BILLERUD

SACK SOLUTIONS

HANDBOOK

FOR SACK KRAFT PAPERS AND PAPER SACKS

The purpose of this Handbook is to provide a set of useful information for people dealing with sack kraft paper, as well as for producers and end users of paper sacks.

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A SHORT PRESENTATION OF BILLERUD

Billerud is a packaging paper company with a business concept to supply customers with innovative and high quality packaging paper and solutions.

A consistent concentration on attractive market segments and a sharp customer focus are the cornerstones of Billerud's strategy.

Billerud focuses on sack paper, kraft paper and packaging boards, and has a world-leading position within several product segments. Examples of interesting and demanding product areas include sack paper for the toughest demands, packaging for medical devices, flexible packaging for the food industry, and paper for packaging boards used to transport demanding products such as domestic appliances and fruit and vegetables.

Billerud's production takes place at the Group's three integrated pulp and paper mills in Sweden, Gruvön, Karlsborg and Skärblacka and at the UK paper mill, Beetham. The white sack paper is mainly produced in the Karlsborg mill, and the brown grades in Skärblacka, but also our Gruvön mill produces significant volumes of sack paper.

For further updated information, please visit:

www.billerud.com

Salesoffices

Headoffice

Production units

SACK SOLUTIONS

Billerud makes the best sack paper in the world. But that is no reason for taking it easy. We want more. Through the years we have gained solid experience and considerable know-how when it comes to the value chain for sacks. This gives us the strength to both identify and solve problems with existing sacks and to develop new and innovative solutions. And now we have gathered everything under one roof – Billerud Sack Solutions.

SACK KRAFT PAPER

Scandinavian sack kraft paper is the strongest paper known to man. The main reason is the high quality raw material, with fibres from trees, which have grown very slowly due to the harsh Scandinavian climate. This makes the fibres extremely long and strong.

PAPER PROPERTIES AND TESTING METHODS

Paper properties are measured in the machine direction (MD) and in the cross direction (CD), since there are significant differences in the properties, depending on the orientated fibre flow out of the headbox on the paper machine.

If the index of a certain property is needed, it should be calculated by dividing the actual value with the grammage for the paper in question. Please observe that the units of the property then might change.

PAPER TESTING CLIMATE (ISO 187)

The paper sample must be conditioned in the standard climate to reach equilibrium moisture before testing. Standard climate for paper testing is 50% RH (relative humidity) and 23°C. The reason for conditioning is that the paper properties are strongly dependent of the paper moisture.

GRAMMAGE, g/m² (ISO 536)

The grammage, basis weight, is measured by weight and surface area. In on-line measurement the grammage is measured by beta radiation.

TENSILE STRENGTH, kN/m (ISO 1924/3)

The tensile strength is the maximum force that the paper will withstand before breaking. In the test a stripe of 15 mm width and 100 mm length is used with a constant rate of elongation. The tensile strength is one parameter in the measurement of the TEA, the most important sack paper property. In the same test the tensile strength, the stretch and the TEA value are obtained.

WET TENSILE STRENGTH MD, "WET STRENGTH", kN/m (ISO 3781)

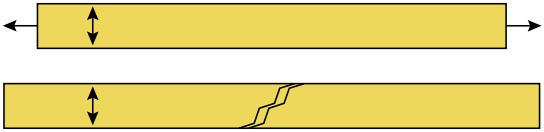
After the test piece has been saturated, the tensile strength is tested in the same way as for a dry paper. For sack paper the test method is used for paper with wet strength resin added. Before testing it must be made sure that the wet strength has fully developed (depending on time and temperature). The relative wet strength is the relation between the wet tensile strength (MD) and the dry tensile strength MD. The wet strength is important e.g. for root crop sacks and refuse sacks.

TENSILE ENERGY ABSORPTION (TEA), J/m² (ISO 1924/3)

TEA is the main paper property for calculating the strength of the paper sack wall. This is verified by the correlation between TEA and drop tests. By dropping a sack the filling goods will move when reaching the floor. This movement means a strain on the sack wall. To withstand this strain the TEA should be high, which means that a combination of high tensile strength and good stretch in the paper will then absorb the energy.

