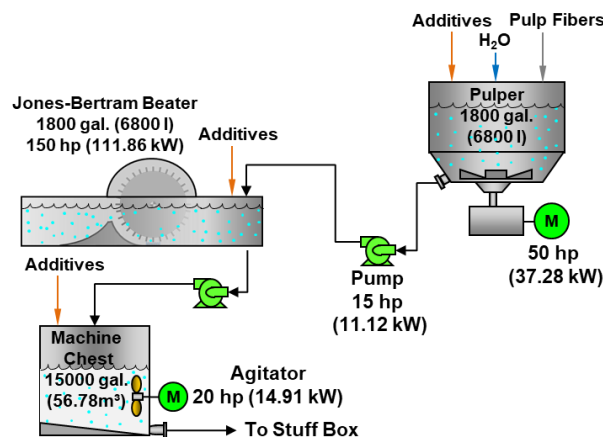


Fig. 1. 48-inch small commercial Fourdrinier paper machine stock preparation [4]

For the third fiber slurry an load of 127 A was applied, resulting in an 81.59 kW power consumption. The applied energy into the fiber slurries was 38.84 kWh/US ton (42.82 kWh/metric ton) of OD fiber, which lead to a reduction of the CSF of the fiber slurries from 670 mL to 600 mL.

The CSF value was measured with TAPPI test method T 227 om-09.

After refining each batch of the refined fiber slurry was transferred into the 15,000-gal (56.78 m³) machine chest of the SCFPM and mixed thoroughly.

The 5,040 gal (19,050 l) of refined pulp fiber slurry in the machine chest was then diluted to a consistency of 2.5% by adding 5,040 gal (19,050 l) of water.

No additives were added to the machine chest.

2.4.2 48-inch small commercial fourdrinier pilot paper machine wet end system

The wet end of the SCFPM, as shown in Fig. 2., consists of a 6,500 gal. (56.78 m³) machine chest with a 20hp (14.91 kW) agitation propeller. As described in Section 2.5.1. the chest contained approximately 5,040 gal (19,050 l) of refined pulp fiber slurry. A 15 hp (11.12 kW) impeller pump transfers the stock from the machine chest to a stuff box. A basis weight mixing valve regulates the pulp fiber flow to a 184 gal (743.3) mixing chest, where the pulp fibers are mixed and diluted with the white water from the paper machine, head box overflow, additives and pressure screen reject flow to a head box consistency of approximately 1%. The white water used for dilution consists of removed water from the table rolls, low vacuum and high vacuum which is pumped from the seal pit to with a 3 hp (2.25 kW) impeller pump to the white-water trough. From the mixing chest, the pulp fiber suspension is pumped with an impeller head box pump having 15 hp (11.12 kW) to a pressure screen driven by a 30 hp (22.37 kW) electro motor. The head box screen supplies the paper machine headbox with the prepared pulp fiber suspension. The volumetric flow to the head box is controlled by a flow control valve. The pressure screen reject is sent back to the mixing chest.

The SCFPM vacuum system consists of 2 vacuum pumps with 40 hp (29.82 kW) and 20 hp (14.91 kW), having a common header. The vacuum systems provide vacuum for the FCFPM high vacuum boxes, the couch roll and the press section vacuum boxes.

2.4.3 48-inch small commercial fourdrinier paper machine run

The SCFPM shown in Fig. 3. has a 280" (7112.0 mm) long Fourdrinier Forming Section (FFS) with a 48" (1219 mm) headbox slice opening and forming board. The Breast roll of the FFS is attached to a shake having 3 hp (2.23 kW) and a stroke of 0 to 7/8-inch (0 to 22.23 mm) adjustable to a frequency between 0 to 10 Hz for improving sheet formation and fiber orientation on the forming wire. In addition, the FFS contains 13 table rolls with a diameter of 3.5" (88.9 mm), 3 foil boxes, 4 high vacuum sections, a 12" (304.8 mm) dandy roll, and a 14" (355.6 mm) diameter vacuum couch roll, including a couch pulper with a 1 hp (0.75kW) electro motor. The couch roll is driven by a 20 hp (14.91 kW) electro motor.

