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CEPI EUROKRAFT
European Producers of Sack Kraft Paper and Kraft Paper

Why recycling paper sacks makes sense

The benefits to standard high-volume recycling mills from including sack kraft paper in the fibre furnish

Performance powered by nature.

SUMMARY

Paper sacks are made from renewable raw materials. The virgin fibres in paper sacks are sourced from sustainably managed forests, using as a starting point the capacity of forests to bind CO_2. Paper sacks store carbon and the recycling of paper and board products delays this CO_2 from returning to the atmosphere. Subsequently, the recycling of paper sacks at end-of-life should be encouraged and pursued.

CEPI Eurokraft and Eurosac commissioned independent research that demonstrates that not only are unused and used paper sacks perfectly recyclable but that they also offer product and process benefits when incorporated into the recovered paper fibre furnish. The results of this systematic and independent analysis challenges long-standing and engrained perceptions that sack kraft paper and paper sacks present problems for recycling.

The results were published in Paper Technology International "Investigating the papermaking potential from recycling kraft paper sacks with standard high-volume paper mills"[I] and revealed that the majority of paper sacks placed on the market in Europe are recyclable also in standard high-volume paper mills as assessed using Cepi recyclability test methodology[I]. This important study also identified that the inclusion of fresh long sack kraft fibres enhanced the strength of recycled paper. Increasing sack kraft fibre content also improved pulp drainage which offers potential to save mill energy. The work provides, for the first time, unequivocal evidence that kraft paper sacks can be recycled in standard mills and that the long fibres increase paper sheet mechanical properties and improve pulp drainage rates.

RATIONALE

Standard, high-volume recycling mills currently face two challenges:

- Successive rounds of paper recycling shorten the cellulose fibres. This reduces inter-fibre bonding leading to decreases in important performance properties such as tear strength, burst strength and tensile strength of the recycled paper sheet. To compensate for this, standard recycling mills require constant supplies of high-yield fresh long fibres to maintain these critical properties. Potential sources of fresh fibre include e-commerce packaging and packaging in contact with food, as well as kraft paper sacks.

- In order to meet pressures to further increase the recycling rate for paper and board, recycling mills are having to access new sources of fibre outside of their traditional sphere of experience. The 4evergreen (4EG) alliance reports that 82.3% of fibre-based packaging is already recycled in Europe. The revisions to the packaging and packaging waste directive propose a target recycling rate of 85% and the 4EG alliance aims to reach a more ambitious 90% target by 2030. To attain this recycling rate, focus is being given to increase recycling rates for household, out-of-home and on-the-go fibre-based packaging where lower recycling rates are currently achieved[II]. These applications, which increasingly replace single-use fossil-based plastic packaging, often incorporate functional barrier coatings and/or layers to extend product shelf life or to prevent leakage, but can be challenging for standard recycling processes.

Kraft paper sacks are a widely used fibre-based packaging format with applications across numerous industrial and consumer end-use sectors including dry food and ingredients, animal feed, pet food and building materials. Much like household, out-of-home and on-the-go packaging, kraft paper sacks sometimes combine other materials with the paper layers, for example polymer coatings and free films, such as polyethylene and also bio-based barriers, to add functionality. These additional materials increase functionality but have contributed to a perception amongst key stakeholders that paper sacks are not compatible with standard high-volume recycling processes. Resistance to paper sacks as a component of the recovered paper fibre furnish is elevated for used paper sacks (with contamination cited as an additional challenge), but the same attitudes also apply to unused paper sacks (process wastes). Indeed, both used and unused kraft sacks with and without poly liners are currently officially classified in the European List of Standard Grades of Paper and Board for Recycling as being in Group 5 Special Grades[III]. The group generally contains more complex paper products, which require enhanced recycling processes to recover the fibres. Inclusion in the special grades of Group 5 aims at reducing their presence in groups 1 to 4.