STRETCH, % (ISO 1924/3)

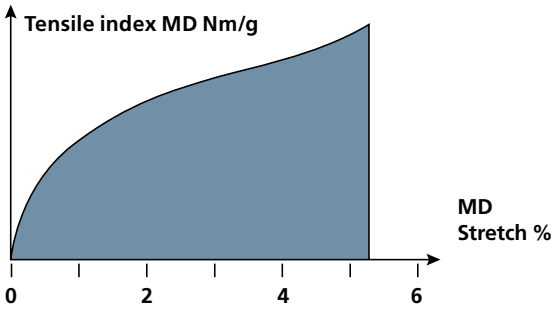
For sack paper the stretch is an important property. The stretch is a measurement of the elongation of the paper extended to rupture. The stretch is very important for the TEA value.



TEAR STRENGTH (TEARING RESISTANCE), mN (ISO 1974)

The tearing force is the force required continuing the tearing from an initial cut in a paper sheet. The tear strength is important for e.g. sewn sacks where the needle holes can be a source of an initial cut.

This diagram shows that TEA is the combination of tensile strength and stretch. The TEA is the coloured area under the curve.



BURST STRENGTH, kPa (ISO 2758)
The burst strength is a measurement of the maximum pressure, which is possible to apply on the paper in a right angle to the surface. A bulging circular elastic diaphragm applies the pressure.

COBB 60s, g/m² (ISO 535)
The sizing of the paper is measured as a Cobb-value. This is the amount of water absorbed by the paper surface in a given time. Most common is Cobb60 where the time is 60 sec.

MOISTURE CONTENT, % (ISO 287)
The moisture content is measured by weighing the sample before and after oven drying at 105°C.
The moisture content is dependent on the surrounding climate and influences most of the paper properties. The moisture content is measured on-line in the paper machine.

FRICTION COEFFICIENT, (NO UNIT) (ISO 15359)
The paper friction is important for good palletising properties of the filled sacks. However the friction is very much influenced by printing and general handling. The friction coefficient can be measured in many different ways, but the ISO standard method is recommended.

AIR RESISTANCE GURLEY, s (ISO 5636/5)
The air resistance is a measurement of the time taken for 100 ml of air to pass through a specified area of the paper sheet. Short time means a highly porous paper, notice that this can be described as high air permeance as well as low air resistance. For valve sacks with powdered goods a highly porous paper gives higher filling speed, smaller sack volume and a cleaner filling process.

SURFACE ROUGHNESS (BENDTSEN, PPS, SHEFFIELD, BEKK, ETC.)
The surface roughness will very much affect printing, lamination and other demanding surface treatments. However, roughness has no direct relation to friction.

BRIGHTNESS, % (ISO 2470)
High brightness gives a good general appearance to printing. The brightness is the amount of the incoming light that will be reflected by the paper surface.
The measurement is made with blue light, wavelength 457 nm.

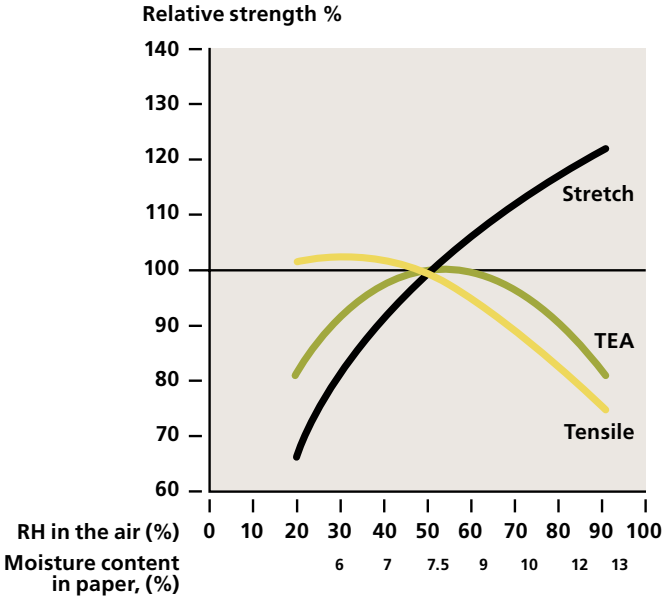
GLOSS, %
The gloss is the paper ability to reflect the incoming light in a specified angle. The paper gloss increases by claycoating and calendering of the surface.

OPACITY, % (ISO 2471)
A high opacity is important for the appearance of the packaging, so that an underlying brown paper or the content of the bag is not to be visible.

In addition to the above tests your supplier can measure many other properties that are essential for specific applications. On pages 44-46 are the most important testing methods and conversion factors listed.


LINE IND.
CC
100
50
150
25
200
300
GURLEY SEC.
ZERO
SEC

MOISTURE INFLUENCE



Paper is a hydrophilic material. This means that the moisture in the surrounding air influences the paper properties.