The blotting paper production run was estimated to run for approximately 3 hours including set up of the paper machine, adjusting the OD basis weights for the 250 g/m² and the 320 g/m². The speed of the SCFPM blotting paper run was set to be 46 ft/min (13.98 m/min) with a headbox slice opening of 0.25 inch (8.3 mm), and a shake frequency of 2 strokes per second. The fiber suspension flow to the headbox was adjusted to 1.1% in the mixing chest by recirculating the white water from the white-water through with an fiber suspension flow of 125.0 gal/min (472.5 l/min) (see Fig. 2.), in order to achieve the targeted basis weight of 250 g/m² OD of the blotting paper. For producing of the 320 g/m² OD blotting paper the machine speed was reduced to 40 ft/min (12.16 m/min) allowing more fiber material to be retained on the Fourdrinier wire section and therefore increasing the basis weight.

The vacuum levels for the fourdrinier table were set for the three low vacuum boxes 1 to 3 at 497 Pa, 1,493 Pa, and 1,990 Pa respectively. The four high vacuum boxes 1 to 4, the vacuum was set at 746 Pa, 746 Pa, 1,244 Pa, and 995 Pa respectively. The couch roll vacuum was set at 1368 Pa.

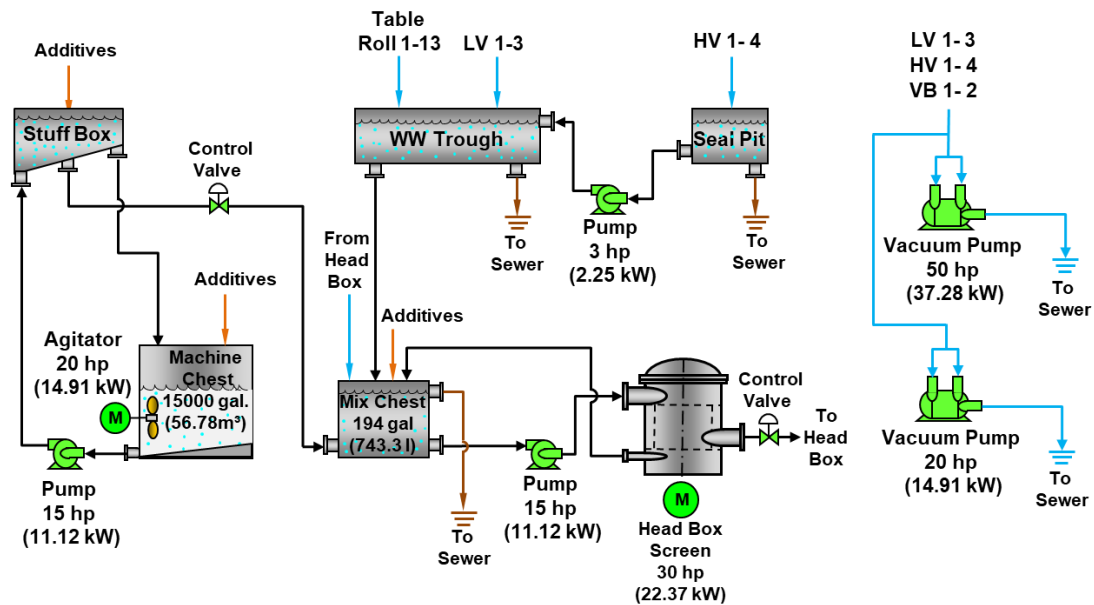


Fig. 2. 48-inch small commercial Fourdrinier paper machine wet end system [4]

The paper is transferred from the FSS to the press section which contains a 1st and a 2nd press with a maximum loading of 500 pound per linear inch (pli) (87.6 kN/m) press loading. The 1st press has a press roll with 13" (330.2 mm) diameter and a 14" (355.6 mm) grooved roll. The 2nd press has a press roll with 14" (355.6 mm) diameter and a 14" (355.6 mm) smooth roll. Each press section is driven by a 10hp (7.46 kW) electro motor.

For the blotting paper run the 1st and 2nd press were operated at 10 psi and 24 psi pressure respectively, which correlates to a line pressure of 7.23 kN/m for the 1st and 25.9 kN/m for the 2nd press.