The perceptions of sack kraft paper and paper sacks as being problematic for standard, high-volume recycling mills are long-standing and engrained in the industry, but there has been no systematic or independent analysis to establish if these beliefs reflect reality. In contrast, independent research commissioned by CEPI Eurokraft and Eurosac (the trade associations representing manufacturers of sack kraft paper and producers of paper sacks) demonstrates that not only are unused and used paper sacks recyclable in standard high-volume recycling mills but that they also offer potential product and process benefits when incorporated into the recovered paper fibre furnish. The research has recently been published in Paper Technology International.[1]

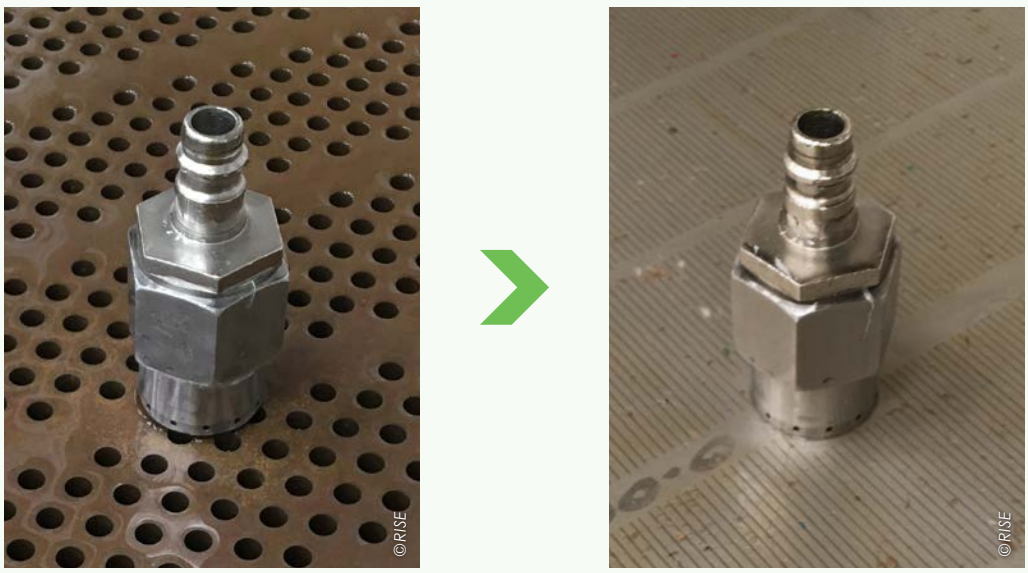
ESTABLISHING THE FACTS

Recovering valuable fresh fibre from kraft paper sacks makes economic and technical sense if proven to be recyclable and the benefits of including sack kraft fibres can be demonstrated. To investigate this, work was carried out to assess the recyclability of five kraft paper sack variants, which are representative of over 80% of kraft paper sacks placed on the European market. In addition, the recyclability of an emptied kraft paper sack which had previously been filled with cement was investigated to determine if there were impacts on fibre dispersion and paper sheet quality from any product residues that may be present. Once recyclability of kraft paper sacks had been established, the benefits from including sack kraft paper fibres at various proportions within a typical recycled fibre furnish used by high-volume standard recycling mills were investigated through measurements of fibre length and coarseness, pulp drainage, dissolved and colloidal substance <10 µm, ash and paper sheet mechanical properties.

Recyclability testing

Hitherto, uncertainty existed as to the evidence required to demonstrate the recyclability of fibre-based packaging. Test methods are in operation in some countries, such as UNI 11743[IV] in Italy, but the results might not be accepted across all European countries. In response, Cepi developed a harmonised European laboratory test method to provide a common approach to evaluate the recyclability of fibre-based packaging materials within standard paper and board mills[V]. The test method provides results relevant to standard recycling mill process efficiency (yield, coarse and fine rejects) as well as to recycled paper quality (visual impurities and sheet adhesion). These output values are described below:

- Coarse reject: mass weight percentage of components of packaging material retained on a 5 mm holed screen after repulping
- Fine reject: mass weight percentage of components of packaging material retained on a 150 µm slotted screen after repulping and coarse screening
- Visual impurities: an evaluation of the optical purity of the paper. This parameter is evaluated on a hand sheet made from the fibre accept fine screening
- Sheet adhesion: an evaluation of the tackiness of a hand sheet made from the accept of the fibre accept fine screening



After repulping, rejects retained by the coarse 5 mm holed screen (left) and fine 150 µm slotted screen (right) are dried and weighed.

To translate the output values into a single "recyclability score", the sum of the scores obtained for yield, visual impurities and sheet adhesiveness are considered. Fibre-based packaging needs to attain a score of between 0 and 100 to be considered "suitable for standard mill recycling". Guidance is provided to assess the impact of each output value on either process efficiency or recycled paper quality and serve to inform the eco-design process. The approach provides recyclability data which gives standard recycling mills confidence that valuable fibres can be recovered from fibre-based packaging which has passed the test.