In a climate with high relative humidity the paper will have higher moisture content and opposite in a drier climate. Therefore all paper testing should take place in a standardised climate of 50% RH and 23°C.

The variations of TEA, tensile strength and stretch with relative humidity in the air, are shown in the figure. Stretch increases with high moisture, tensile strength decreases. TEA has an optimum at 7 - 10% moisture contents in the paper, corresponding to 40 - 70% relative humidity. But also at very low paper moisture, for example after filling with hot cement of 90 - 100°C, still a major part of the TEA is left.

WRAPPING AND STORAGE

The reason for wrapping the reels carefully is to avoid damage or contamination during handling. Additionally a PE-coated wrapping keeps the moisture content of the material at a stable level, this is important for good runability at the sack producer and end user.

An optimised stock level should be held to ensure a fluent operation at the sack converter with regard to raw material demand as well as to delivery fluctuations.

BASIC RULES

- Keep the reel wrapping in place on the reels as long as possible.
- Allow 24 hours storage time for the reels in machine/ printing room for conditioning, with the wrapping on.
- Use a well-ventilated warehouse with preferably a temperature of 0 - 25 °C.
- Avoid extreme atmosphere and temperature variations.
- Handle stored materials with care.
- Store reels on the end, and arrange reels so that their labels are clearly visible.
- Keep cleanness and order in the warehouse with good access to the stored material.
- Use clamp trucks for reel handling.
- Train the personnel in handling techniques.

PAPER SACKS

The fact that the paper quality is most important for the sack quality and the cost efficiency in the distribution system, is well known world-wide. The development of high quality extensible papers, with excellent cross direction properties, has made a major contribution in that respect.

PAPER SACKS STRENGTH

For filling and handling systems in general we recommend balanced TEA-values according to the following table.

HANDLING CONDITIONS

	NORMAL	TOUGH
Balanced TEA for 25 kg - sack J/m²	330-390	400-450
Balanced TEA for 50 kg - sack J/m²	430-490	500-550

Balanced TEA-values may be calculated from the machine and cross direction values by use of the following formulas.

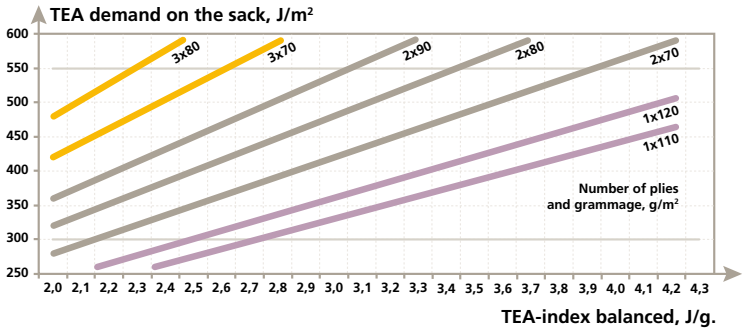
Geometrical TEA = $\sqrt{(\text{TEA MD x TEA CD})}$

Balanced TEA could also be calculated as:

0.43 TEA MD + 0.57 TEA CD	For a 4-ply sack
0.37 TEA MD + 0.63 TEA CD	For a 3-ply sack
0.31 TEA MD + 0.69 TEA CD	For a 2-ply sack
0.27 TEA MD + 0.73 TEA CD	For a 1-ply sack

These formulas are used for paper qualities where TEA CD shows lower value than TEA MD.

THE IMPORTANCE OF TEA FOR THE SACK CONSTRUCTION. NONPERFORATED SACKS



From the diagram we can see the following:

» To reach 400 J/m² when a low quality paper is used with a balanced TEA-index of 2.25 J/g, the sack must be made of 2-ply of 90 g/m² each.

» High quality paper, with a balanced TEA-index of 2.9 J/g, makes it possible to use 2 ply of 70 g/m²-paper for the same total sack strength.

» A single-ply sack, for 25 kg goods, can be made of a 110 g/m² paper with a TEA-index of 3.65 J/g. The TEA-value will then be 400 J/m².

Today Billerud deliver sack paper grades with very high balanced TEA index. This means there are great possibilities to reduce packaging material by use of Billerud papers.

CALCULATIONS FOR PAPER SACKS

THE SACK STRENGTH AND MATERIAL REDUCTION WILL BE BEST CALCULATED WITH THE BILLERUD SACK CALCULATION TOOL, A PROGRAMME SUITABLE FOR MOST COMPUTERS AND AVAILABLE FOR BILLERUD CUSTOMERS.