For the 320 g/m² OD blotting paper run the 1st and 2nd press were operated at 14 psi and 30 psi pressure respectively, which correlates to a line pressure of 12.7 kN/m for the 1st and 34.0.

The pressed blotting paper is fed into the dryer section featuring dryer cans that have a non-chrome smooth metal surface and kN/m for the 2nd press.

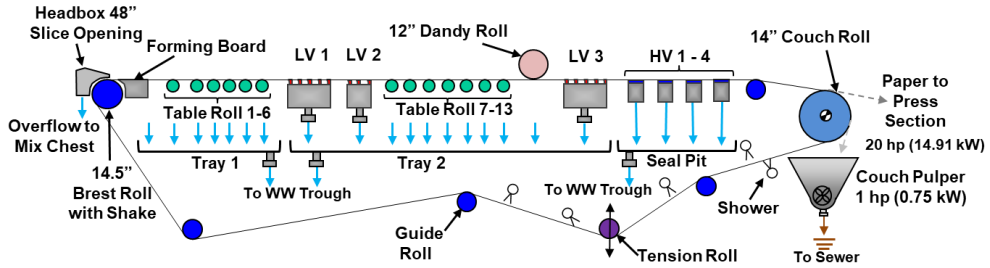
In general, based on experience, the solids content of the paper product leaving the Fourdrinier section and entering the press section is approximately 34%. After the press

section the solids content is increased to approximately 40%.

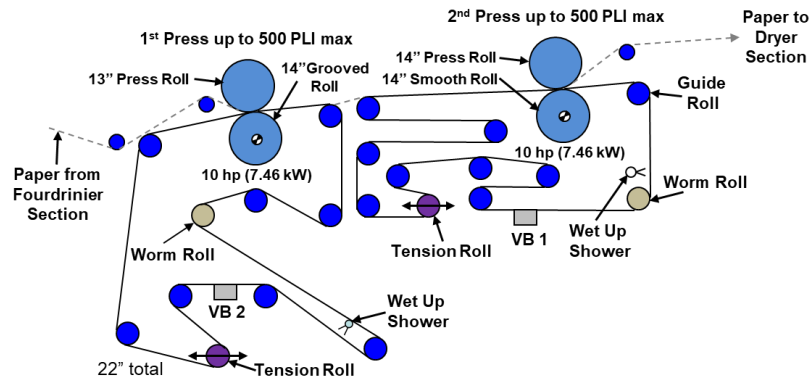
Doctor blades are used to keep the drying cylinders clean during operation. The 1st dryer section contains 13 dryer cylinders. The first dryer cylinder has a diameter of 24" (609.6 mm). The remaining dryer cylinders have a diameter of 48" (1219.2 mm). The dryer section is driven by interlocking gear drive powered by a 30 hp (22.37 kW) electromotor. The 2nd dryer section contains five 48" (1219.2 mm) diameter drying cylinders driven by an interlocking gear drive powered by a 20 hp (14.91 kW) electromotor. All dryers in the drying section are supplied with steam at a pressure of up to 15 psi (103.42 kPa).

The two dryer sections of the SCFPM, as shown in Fig. 3, contain eighteen dryer cans D1 to D18. The seam supply for the first dryer section was at 7.5 psi (51710 Pa) and for the second dryer section at 10 psi (68947 Pa). For the blotting paper production run dryer can D1 to D10 were operated in the first dryer section at a temperature of up to 173°F (78.3°C), Dryer can D11 and D12 were not heated. In the second dryer section Dryer can D 14 to D 16 were heated with temperatures of up to 239°F (115°C). Dryer can D17 and D18 were not heated. The produced art paper for screen printing had a dry content of 95± 2%.

