Going circular with paper sacks

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Catherine Plitzko-Kerninon, EUROSAC, and Elin Gordon, CEPI Eurokraft, discuss why recycling paper sacks can support the European cement industry on its way towards a circular economy and its net-zero targets.

Keeping valuable raw materials in the loop is one of the European Circular Economy Action Plan's targets. This entails recycling packaging waste. Thanks to their performance and efficiency, paper sacks are widely used for packaging cement and other building materials. Their environmental credentials can also support the European cement industry in reducing packaging waste and CO_2 emissions. As there is no Europe-wide recycling system solely for paper sacks, they are mostly collected as part of a mixed paper packaging for recycling stream. However, not all paper sacks are

Paper sacks are widely used for cement and other building materials. Copyright: GemPSI.

Cleaned kraft paper is a valuable raw material for technically sophisticated packaging. Copyright: Interzero Repasack.

currently collected and recycled. The European sack kraft paper and paper sack industry sees potential to change this. As the largest customer segment of the European sack kraft paper and paper sack industry, the cement sector can play an important role. More than 3 billion paper sacks for cement and other building materials were placed on the European market in 2023.[1] Some paper sacks combine other materials with the paper layers to add functionality, for example polymer coatings and free films, such as polyethylene and bio-based barriers. These materials, as well as possible product residues, have contributed to ingrained perceptions amongst key stakeholders that paper sacks are not compatible with standard high-volume recycling processes.

Study to demonstrate recyclability

EUROSAC and CEPI Eurokraft have commissioned independent research to understand if these perceptions reflect reality. For the recyclability testing, the harmonised European laboratory test method by the Confederation of European Paper Industries (Cepi) was used which provides a common approach to evaluate the grade of recyclability of fibre-based packaging materials.[2] It tests parameters such as yield, coarse and fine rejects that are relevant to process efficiency as well as visual impurities and sheet adhesion that influence the quality of recycled paper. The recyclability of five paper sack variants was assessed, which are representative of over 80% of paper sacks placed on the European market. Among them was a 25 kg printed valve sack typically used for cement or other building materials made from three plies: 70 gsm white kraft, a 9.5 gsm (10 µm) HDPE free-film and 70 gsm brown kraft with a paper reinforced valve. In addition, the same sack previously filled with cement was investigated. The sum of the scores obtained

Table 1. Summary of recyclability scores and suitability for standard mill recycling.

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.

for yield, visual impurities and sheet adhesiveness were translated into a recyclability score.[3] According to the Cepi test method, fibre-based packaging needs to attain a score between 0 and 100 to be considered 'suitable for standard mill recycling'.

Excellent recyclability performances

The study results (presented in Table 1) show that five of the six samples are suitable for standard mill recycling.[4] Recyclability scores ranged from 63 to 96 for the recyclable sacks. The highest score is to be judged as 'Best in Class' which means it is unlikely to pose any repulpability issues. Both cement paper sacks tested have obtained excellent repulpability scores. While the unused cement sack achieved a recyclability score of 75, the used cement sack, carefully emptied of its contents before the test, achieved a score of 83. The slightly better result can be attributed to a natural variability in the test results due to the number of samples analysed. The residual traces of the contents remaining inside the agitated sack did neither impact fibre dispersion nor sheet quality parameters.

Sack kraft paper in the recycling mix is used to produce strong recycled paper. Copyright: Alier.

Results from fibre inclusion

To evaluate the potential of including sack kraft fibres in a typical recycled fibre mix, sack kraft paper was repulped with a 100 gsm testliner, a recycled fibre-based paper, at various mixes. The pulp was used to prepare paper hand sheets from which different properties were measured. Among them, fibre length, optical coarseness, pulp drainage rate, dissolved and colloidal substances <10 µm as well as ash and paper sheet mechanical properties. The results (presented in Table 2) show a linear improvement of the paper quality with increasing percentages of sack kraft fibre in the fibre furnish. By including just 5% sack kraft fibre, the tear index of the recycled paper increased by 15.5%, the burst index by 2%, and pulp drainage improved by 7.1%. With 20% sack kraft fibre, the increase for the tear index was 44.4%, and for the burst index 45.1%. Pulp drainage improved by 12.5% and the ash content was reduced by 5.5%.

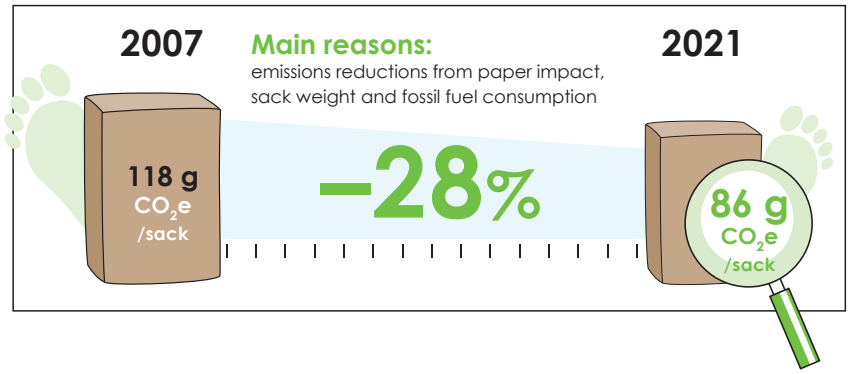
As increased tear, burst and tensile indices indicate a stronger paper sheet, the test results clearly show that even relatively low percentages of sack kraft fibres in the fibre furnish will contribute to more tear-resistant recycled paper. Adding to that, improved drainage has the potential to contribute to reduced energy consumption for drying which could equate to reduced production costs and carbon emissions. Lower quantities of dissolved and colloidal substances and ash suggest a beneficially high fibre yield. To pave the way for the recycling of paper sacks on a larger scale, the next step will be to run trials with standard, high-volume recycling mills and promote collection circuits.