Paper Quality	Total TEA needed in the sack	Balanced TEA index of paper	Total grammage in sack	Grammage of each ply		Weight of each sack	Material reduction	Amount of paper needed
				2- ply	3- ply	at 1 m^2 sack surface		for 1 million sacks
	J/m^2	J/g	g/m^2	g/m^2	g/m^2	g	%	tonnes
Supplier 1, unperforated sacks	450	2.15	210		70	210	0	210
Supplier 1, perforated sacks *)	450	1.88	240		80	240	-14	240
Brown QuickFill SE	450	3.25	140	70		140	33	140

*) The perforation reduces the TEA-index by 13% in this example.

The reduction of packaging material also brings the following advantages:

» Less transport costs for the reels.

» Less paper per sack – better profitability.

» Less paper in stock per million sacks produced (less capital in store).

» Fewer reel changes in the tuber.

» More sacks per pallet – less transport costs.

» Faster filling thanks to better total porosity.

» Better tear strength of each ply – if fewer layers but higher grammage is used.

Billerud sack paper is among the strongest paper in the world. The main reason is a high-quality fibre raw material from trees which have grown slowly in a harch Scandinavian climate.

POROSITY FOR VALVE SACKS

The ability of sack paper to allow air to pass is often specified as Gurley value in seconds. Following the increased demand of high filling speeds, the demand for porous papers has increased, i.e. a decrease of the Gurley levels from 20 sec. to 3 sec. over the last 20 years. Billerud QuickFill papers have 3 - 5 sec. Gurley. Sacks filled with powdered materials like cement, gypsum, clays, fine-grained sugar, etc, require a paper with very good porosity.

ADVANTAGES OF HIGH POROSITY PAPER

The sack will be exposed to less strain during filling, therefore a lower sack breakage could be expected. The air escapes quicker from the filled sacks and therefore the size of the sack can be reduced; experience shows that a reduction of 4 - 10 % is possible. Perforation of the sack is no longer necessary, which then reduces dusting at filling and gives a better environment and cleaner sacks. Perforation of the sack reduces the TEA value by at least 10 - 20%.

PRODUCTION OF POROUS PAPER

Normally the strength of a paper is increased by refining of the fibres. The disadvantage of traditional refining (low consistency) is that this also makes the paper less porous. High consistency refining develops the stretch of the paper without reducing the porosity to any appreciable extent. The latest development is the production of highly porous papers in combination with very high strength values.

FREE-FILM AND POROUS PAPERS

When a free-film, perforated or slitted, is incorporated in the sack construction, the total porosity of the sack will be reduced. In such cases it seems unnecessary to use highly porous papers. That is however not true. Extensive studies show that a combination of free-film and porous papers give an acceptable permeability of the sack, especially when the film has a rather open area.

The water vapour transmission rate (WVTR) increases with the open area of the film. Therefore it will be a compromise between sack permeability and WVTR value. A very high porosity of the paper, and a somewhat less open free-film, may result in a sack with sufficient porosity, but still acceptable protection from moisture.


25 KG
HOCHOFENZEMENT
CEM III/A-LL 32,5 R EN 197-1
CHROMATARM

PRINTABILITY AND APPEARANCE

Most paper sacks are printed on the outer ply. The main reason for printing industrial sacks is to identify the content, but there is an increasing demand for more information and improved appearance. For consumer sacks a high quality finish is an important commercial factor.

The dominant printing method in the sack industry is flexography. For simple 1 - 3 colour prints, sack paper may be printed in-line in the tubers, or more often nowadays, in separate pre-printers. Print quality as well as productivity is improved with pre-printing.

The print quality depends on the right combination of the artwork, printing press, plates, anilox rollers, colours and paper surface. The skill of the printing operators is of course also very important. Most industrial sacks are printed in 1 - 4 colours. For more demanding applications, such as consumer sacks, process pre-printing is mostly used.

FLEXOGRAPHIC PRINTING MACHINES

Flexography is the fastest growing printing method. For modern flexo presses the technology, efficiency and capacity is very much improved. For process printing the anilox rollers, colour application system, web video control, and the cleaning and drying system are all very important. New presses may be equipped with 8 - 10 colour stations. Older flexo presses can still give good print quality if the machines are well maintained and the anilox rollers regularly changed.

PRINTING INKS

Most flexo printers use water based inks. In-house colour blending systems and viscosity control are useful tools. Where friction properties are critical, it will help to reduce the area covered by ink, and to modify the ink composition.