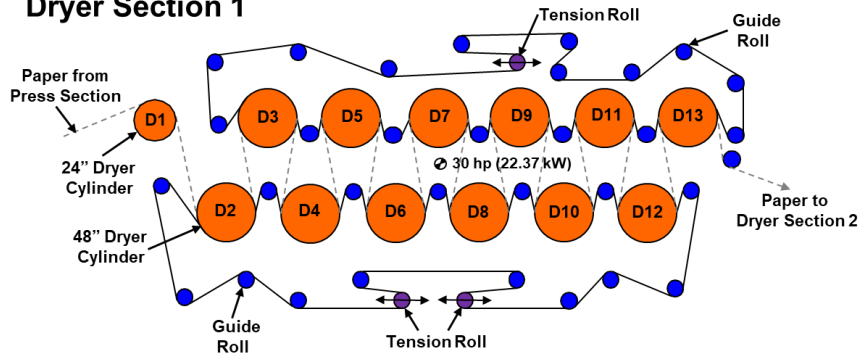
Fourdrinier Section



Press Section



Dryer Section 1



Dryer Section 2, Calendar and Reel

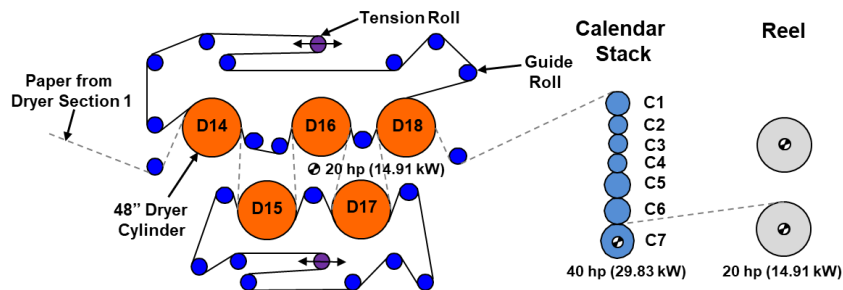


Fig. 3. 48-inch small commercial Fourdrinier paper machine [4]

Afterwards, the drying section the paper is transferred through a 7-roll vertical calendar stack. The first roll (top) has a diameter of 14" (355.6 mm) and a weight of 4000 lb (kg). The 3rd, 4th, and 5th roll have a diameter of 10" (330.2 mm) and a weight of 2500 lb (kg). The 5th and 6th roll have a diameter of 13" (330.2 mm) and a weight of 4000 lb (kg). The 7th roll is the supporting and drive roll with a diameter of 20" (508 mm) and is driven by a 40 hp (29.83 kW) electro motor.

For blotting paper manufacturing operation, the calendar stack was not used and the paper fed through the calendar stack without applying a load. This allowed the sheet to retain bulk and thereby created a more absorbent blotting paper.

The finished paper is rolled up at a two-roll reel section of up to approximately 750 lb. (340 kg) each. The reel is powered by a 20 hp (14.91 kW) electro motor. The SCFPM can produce a finished paper product with a basis weight between 20 g/m² and 750 g/m² at a width of up to 44" (1,118 mm) at a maximum speed of up to 350 ft/min (106.7 m/min).

The total installed electrical power of the wet end system, the SCFMP, and SCFPM vacuum system is 83 hp (61.89 kW), 151 hp (112.60 kW), and 100 hp (74.57 kW) respectively, with a total installed electrical power of 234 hp (174.49 kW) for the complete paper production system.

The steam for the FCFPM dryer section is supplied as low-pressure steam at 15 psi (103.42 kPa).

A winding station is used to wind the paper on a smaller core for later converting/cutting the paper from the roll into approximately 44-inch x 36-inch (1118 mm x 914 mm) sheets, which can then later be converted into any paper sheet size needed. For the blotting paper run the large paper sheets are cut into 8" (203 mm) by 10" (254 mm) blotting sheets for later use in the papermaking laboratory testing.

3. RESULTS AND DISCUSSION

All tests for this research and development project were performed in accordance with the referenced TAPPI and ISO methods. All results stayed in the precision statements for the referenced TAPPI and ISO methods.

3.1 Blotting Paper Properties

Table 1. shows the paper properties required for the manufactured blotting paper that need to be tested according to the TAPPI standard T205 sp-06 [16] for the targeted basis weight of 270 g/m² and 320 g/m². Both basis weights represent different blotting paper, and therefore will show different paper properties.

