BHS
CORRUGATED

REQUIREMENTS ON PERSONNEL, PAPER, STARCH AND STEAM

for Good Quality at High Speeds

Revised edition dated November 02, 2004

Sheet 1 to Sheet 13

We reserve the right for changes serving technical progress.
The testing method on the sample taking has to be carried out according to VDW, FEFCO and TAPPI Standards.

1. Paper

The usual paper grades used according to VDW, VPW, FEFCO and TAPPI recommendations for liners and media must, in respect to their runnability, have the following properties:

* paper moisture corresponding to the nominal value of the respective paper grade
* constant paper moisture (± 1 % in and across machine direction)
* optimum water absorption / Cobb / drop test
* optimum tensile stresses
* clean, well cut front edges without damage of the front sides of the paper rolls
* paper shrinkage must be < 0.4 % of the paper width
* exact design of the splice joints in the roll on the rewinding device after the paper machine (no web overlaps)
* uniform and flat, tightly wound paper rolls over total roll-diameter (criterion: e.g. hammer test) to ensure perfect flute formation and bonding and sufficient flatness at the intended speeds. Unwinding of the paper webs from the roll must be uniform and smooth across the working width.
* heat- and scratch-resistant surface with coated liner

During production, the use of

- extremely bouncing of paper rolls
- warm "green" rolls, which means rolls that are still warm from the paper machine
- very cold paper rolls
- extreme deviation from the nominal values
- eccentrically and non-uniformly wound paper rolls
- coated papers
- strongly sized and size-blocked papers (nearly no water absorption)
- extreme shrinking of papers (media and liners) > 0.5 % and a combination of different papers with an extreme heterogeneously composition referring to the type of paper and basis weight

will result in production restrictions and non-flat sheets, resulting in reduced production speed.

Paper Composition

- Extreme difference of papers i.e. type of paper and basis weight, etc. results in a reduced runnability
- Liners with **more** than ± 1 % of moisture difference across the working width have a reduced flatness
- Liner papers with a lateral shrinkage of more than 0.5 % have a reduced flatness (warp)
- Media with a shrinkage of more than 0.5 % have a negative effect on flatness (formation of longitudinal creases)

2. Starch

Starch adhesives with a solids content of 23 - 28 %, a gelatinization temperature of approx. 52 - 56 °C, a constant viscosity of approx. 50 - 65 sec. Steinhall (values measured in the glue pan).
The exact starch composition is coordinated and adjusted to the production conditions (quality mix, etc.) in cooperation with the starch supplier after start-up.
It is necessary to preserve and disinfect the starch adhesive at reasonable intervals.
The starch temperature in the starch kitchen should be between 25 - 30 °C.
It is not recommended to use color-tainted water and mains water for starch preparation. Fungal growth may occur.

3. Steam

Sufficient and constant supply of saturated steam (min. 14 or 15 bar of saturated steam in the main pipe of the corrugator), optimum condensate removal and sufficient pressure differential between supply (= feed) and return (= exit).

Modul Facer or Mono Facer
Differential pressure between supply (= feed) and return (= exit) with peripherally drilled corrugating rolls min. 3 bar.

Recommendation: 8 t/h boiler performance for double-wall corrugator (double-double face).
Design pressure of steam boiler: 18 bar, pressure reduction to 14 or 15 bar in the main steam pipe on connection to the corrugator (boiler house in the area of the corrugator). Professional pipe laying and dimensioning are prerequisites.

The feed-water/fresh water preparation for boilers with thermal degassing at approx. 105°C.

The fresh water (untreated water) must have been softened.

Well insulated supply pipes and condensate vessels are not included in the scope of delivery of BHS. Please observe that they, however, are absolute necessary at the prerequisite.

Optimum and professional maintenance of the steam system and reliable condensate return are required.

A degassed steam and condensate unit is prerequisite.

4. General Prerequisites

1. Flat infeed across the working width of the paper webs (no web snatching).
2. Uniform paper caliper, basis weight and moisture etc. across the working width.
3. No moist streaks.
4. No damage of the front sides of the paper rolls.
5. No foreign matters in the paper (bitumen, wax, plastic, sand, quartz, aluminium etc.)
6. Uniform glue application across the working width
7. Recommended air change: 5- to 7-fold air change/hour in the section of the corrugator
8. Clean, smooth and sealed floors for the corrugator and in the paper warehouse, no bitumen coating, no sand and concrete grains, etc. (corrugating roll damage).
9. Perfect dewatering, deaeration and degassing of the steam and condensate system of the corugator
10. The core quality must be designed for high speeds of the corrugator and must not wear, break or tear, etc. The cores must be manufactured in one piece across the entire working width and must be stable under axial loading (according to DIN ISO 11093-1):
    - inner ∅ 100 mm ± 0.5 mm
    - outer ∅ 120 mm ± 0.5 mm
    - moisture 7-9 %
    - straight cores
    - length to paper width + 0 mm / - 3 mm

General Conditions

Stops occurring during the test runs, which means operational test, performance tests and availability tests are generally excluded. These stops are to be deducted from the overall operating time and to be taken into consideration on calculation of the average speed of the corrugator.