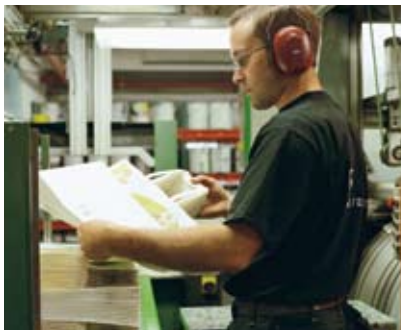
PRINTING PLATES

Photopolymer plates have gradually replaced rubber plates. For high quality process printing the trend is to reduce the plate thickness. The plate manufacturers have materials with different hardness. For rough substrates a softer plate gives improved print quality.

PAPER GRADES

Billerud has a wide range of sack kraft papers for various sack constructions as well as printing demands. For good printing results the paper grade selected should have the right appearance, formation, opacity and a generally suitable print surface.

Also brown sack paper gives a good print quality but when lighter colours, half tone printing and improved total appearance is required, white sack papers are recommended. The paper surface represents the white colour and together with the black and the three process colours; cyan, magenta and yellow, a four-colour process picture can be printed. For more demanding process printing, then calendered or clay-coated paper grades should be selected due to the optimised surface properties.



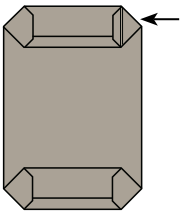
TYPES OF SACKS

There are two principal types of paper sacks, open mouth sacks and valve sacks. They may all be of one or more plies and may incorporate barrier plies for specific applications. The types may be summarised as follows:

VALVE SACKS

VALVED PASTED

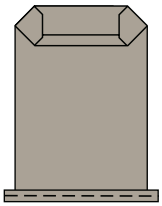
Flat sacks from flush cut or stepped end tubes. The bottoms have a hexagonal shape. The flush cut tube is the simplest way to produce a sack with folded and pasted ends. The bottoms must be capped with a rectangular paper sheet to give them sufficient strength, to improve sift-proofing and to give a flat surface, which may be used for identification data, etc.



Valved Pasted

VALVED PASTED AND SEWN

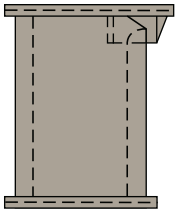
Flat sacks generally from flush cut tubes. This type of sack allows for valve filling at one end and sewing, with easy opening, at the other end. A carrying handle may be incorporated into the sewing line, but this is not appropriate if the package exceeds 15 kg in weight. When opening the sewing line the end user has easy access to the content.



Valved Pasted and Sewn

VALVED SEWN

Flat or gusseted sack from flush cut tubes only. The valve is inserted by a manual operation. The shape of the filled sack is not as good as the pasted type.



Valved Sewn

SINGLE PLY SACKS

The TEA-values of sack papers have been increased due to intensive development work during the years. The 2x70 g/m^2 sack is now standard in many countries. A further reduction of grammage may however bring some disadvantages like unstable convertability in the sack production lines. An interesting alternative is then to make 1-ply sacks of 110 or 120 g/m^2 paper. Billerud has therefore developed suitable paper grades for this application; White and Brown QuickFill Single.

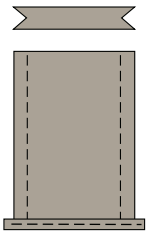
VALVE DESIGNS

The valves that may be incorporated into sacks are many and varied, they may be internal or external. Different types of material can be used, for example paper, PE, non-woven and textile. Special coatings are also in use to allow the valve to be heat-sealed using hot air, high frequency or ultra sonic. External valves may be provided with a thumbhole notch to make their opening easier. After filling external valves can be tucked by hand into the pocket formed by the fold. If necessary some valves may be made narrower than the sack end.

OPEN MOUTH SACKS

OPEN MOUTH SEWN

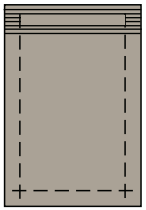
Flat or gusseted from a flush cut tube. This type of sack is easily filled using simple equipment. They are suitable for powdered, granular products, cereals and root crops.



Open Mouth Sewn

OPEN MOUTH PINCH CLOSED

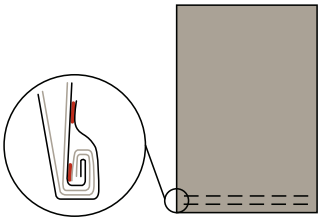
Flat or gusseted from a stepped end tube. This type of sack may be used as an alternative to a sewn sack. It may be preferred where a hermetically sealed package is required. If necessary the open end can be sealed by reactivating a pre-applied coating of hotmelt adhesive. The inside ply, if polymer coated, can be heat sealed to prevent ingress of moisture. This type of sack is particularly useful for packaging hygroscopic materials.