The produced blotting paper on the 48-inch SCFPM with targeted basis weight deviation of ± 10 g/m² s was achieved, having 269.8 g/m² and 322.6 g/m² for the 270 g/m² and 320 g/m² targeted bases weight respectively. However, paper tests were performed as required by TAPPI T 402 sp-08 [20] at a temperature of 23°C ± 1 °C and a humidity of 50% ± 2 %. This increased the basis weight of the 270 g/m² and 320 g/m² to 293.3 g/m² and 348.1 g/m² respectively.

The thickness of the manufactured blotting paper was 484 μ m for the 270 g/m² and 566 μ m 320 g/m² targeted bases weight respectively.

The wet tensile index and stretch was 0.9 Nm/g and 3.54% and 0.94 and 4.04 % for the 270 g/m² and 320 g/m² targeted bases weight respectively. Due to the heavier paper grade the stretch of the blotting paper increases and therefore was greater than 2.5% as required for a 250g/m² basis weight blotting paper.

The water absorbance measured as Cobb value was 44.42 mL/s for the top side and 25.43 mL/s for the bottom side (wire side) of the 270 g/m² blotting paper, meeting the minimum required properties of 25 mL/s according to TAPPI T 205-sp 06 [16]. The 320 g/m² blotting paper has a water absorbency of 27.91 for the top side and 20.55 mL/s for the bottom (wire side). Both blotting paper show a lower water absorbance for the wire side. This can be explained with a higher compacted paper structure at the wires side of the paper. For the wire side of the 320 g/m² blotting paper the minimum requirements of 25 mL/s were not met, most likely due to the more compact structure of the paper sheet. However, the blotting paper can still be used, because the top side (smother side of the blotting paper) is used as receiving surface on which the paper handsheets are couched on.

Both blotting paper basis weights met the minimum total absorbency requirements of the blottingpaper of 500 \pm 50 g/m².

Table 2 shows the additional paper properties that were tested. The burst index for the 270 g/m² and 320 g/m² targeted bases weight was 0.57 kPa*m²/g and 0.61 kPa*m²/g respectively. The porosity for the blotting paper with a target basis weight of 270 g/m² and 320 g/m² was 332 mL/min and 357 mL/min and 357 mL/min and 469 mL/min for the top and wires side respectively. This can be explained with a higher compacted paper structure at the wires side of the paper. The smoothness values reached 2,508 mL/min for the top and 2,743 mL/min for the wire side for both the 270 g/m² and 320 g/m² blotting paper, because it was manufactured on the same machine using the same supporting wires and felts. The wire side tends to be the lower smoothness (higher air flow) due to the imprint of the wire structure in the paper. The top side is contacting the drying cylinder surface and

therefore tends to be the smoother side (less air flow).

The tear index for the 270 g/m² and 320 g/m² targeted bases weight was 10.32 mNm²/g and 11.09 mNm²/g for the machine direction (MD) and 8.10 mNm²/g and 8.70 mNm²/g for the CD of the paper machine respectively.

Tensile index, elongation, and Tensile Energy Absorption (TEA) in MD of the paper machine were 28.03 Nm/g, 0.67% and 5.29 J/m² for the 270 g/m² and 28.91 Nm/g, 0.69% and 5.46 J/m² for the 320 g/m² blotting paper. For the CD paper machine direction 18.36 Nm/g, 3.11% and 12.57 J/m² were achieved for the 270 g/m² blotting paper and 18.94 Nm/g, 3.21% and 12.97 J/m² for the 270 g/m² blotting paper.

Table 1. Blotting paper properties

Measurement	Value	
Basis weight OD Target [g/m ²]	270	320
Basis weight OD [g/m ²]	269.8	322.6
Basis weight Cond [g/m ²]	293.3	348.1
Thickness [µm]	484	566
Wet Tensile Index [Nm/g]	0.9	0.94
Stretch CD [%]	3.54	4.04
Cobb Top Side [mL/s]	44.42	27.91
Cobb Wire Side [mL/s]	25.43	20.55