Insights for future developments

Thanks to new production technologies, sack manufacturers have reduced the use of polymer required for the barrier properties of paper sacks by almost half in recent years. Today, the HDPE content in a cement sack is already less than 5% of the total weight of

Table 2. Impacts from step wise substitution of recycled liner with sack kraft fibre.

	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



The fossil carbon impact of an average European paper sack was reduced significantly between 2007 – 2021.

the sack. Minimising the plastic content of paper sacks or eliminating and replacing them with other materials is one area that the European sack kraft paper and paper sack industry aims to keep working on to further improve paper sack recyclability. These strategies align with those being proposed within EUROSAC and CEPI Eurokraft's recently published 'Paper Sacks – Design for Recyclability Guidelines'.[5] The document provides recommendations for all players in the paper sack supply chain on how to maximise the recyclability of the paper sacks they place on the market.

Recycling in practice

Examples from recycling facilities and paper mills throughout Europe demonstrate that recycling paper sacks is feasible and beneficial not only in laboratory testing. In Germany, a system for the collection of used paper sacks was established more than 30 years ago. Today, it has a throughput of 100 million sacks annually. As part of the collection, the sacks are sorted by product use, freed from product residues and then processed in a recycling plant into a valuable secondary raw material. The residues retrieved from building materials sacks are also recycled – specialised companies utilise them for road construction on landfills which also conserves primary resources. In other countries such as Italy and Spain, several mills integrate paper sacks and other kraft paper products purposefully into their fibre mix to produce strong recycled paper which can then be produced into new packaging products that need extra strength, such as paper sacks, paper carrier bags or kraft liners for corrugated board. The residual contents of the plastic layers are also given a second life. They are cleaned and processed into granules and pellets which can be used to produce new plastic products. In Spain, a pilot project has been initiated involving the entire value chain of paper sack manufacturers, building material manufacturers, construction companies, collectors and recyclers. It aims to increase the collection of paper sacks on construction sites to have more valuable paper sack fibres available for recycling. It is planned to extend this type of initiative to other countries.

Low fossil CO_2 emissions

Recycling paper sacks does not only save valuable natural resources; it also reduces greenhouse gas (GHG) emissions. Fillers of cement and other building materials can minimise their scope 3 emissions with paper sack recycling. As young trees grow, they absorb CO_2 from the atmosphere. The CO_2 is stored in forest products such as paper sacks during their life cycle and also when the sacks are recycled. According to a study by the Fraunhofer Institute UMSICHT, paper sack recycling saves an average of 183 kg of GHG and 3150 kg of primary resources (wood) per tonne of recycled paper sacks.[6] Paper sacks are already a low carbon packaging solution. The European sack kraft paper and paper sack industry continuously works on improving the sustainability of their operations and products. A recent carbon footprint study by RISE found that the carbon intensity of a single average European paper sack was reduced by 28% between 2007 – 2021, from 118 g CO_2e per sack in 2007 to 86 g CO_2e per sack in 2021.[7] This can be attributed to reductions in sack weight and in fossil fuel consumption. When looking at the carbon footprint of paper cement sacks, another study found that it is 2.5 times smaller than the carbon footprint of form-fill-seal (FFS) polyethylene cement sacks.[8]

Energy efficient production

The production of sack kraft paper, the main component of paper sacks, is very energy-efficient and uses a high degree of renewable energy sources. According to the latest study, in 2021, biofuels accounted for 92% of all fuels consumed on-site, the majority (78%) of which was internally produced.[9] The mills also produced 59% of their own electricity requirements. Of the purchased grid electricity, 29% was identified as low carbon electricity which means it was generated by wind, solar, hydro, nuclear, etc.

Extending the system boundaries

Besides the cradle-to-gate fossil carbon footprint of sack kraft paper and paper sacks, the study investigated the total carbon impact. When including cradle-to-gate biogenic removals and emissions in the calculation, the carbon footprint of a paper sack would even be negative. This

reinforces the fact that paper sacks are potentially a carbon-negative solution. Incorporating a sack's end-of-life would give a more complete picture. However, this methodology is problematic due to data accuracy and sensitivity. In general, it can be stated that the recycling of paper sacks should be encouraged and pursued.

Conclusion

The lab test showed that whether with or without a plastic film layer, used or unused, most paper sacks are perfectly recyclable. It also identified that the inclusion of sack kraft fibres enhanced important properties of the recycled paper. Therefore, recovering valuable fibre from paper sacks makes economic, technical and environmental sense.

It will benefit mills and support the paper packaging industry's efforts to meet the recycling targets under the revised packaging and packaging waste directive. For the European cement industry, recycling paper sacks can be one further piece of the puzzle in its progress towards a circular economy and net-zero targets. ■

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