Open Mouth Pinch Closed
(Roll bottom, single closed)

OPEN MOUTH PASTED DOUBLE FOLD

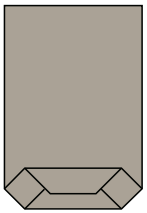
Flat or gusseted from a flush cut tube. This is a variation on the Pinch sack. This type of sack can be made with an "Easy Opening" closure whilst still giving a very good sift-proof closure.



Open Mouth Pasted Double Fold

OPEN MOUTH PASTED

From a flat tube only, generally flush cut. The bottom has a hexagonal shape, but when filled the sacks have rectangular bottoms.

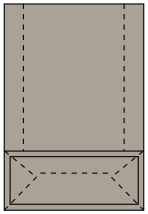


Open Mouth Pasted

These result in greater stability of the filled sacks on conveyors during top closure and also present a good flat area for the addition of extra identification data.

OPEN MOUTH S.O.S.

The sack is always gusseted. This sack is produced on a specific machine combining a tuber and a bottomer. The bottom has a rectangular shape. S.O.S. means Self-Opening Satchel.



Open mouth S.O.S.

TOP CLOSURE OF OPEN MOUTH SACKS

All open mouth sacks may have their tops closed by sewing. However pinch sacks are generally closed by reactivation of a pre-applied hotmelt adhesive and this requires the use of special equipment.

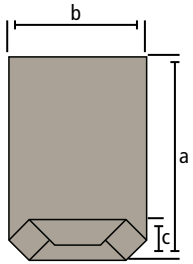
NORMS FOR PAPER SACKS

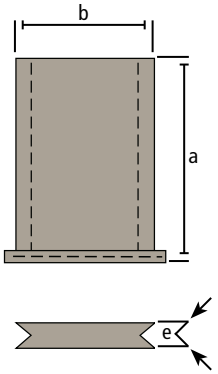
MEASUREMENT OF EMPTY SACKS (EN 26591 –1)

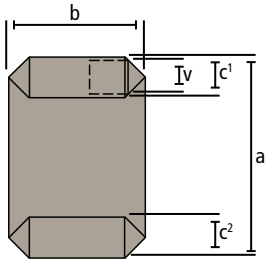
This norm specifies the method of measuring the dimensions of empty paper sacks. All dimensions are external and will be expressed in millimetres. Measurements will be made in the centre of the sack.

DEFINITIONS AND SYMBOLS:

- Length of sack (a): distance between the transverse edges of the flat sack.
- Width of sack (b): distance between the longitudinal edges of the flat sack.
- Width of gusset (e): distance between the external creases of the opened out gusset .
- Width of bottom (c): distance between the bottom edge folds.
- Width of the valve (v): internal dimension of the valve between the valve edge folds.

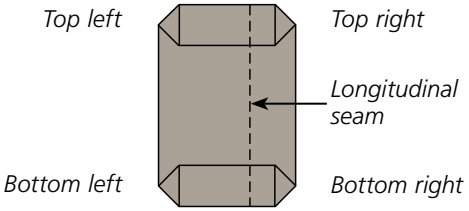






VALVE POSITION (EN 26591-1)

The following designation is applicable to both pasted and sewn valved sacks. With the longitudinal seam downward and displaced to the right of the sack, when viewed from above, the valve position shall be described as TOP or BOTTOM and as LEFT or RIGHT as shown in figure below



SACK VOLUME CALCULATION (ISO TECHNICAL REPORT 8281/1)

The ISO Committee has developed a formula giving the possibility to calculate the volume and the size of a filled sack by using the dimensions of the empty sack. The symbols of the empty sack dimensions are the same as those described in EN 26591-1.

Volume calculation for valved pasted sacks.
(V in litres, A, B, C in mm).

$V = b^2 (0.2668\ a + 0.4047\ c - 0.1399\ b) \times 10^{-6}$

Filled dimensions from flat dimensions (mm).

A (length of filled sack)
$= 1.025\ a + 1.02\ c - 0.0028\ c^2 - 80$

B (width of filled sack)
$= 0.920\ b - 0.0015\ c^2 - 35$

C (width of bottom of filled sack)
$= 0.095\ b + 0.0025\ c^2 + 58$

The choice of the filled sack dimensions is also dependent on the pallet pattern if sacks are palletised. The sack volume and other parameters could preferably be calculated with Billerud's sack calculation tool, a programme suitable for most computers.