The Sommerville Fractionator houses the coarse or fine screen to facilitate separation of fibres from rejects. The fibres are made into hand sheets to assess the properties of the paper.

The kraft paper sacks constructions tested according to the Cepi harmonised European laboratory test method by the Centro Qualità Carta[VI] laboratory are shown below.

Sample	Specification and typical application
Sample 1: Printed valve sack for 25 kg flour	Cellulose fibre-based product. Printed valve sack made from two paper plies: 70 gsm white kraft / 70 gsm brown kraft representative of 25 kg flour or animal feed sack (with internal paper valve)
Sample 2: Printed valve sack for 25 kg cement/building material	Cellulose fibre-based product. Printed valve sack made from three plies: 70 gsm white kraft / 9.5 gsm (10 µm) HDPE free-film / 70 gsm brown kraft representative of 25 kg cement or other building materials with paper reinforced valve
Sample 3: Printed open mouth bag for animal feed	Cellulose fibre-based product. Printed open mouth sack made from three plies: 70 gsm white kraft / 80 gsm brown kraft / 70 gsm brown kraft + 13.8 gsm (15 µm) LDPE coating representative of seeds or animal feed sack
Sample 4: Printed open mouth bag with plastic tube for powdered milk	Cellulose fibre-based product. Printed open mouth sack made from two paper plies with separable LDPE tube: 90 gsm brown kraft paper / 90 gsm brown kraft / 55.2 gsm (60 µm) LDPE tubular film representative of paper sack for powdered milk
Sample 5: Printed open mouth bag for 15 kg pet food	Cellulose fibre-based product. Printed open mouth sack made from three plies: 80 gsm white clay-coated kraft paper fully printed with non-slip glossy varnish / 70 gsm brown kraft / 70 gsm brown kraft + 21.2 gsm (23 µm) LDPE film representative of a pet food sack
Sample 6: Used printed valve sack for 25 kg cement	Cellulose fibre-based product. Printed valve sack made from three plies: 70 gsm white kraft / 9.5 gsm (10 µm) HDPE free-film / 70 gsm brown kraft representative of 25 kg cement or other building materials with a paper reinforced valve. The sack had been thoroughly shaken-out before testing

Table 1 Summary of paper sacks tested for recyclability

The test results (shown in Table 2) show that four out of the five samples of unused kraft paper sacks are suitable for standard mill recycling. Recyclability scores ranged from 63 to 96 for recyclable sacks with the highest yield score being judged "Best in Class" and unlikely to pose any repulpability issues in a standard recycling mill.

Only one of the sacks tested (sample 4, milk powder sack) was noted to pose "major repulpability issues" due to the presence of a heavy-gauge plastic film tube. It should be noted that this paper sack is designed to be separated from the plastic tube with the milk powder contents before it is brought into the food preparation area as part of its intended use. As such, the results presented here are a worst-case scenario. Once used, only the paper sack would be collected for standard mill recycling.

Sample 6, the kraft paper sack which was used to pack cement also attained a high recyclability score (83) and would be considered suitable for recycling by standard mills. The slightly better result can be attributed to a natural variability in the test results due to the number of samples used. Any cement which remained within the shaken sack did not impact fibre dispersion nor sheet quality parameters.

Sample	Recyclability score	Suitable for standard mill recycling	Notes
Sample 1: Printed valve sack for 25 kg flour	96	Yes	
Sample 2: Printed valve sack for 25 kg cement building material	75	Yes	
Sample 3: Printed open mouth bag for animal feed	80	Yes	
Sample 4: Printed open mouth bag with plastic tube for powdered milk	-27	No	LDPE film recovered as coarse reject negatively impacts yield score. Would be suitable for standard mill recycling if the paper portion of the sack was recovered for recycling as part of intended use
Sample 5: Printed open mouth bag for 15 kg pet food	63	Yes	
Sample 6: Used printed valve sack for 25 kg cement building material	83	Yes	Residue did not impact recyclability

Table 2 Summary of recyclability scores and suitability for standard mill recycling

The Cepi laboratory test method identified that reducing or eliminating the plastic content of the kraft paper sack would increase the recyclability score. These strategies align with those being proposed within Eurosac and CEPI Eurokraft's recently published Paper Sacks – Design for Recyclability Guidelines[VII].