Table 2. Additional blotting paper properties

Measurement	Value	
Basis weight Cond [g/m ²]	293.3	348.1
Burst Index [kPa*m ² /g]	0.57	0.61
Porosity Top Side [mL/min]	332	357
Porosity Wire Side [mL/min]	436	469
Smoothness Top Side [mL/min]	2508	2508
Smoothness Wire Side [mL/min]	2743	2743
Tear Index MD [mNm ² /g]	10.32	11.09
Tear Index CD [mNm ² /g]	8.10	8.70
Tensile Index MD [Nm/g]	28.03	28.91
Elongation MD [%]	0.67	0.69
TEA MD [J/m ²]	5.29	5.46
Tensile Index CD [Nm/g]	18.36	18.94
Elongation CD [%]	3.11	3.21
TEA CD	12.57	12.97

According to T 205 sp-06 [16], the manufactured blotting paper should contain no dirt and shall have a white color. The optical properties of both 270 g/m² and 320 g/m² blotting paper, manufactured with a 48-inch SCFPM, had the same values, because the manufacturing process, machinery, and fiber raw material used were the same. For the opacity, measured according to ISO 2471 [29], a value of 99.98% resulted. Brightness measured according to ISO 2470 [28] was 86.89%. The achieved CIE (Commission Internationale de l'Éclairage; engl. International Commission on Illumination) whiteness and colour measured according to ISO 11476 [30] was 76.03% for the whiteness, and 96.43% for the L* value, -0.93 for the a* value, and 3.33 for the b* value.

4. CONCLUSION

The present project work describes the manufacturing of an blotting paper product with an OD basis weight target of 270 g/m² and 320 g/m². The blotting paper was manufactured from northern bleached hardwood, sulfite softwood, northern bleached softwood, and cotton pulp on a 48-inch small commercial Fourdrinier paper machine.

The produced blotting paper had an OD basis weight of 269.8 g/m² and 322.6 g/m² and a conditioned basis weight for testing purpose of 293.3 g/m² and 348.1 g/m² respectively, with a thickness of the manufactured blotting paper of 484 µm for the 270 g/m² and 566 µm for the 320 g/m² bases weight. The wet tensile index and stretch was 0.9 Nm/g and 3.54% and 0.94 and 4.04 % for the 270 g/m² and 320 g/m² bases weight. Water absorbance was measured with values of 44.42 mL/s for the top side and 25.43 mL/s for the wire side for the 270 g/m² blotting paper and 27.91 for the top side and 20.55 mL/s for wire side of the 320 g/m² blotting paper. The minimum total absorbency requirements of of 500 ± 50 g/m² was achieved for both basis weights.

Additional paper properties tested included burst. The burst index for the 270 g/m² and 320 g/m² of 0.57 kPa*m²/g and 0.61 kPa*m²/g respectively. Porosity of the blotting paper with a basis weight of 270 g/m² and 320 g/m² was 332 mL/min and 357 mL/min and 357 mL/min and 469 mL/min for the top and wire side respectively. The smoothness values reached 2508 mL/min for the top and 2743 mL/min for the wire side for both basis weights produced.

The tear index for the 270 g/m² and 320 g/m² bases weight was 10.32 mNm²/g and 11.09 mNm²/g for the MD and 8.10 mNm²/g and 8.70 mNm²/g for the CD respectively.

Tensile index, elongation and TEA in MD were 28.03 Nm/g, 0.67% and 5.29 J/m² for the 270 g/m² and 28.91 Nm/g, 0.69% and 5.46 J/m² for the 320 g/m² blotting paper. For the CD 18.36 Nm/g, 3.11% and 12.57 J/m² were achieved for the 270 g/m² blotting paper and 18.94 Nm/g, 3.21% and 12.97 J/m² for the 270 g/m² blotting paper.

Opacity of 99.98%, brightness of 86.89%, whiteness of 76.04% and a color of 96.43% for the L* value, -0.93 for the a* value, and 3.33 for the b* value.

The manufactured blotting paper has been successfully used for the manufacturing of paper handsheets utilizing TAPP T 205 sp-12 [16], producing handsheets with basis weights between 20 g/m² and 300 g/m² utilizing virgin and recycled fiber material.

DISCLAIMER

The products used for this project are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing entity rather it was funded by personal efforts of the authors.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
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