DIMENSIONAL TOLERANCES FOR PAPER SACKS (EN 28367-1)

This norm specifies a set of tolerances applicable to the manufacture of paper sacks.

REGULATIONS TO CONSIDER

A wide range of products can be packed into paper sacks. These might then be transported world-wide by a number of different methods. It is necessary to be aware of any hazardous properties of products being packed and of any relevant National or International Regulations. The following list gives an indication of some bodies that produce regulations.

- United Nations: The recommendation on the Transport of Dangerous Goods. Commonly called the "Orange Book".
- Forschungsgemeinschaft Kraftpapiere und Papiersäcke E.V. Germany.
- FDA, Food and Drug Administration, USA.
- BfR, Bundesinstitut für Risikobewertung, Germany.
- IATA, International Air Transport Association.
- ADR, European Agreement concerning the International Carriage of Dangerous Goods by Road.
- Pira International, UK.


PENNCOZEB® DG

TESTS FOR SACKS

Drop testing of filled sacks until they break can be used to compare the relative strength of different sack constructions. This is normally made during the product development and when establishing a new sack specification.

DROP TESTS

BUTT DROP TESTS (EN 27965-1 OR ISO 7965/1)

Drop testing of filled sacks onto one end from a constant height, or regularly increasing height, will test the strength of component plies of a sack but will not test the strength of the end closures. The progressive drop height method will start from 0.3 m with an increment of 0.05 m after each drop.

FLAT DROP TESTS (EN 27965-1 OR ISO 7965/1)

Drop testing of filled sacks onto the main faces from a constant height, or regularly increasing height, will test the strength of the end closures as well as of the component plies.
The drops will be made alternatively on the front face and on the back face of the sack. The progressive height method will start from 0.85 m with an increment of 0.15 m after each drop.

FILLING TESTS

SACK POROSITY TEST

Porosity of manufactured valve sacks can be tested with special equipment by blowing air into the sack. The valved sack is mounted on an expanding spout, which ensures no leakage of air. Airflow is measured with rotameters at different pressure drops.

FIELD TRIALS

When paper sacks are being introduced into an entirely new market area, and particularly if multiple handling is involved, it is advisable to carry out at least a small initial field trial. Then all involved parties have the possibility to follow and evaluate the technical performance.

FRICTION AND PALLETISING

To get good stability of the pallets when transported a certain minimum level of friction is required. From the beginning paper normally has a good friction level, which however runs the risk of being reduced in the various production lines, mainly after printing and when filling materials act as lubricant between the sacks.

GENERAL INFORMATION

It is no longer difficult to measure friction as there is an approved ISO method (ISO 15359). The treatment of samples is however extremely critical, a fingerprint for example, reduces the friction considerably.
The same goes for sheets rubbing against each other.

Two main principles are being used when measuring friction on paper, namely the inclined plane and the horizontal test. The inclined plane can only measure the static friction, i.e. the power needed to start the sliding, whereas with the horizontal method you can also measure the dynamic friction, i.e. the continued sliding. Basic information about friction is given in a special brochure written by the research institute STFI-Packforsk, Sweden.

PRINTING

Printing inks containing waxes reduce friction considerably. If the friction is of vital importance the printed surfaces should be minimised and “friction inks” should be used; i.e. inks developed to give a minimum reduction of friction.

FRICTION INCREASING AGENTS

When producing sacks, silicate solutions can be printed on the sack to improve friction properties. Disadvantages are costs and wear on manufacturing machinery, as some particles are also removed from the surface during the sack converting process.

STABILISING OF PALLETS

Various glues can be used when stacking sacks on pallets. The most frequently used is hotmelt, but spraying water can also improve the stability of pallets. Special sheets of paper covered with anti-slip agents can also be placed between the sack layers.

FRICTION PAPER

Various types of patterns have been developed to improve the friction properties. The most prominent feature of friction paper is that they keep the higher friction properties longer if the sack surface becomes dusty. Billerud offer special grades with an embossed pattern in order to improve friction in dusty environment.

STORAGE CONDITIONS FOR PAPER SACKS

The storage area for paper sacks should be a weatherproof covered building having good ventilation. Sacks should be stored raised off the ground to allow air to circulate beneath them.

Storage areas should be free from contamination sources such as dust or corrosive vapours. Dusts may encourage mould growth and insect infestations, and corrosive vapours will damage the paper plies and reduce the strength of the sacks.