Stops are for example caused by:

- intended stops for maintenance
- cleaning of the corrugator per shift (approx. 20 to 30 minutes)
- flute change
- operational errors
- insufficient maintenance
- non-observance of BHS-instructions
- lack and inadequate raw materials (paper, starch, etc.)
- lack and inadequate aids (e.g. splicer tape, etc.)
- energy problems (no power, no steam, no compressed air, no cooling water, etc.)
- insufficient maintenance according to the maintenance instructions of the manufacturer (e.g. low oil level in the gear box, etc.)
- production jam (no operating transport system, no forklift truck, etc.) on the converting machines after the corrugator
- lack of orders / poor coordination, combinations, etc.
- use of poor raw material, for example paper, steam, etc.
- coffee breaks
- insufficient communication
- etc.

5. Requirements on the Personnel Provided by the Customer

For mechanical and electric installation, maintenance and operation of a heavy-duty corrugator, we require the following from our customer personnel:

a) committed personnel with sufficient management support
b) experienced installation and service personnel with relevant mechanical, electrical, electronic or packaging qualifications
c) qualified operating personnel
d) willingness for further education and training by the machine manufacturer

Explanations for the terms: see “Index” on pages 7-12:

TSI = Tensile Stiffness Index (kNm/g or MNm/kg) for the paper measured with the ultrasonic method.

TSO = is the measure of the TSI deviation of the sheet of the machine direction. TSI values are normally between 3 – 15 kNm/g, whereas TSO values are normally within the scope of 3 degrees.

TSO angle ± 5°. The TSO angle reflects elasticity properties of the paper sheet. Deviations lead to production restrictions and non-optimum flatness.

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SCHRENZ

Nominal Values

Caliper	e.g. 120 g/m² - approx. 0.19 mm
Air permeability according to Gurley 100 ml of air	35 s ± 10 %
Moisture content	with a basic moisture of 7 % no higher deviations, however, than a total of ± 1 % of moisture content across the paper width
Drop test (0.02 ml of water) bonding side	approx. 25 - 50 s
Tensile power in machine direction	min. 4 KN/m

For test runs, paper of the customer is used. This paper is to correspond to the prerequisites prescribed by BHS to ensure optimum production.

Index:
Precondition is an optimal fibre orientation (optimal TSO angle, optimal TSI value).

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SEMICHEMICAL PAPER

Nominal Values

Caliper in mm:	110 g/m² - approx. 0.17 mm 112 - 127 g/m² - approx. 0.18 - 0.25 mm 160 g/m² - approx. 0.26 mm
Air permeability according to Gurley 100 ml of air	35 - 80 s
Moisture content	with a basic moisture of 8 % - 9 % no higher deviations, however, than a total of ± 1 % of moisture content across the paper width
Drop test (0.02 ml of water)	approx. 30 – 50 s

For test runs, paper of the customer is used. This paper is to correspond to the prerequisites prescribed by BHS to ensure optimum production.

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MEDIUM - WELLENSTOFF (RECYCLED MATERIAL)

Nominal Values

Caliper	110 g/m² - approx. 0.17 mm
Max. grammage allowance	112 - 120 g/m² - approx. 0.18 – 0.20 mm 160 g/m² - approx. 0.26 mm 125 - 150 g/m² - approx. 0.20 – 0.25 mm
Air permeability according to Gurley 100 ml of air	35 – 65 s
Moisture content	with a basic moisture of 8 % no higher deviations, however, than at total of ± 1 % of moisture content across the paper width
Drop test (0.02 ml of water) approx.	40 - 100 s
Tearing strength in machine direction	according to standard values 4.000 – 6.000 m breaking length) for media at high speeds

Tensile power in
machine direction min. 4 KN/m

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TESTLINER

Nominal Values

Bursting strength	125 g/m² up to 200 g/m² TL1 > 300 kPa or 3.0 TL2 >250 kPa or 2.5 TL3 > 200 kPa or 2.0 Bursting strength (kPa) x 100 g/m² Weight per square meter (g/m²) e.g. $\frac{250 \text{ kPa} \times 100 \text{ g/m}^2}{125 \text{ g/m}^2} = 200 \text{ kPa}$ or $\frac{250/\text{kPa}}{125 \text{ g/m}^2} = 2.0$ a bursting strength below 200 kPa or 2.0 means Schrenz
Air permeability according to Gurley 100 ml of air	30 sec - 80 sec. / max. 90 sec.
Moisture content	with a basic moisture of 7 % - 8 % no higher deviations, however, than a total of ± 1 % of moisture content across the paper width

Surface structure (Bendtsen smoothness)	1500-2000 ml/min
Slip angle	≥ 18° TAPPI-542 > 22° DIN
Drop test (0.02 ml of water) bonding side	approx. 40 - 125 s TL1/TL2: inside < 120 outside approx. 120
Cobb test (1 min): outside	25-60 g/m²

We assume that the testliner papers T1-T2-T3 have the same good running properties and moisture profiles, etc., and that the only difference is the bursting strength.

For test runs, paper of the customer is used. This paper is to correspond to the prerequisites prescribed by BHS to ensure optimum production.

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KRAFTLINER
(uncoated)

Nominal Values

Air permeability according to Gurley 100 ml of air	40 – 80 s exception: uncoated medium
Moisture content	8 % - 8,5 % no higher deviations, however, than a total of ± 1 % across the paper width
Surface structure: (Bendtsen smoothness)	1500-2000 ml/min
Slip angle	≥ 18° TAPPI-542 > 22° DIN
Drop test glue side of corrugator 0.02 ml of water:	approx. 40 – 125 s
Cobb test (1 min): *(outside)*	25-60 g/m²

For test runs, paper of the customer is used. This paper is to correspond to the prerequisites prescribed by BHS to ensure optimum production.

Index:
Precondition is an optimal fibre orientation (optimal TSO angle, optimal TSI value).