Identifying the benefits of sack kraft fibre to standard high-volume recycling mills

The benefits from including sack kraft paper fibres within a typical recycled fibre furnish which is used by standard recycling mills were investigated through measurements of fibre length and optical coarseness, pulp drainage rate (measured using the Schopper-Riegler (°SR) method), dissolved and colloidal substances <10 µm, ash and paper sheet mechanical properties (burst, tear and tensile index). These techniques are described below:

Parameter	Description of parameter	Method
Fibre		
Average fibre length (mm)	Length-weighted fibre length	Valmet Fiberline Analyzer
Gravimetric coarseness (mg/m)	A measure of the average mass per unit length of the fibre; related to fibre thickness and cell wall thickness	Valmet Fiberline Analyzer
Paper hand sheet		
Tear index (mN)	Tear index = tearing strength/grammage. Tearing strength indicates the paper strength to resist tearing	Tappi T414
Burst index (Kpa)	Burst index = bursting strength/grammage. Bursting strength tells how much pressure paper can tolerate before rupture	Tappi T403
Tensile index (N)	Tensile index = tensile strength/grammage. Tensile strength is the force required to rupture paper	Tappi T494
Pulp drainage rate (°SR)	Rate (seconds) at which pulp drains	Schopper-Riegler
Ash (%)	% residue remaining after complete combustion at 900 °C	Tappi T413
DCS <10 µm	Quantity of dissolved and colloidal substances <10 µm expressed as residue/kg packaging	CEPI Recyclability Laboratory Test Method Version 2

Recycled liner (100 gsm) was obtained from a UK paper mill and used as the reference recycled fibre pulp and paper. The reference sack kraft paper comprised 70 gsm white kraft and 70 gsm brown kraft paper which was collected from a printed valve sack used to pack 25 kg flour or animal feed. Both sets of paper samples were reduced to pieces measuring 3 cm x 3 cm (±0.5 cm) in size. Trial mixes of recycled liner and sack kraft paper were prepared in the ratios from 95:5 (recycled liner to sack kraft paper) through to 5:95 (recycled liner to sack kraft paper). The fibre mixtures were repulped in an L&W Pulp Disintegrator under the conditions specified in the Cepi laboratory test method, i.e. 2.5% consistency, 40°C for ten minutes (30,000 stirrer revolutions) in tap water.

Source of reference sack kraft paper

Weighing of sample pieces

Temperature check during repulping

Recycled liner (%)	100	95	80	50	20	5	0
Sack kraft paper (%)	0	5	20	50	80	95	100

Measurement

Pulping: 2.5% consistency, ten minutes (30,000 revolutions), 40 °C → °SR; fibre length, fibre coarseness, dissolved colloidal substances <10 µm, ash content

Sheet forming (60 gsm) → Burst index, tear index, tensile index

Figure 1 Schematic of test methodology

Average fibre length, fibre coarseness, pulp drainage rate, DCS <10 µm, and ash content were determined on each pulped mixture. Pulps were converted into 60 gsm hand sheets and tear, burst and tensile indices were measured on the paper. The analysis indicates that substitution of recycled fibre with sack kraft fibre resulted in linear increases to tear, burst and tensile indices, pulp drainage rate and a liner reduction in ash content (Table 3):

- Inclusion of sack kraft fibre at 5% increased length-weighted fibre length by 8.2% which increased tear, burst and tensile indices by 15.5, 2.0 and 2.2% respectively
- Inclusion of sack kraft fibre at 20% increased length-weighted fibre length by 19.8% which increased tear, burst and tensile indices by 44.4, 45.1 and 16.6%
- Substitution with sack kraft fibre at 5 and 20% increased recycled fibre pulp drainage by 7.1 and 12.5% as evidenced by a decrease in Schopper-Riegler values from 28 to 26 and 24.5 seconds respectively. Such a result, if substantiated at mill scale, could lead to a drier sheet entering the press and dryer sections which would lead to energy savings in the paper machine
- Sack kraft paper contained lower quantities of dissolved and colloidal substances (DCS) <10 µm (0.1 to 0.9%) and ash (0.53%) than a recycled furnish (DCS 3.1% and ash 1.82%) which implies beneficial high fibre yield.