When automatic sack applicators are used, the supplier will deliver sacks packed as flat as possible and put a frame on the top of each pallet. Ensure that sacks are maintained in good condition by careful stacking, especially of partly used units. Always store sacks so that they may be used in rotation according to when they were delivered (first in, first out).

It is recommended that newly manufactured sacks should be allowed to stand for at least some days before use so that the moisture from water based adhesives can migrate evenly through the sacks.

CONVERSION FACTORS

	From US units	Conversion factor	To ISO units
Grammage	1 lb/3000 ft²	1.627	g/m²
Tensile strength	1 lb/inch	0.17513	kN/m
	1 kp/15 mm	0.65402	kN/m
Tensile index	1 m	0.00980	Nm/g
Stretch	1 %	1	%
TEA	1 ft.lb/ft²	14.60067	J/m²
	1 lb-in/100in²	1.75223	J/m²
	1 kpm/m²	9.81000	J/m²
TEA-index	1 kpm/kg	0.00981	J/g
Tearing resistance	1 g	9.81000	mN
Tear index	1 100 gm²/g	0.09810	mNm²/g
Burst strength	1 kp/cm²	98.10000	kPa
	1 lb/in²	6.89500	kPa
Air resistance Gurley	1 sec/100 ml	1	sec/100 ml
Weight	1 Short Ton	907.2	kg

	From ISO units	Conversion factor	To US units
Grammage	1 g/m²	0.6146	lb/3000 ft²
Tensile strength	1 kN/m	5.710	lb/inch
	1 kN/m	1.529	kp/15 mm
Tensile index	1 Nm/g	102	m
Stretch	1 %	1	%
TEA	1 J/m²	0.0685	ft.lb/ft²
	1 J/m²	0.5707	lb-in/100in²
	1 J/m²	0.102	kpm/m²
TEA-index	1 J/g	102	kpm/kg
Tearing resistance	1 mN	0.102	g
Tear index	1 mNm²/g	10.2	100 gm²/g
Burst strength	1 kPa	0.0102	kp/cm²
	1 kPa	0.145	lb/in²
Air resistance Gurley	1 sec/100 ml	1	s
Weight	1 Kg	2.2046	Lb

STANDARD TESTING METHODS FOR PAPER AND PAPER SACKS

Please note that the testing methods in the different standards might not always be identical. Therefore, it is very important to specify which standard and method is used. In the column next to the ISO standard SI-units are given only for properties tested with the ISO standard.

PROPERTY	ISO	ISO	EN	SCAN-P	DIN	Tappi
Grammage	536	g/m^2			53104	410
Thickness	534	µm	20534		53105	411
Density	534	g/cm^3	20534		53105	411
Tensile strength	1924/3	kN/m		67:95	53112/1	494
Stretch	1924/3	%		67:95	53112/1	494
TEA (Tensile energy absorption)	1924/3	J/m		67:95		494
Tear strength	1974	mN	21974	11:96	53128	414
Burst strength	2758	kPa		24:77	53113/141	403
Bending resistance (Static bending force)	2493	mN		29:84	53121	543
Bending stiffness	5629	mN*m		64:90		535
Wet tensile strength	3781 (15 min)	kN/m		20:95	53112/2	456
Surface strength Denison						459
IGT, Picking velocity	3782, 3783	mm/s, m/s				
Bendsten porosity	5636/3	ml/min		60:87		
Roughness Bendtsen	8791/2	ml/min		21:67	53108	538
Roughness Bekk	474	ml/min			53107	479
Roughness PPS, H10	8791	µm				
Roughness Sheffield	8791	ml/min				

PROPERTY	ISO	Unit	EN	SCAN-P	DIN	Tappi
Friction	15359				53375	815
Cobb 60s (water absorption)	535	g/m²	20535		53132	441
WVTr (water vapour transmission rate)	2528	g/(m² *24h)				
Air resistance Gurley	5636/5	s		19:78		460
Moisture	287	%	20287		53103	412
Ash	2144	%		5:63	54371	413
Opacity	2471	%			53146	519
Brightness	2470	%			53145	452
Lightness L	Cie lab 1964	%				425
Gloss		%				480
pH cold water extract				14:65	53124	435
Measurements of empty sacks			26591-1			
Valve position in paper sacks			26591-1			
Paper sack volume	8281/1					
Dimensional tolerances for paper sacks			28367-1			
Butt drop test for paper sacks	7965/1		27965-1			
Flat drop test for paper sacks	7965/1		27965-1			

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