	Recycled liner (100 gsm)	Sack kraft paper	Length-weighted fibre length	Optical coarseness	Burst index	Tensile index	Tear index	Schopper-Riegler	Ash
	%	%	%	%	%	%	%	%	%
Trial									
1	100	0	0.0	0.0	0.0	0.0	0.0	0.0	0
2	95	5	8.2	0.0	2.0	2.2	15.5	-7.1	3.3
3	80	20	19.8	2.6	45.1	16.6	44.4	-12.5	-5.5
4	50	50	52.2	17.0	102.3	42.1	88.7	-26.8	-28.6
5	20	80	75.0	15.7	166.2	70.6	144.5	-30.4	-37.4
6	5	95	94.8	34.6	192.2	85.8	170.5	-35.7	-51.6
7	0	100	99.9	30.7	231.2	107.0	170.5	-39.3	-70.9

Table 3 Summary impacts from stepwise substitution of recycled liner with sack kraft fibres

Increased tear, burst and tensile indices suggest that a stronger paper sheet – clearly, including sack kraft fibres as part of the fibre furnish, even at relatively low percentages – will contribute to the production of an improved recycled paper product.

Improved drainage has potential to contribute to reduced energy consumption for drying. Energy savings could equate to reduced production costs and reduced carbon emissions.

Lower quantities of dissolved and colloidal substances (DCS) and ash suggest beneficial high fibre yield from incorporating sack kraft fibres into the fibre furnish.

CONCLUSIONS

The results of independent analysis commissioned by CEPI Eurokraft and Eurosac dispel the myth that sack kraft paper and unused and used paper sacks present problems for recycling. Testing according to the industry standard, the Cepi recyclability test method, has shown that the majority of paper sacks in the European market, both with and without plastic film layers, are recyclable in the process conditions operated by standard, high-volume recycling mills. Even used paper sacks are recyclable in standard recycling mills if product contamination is kept at manageable levels. Many kraft paper sacks are used by industry and are meticulously cleaned to recover the contents as part of their intended use and could serve as a valuable, clean fibre stream for standard recycling mills.

Further investigations have shown that not only are paper sacks recyclable, but the inclusion of sack kraft fibres in the recovered paper fibre furnish contributes to an improved, stronger recycled paper product. Inclusion of sack kraft fibres may also have processing benefits, contributing to lower drying energy requirements and improved yield at the recycled paper mill.

Alongside fibre fractionation and chemical treatments, the controlled addition of clean fresh fibres obtained from sack kraft paper could become a strategy of increasing importance to standard recycling mills to improve pulp drainage and increase dry sheet mechanical properties.

These are important findings as European recycled paper producers seek to deliver highly functional products whilst at the same time meeting increasing recycling targets.

In conclusion, paper sacks are not only recyclable in standard, high-volume recycled paper mills, but they are a desirable component of the fibre furnish mix. This will deliver benefits to the mills and will assist the paper packaging industry's efforts to achieve the recycling targets under the revised packaging and packaging waste directive and the 4evergreen target for 90% of fibre-based packaging to be recycled by 2030.

REFERENCES

[I] Kay M, Sturges M and Langley R (2023) Investigating the papermaking potential from recycling kraft paper sacks within standard high-volume paper mills. In Paper Technology International (PITA), Vol. 64, No. 3, Autumn 2023, PP. 10-15. https://www.pita.org.uk/ The 6-page article is also available here: https://www.eurosac.org/media/news/recycling-kraft-paper-sacks/

[II] 4evergreen, Recyclability: Towards 2030 and Beyond: https://4evergreenforum.eu/wp-content/uploads/WS1-Mills-network-in-Europe.pdf

[III] European Standards, European List of Standard Grades of Paper and Board for Recycling: Guidance on the revised EN 643 (2013 revision): https://www.en-standard.eu/bs-en-643-2014-paper-and-board-european-list-of-standard-grades-of-paper-and-board-for-recycling/

[IV] UNI 11743 paper and board – Determination of parameters of recyclability of cellulose-based materials and products

[V] Cepi, Harmonised European laboratory test method to produce parameters enabling the assessment of the recycling of paper and board products in standard paper and board recycling mills (Version 1, December 2020): https://www.cepi.org/wp-content/uploads/2021/02/REC-21-002.pdf

[VI] Centro Qualità Carta, Unità, Operativa di Lucense, Lucca, Italy: https://www.cqc.it/

[VII] EUROSAC and CEPI Eurokraft, Paper Sacks – Design for Recyclability Guidelines (June 2023): https://www.eurosac.org/media/news/paper-sacks-design-for-recyclability-guidelines/

MORE INFORMATION

For more information on paper sacks, contact your sack producer or either of the two organisations below.

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