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Beverage cartons as an alternative fuel and raw material

Beverage cartons, a mixture of plastic, foiled aluminium and paper, represent a significant waste-recovery challenge. However, they can be effectively used as both an alternative fuel and alternative raw material source for the cement industry, as Dirk Lechtenberg highlights in this article, which features information from the MVW '*Alternative Fuels and Raw Materials Handbook.*'

When opening a carton of milk or orange juice nobody thinks about the volumes of waste that such receptacles produce every day. However, the Alliance for Beverage Cartons and the Environment (ACE) includes beverage carton producers Tetra Pak, SIG Combibloc and Elopak, (and their major paperboard suppliers), and estimates that companies produce 1.4Mt/yr of beverage cartons in Europe alone.

According to industry figures, 37% of beverage cartons were recycled across Europe (EU-27, Norway and Switzerland) in 2011. This represents an increase from the previous years and follows industry's efforts to continually increase beverage carton recycling rates across Europe (See Figure 1).

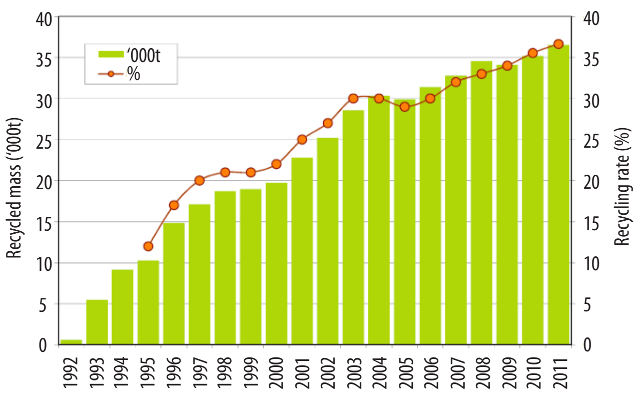
Used beverage cartons, however, are behind the curve in terms of recycling systems in Europe. There are few separate collection systems in place. In some EU member states, producers of such cartons have to implement 'take back and recycle' programmes but in many EU countries beverage cartons are disposed of together with municipal solid wastes, often to landfill.

Sustainable packaging?

Many studies have evaluated the life cycle of beverage cartons compared to PET and/or glass bottles. These studies only ever give a preliminary view depending on local conditions but where no separate collection system for beverage cartons is available, the use of re-usable packages such as refillable glass bottles is often far more sustainable.

If beverage cartons are separately collected and shredded, they can be used directly as alternative fuel in cement plants. Beverage cartons afford satisfactory calorific values on the one hand, as well as ashes abundant in aluminium, which contributes as a raw material (see Table 1).

Below - Figure 1: Beverage carton recycling figures for EU27, Norway and Switzerland for 1992 - 2011. **Source:** Tetra Pak.



If beverage cartons are collected together with used paper (magazines, cardboard etc.), they should not be incinerated but recycled, since further separation can be performed in paper recycling plants. In these plants beverage cartons are separated by dedicated paper mills, which are able to pulp the cartons.

Dedicated paper mills, like Stora Enso in Spain or the Niederauer Mill in Germany, are able to separate the paper fibres for further recycling into paper and thus also separate out plastics and aluminium. Such materials are so called 'mechanically-separated rejects.'

After the dissolution and defibration of the waste paper, the foreign matter is separated mechanically from the accepted stock by means of a multi-stage process. The residues, often referred to as rejects, are mostly drained and consist of a heavy fraction (normally glass, sand and staples), a light fraction group (including non-dissolved fibres, plastic, aluminium foils and adhesive strips) and water.

Right - Table 1: Typical composition of beverage cartons (Tetra Pak).[1] LDPE = Low-density polyethylene.

Paper	75%
Aluminium foil	5%
LDPE foil	20%

Several processes, mainly pilot projects, have been started to separate the aluminium content from the other rejects. In Barcelona a pyrolysis plant thermally treats the residues in an oxygen-free reactor. This vaporises the plastics at a certain temperature so that the aluminium can be extracted. In Germany a company has developed a dissolving process, which, according to the company, can separate plastics and aluminium. Alcoa has built a plant in Brazil, a jet plasma technology, which has separated the contents of cartons.

Most of these processes are quite expensive and cannot be paid off by the value of the recycled aluminium or plastics, so that additional process costs have to be covered by gate fees to be paid by the waste supplier. As waste is always going 'the cheapest way' in conjunction with legal requirements, most of these rejects are still landfilled or incinerated.

However, the cement industry can offer a more reliable solution. The calorific content and the aluminium content both have economic value for the industry. Most of these rejects are used as alternative fuels and have added value as secondary raw material.

Parameter	Unit	Value (as received)
Net calorific value	kJ/kg	16,910
Moisture	%	1.2
Volatile matter	%	83.4
Carbon	%	47.42
Hydrogen	%	6.22
Nitrogen	%	0.08
Oxygen	%	38.57

Right - Table 2: Example of beverage carton analysis.[2]

Composition

The paper and pulp industry belongs to those industries that exhibit a high environmental relevance. Approximately every fifth tree lumbered worldwide goes to the pulp industry. Hence waste paper is of high ecological and economic importance.

The requirements of waste paper as a resource for the different product groups (printing and press papers, recycling paper, hygiene paper and recycling cardboard) are focused upon in the RAL German Institute for Quality Assurance and Certification, regulations TO 5, TO 14, TO 56 and TO 72. They include not only the technical requirements, such as fibre length and fillers, but also ecological specifications such as removal of hazardous bleaching chemicals and complex binders.

AFR analysis

Tables 3 and 4 show waste analyses for mechanically-separated rejects from pulping of waste paper and cardboard and ash composition of sludges and paper. The broad scattering of the data results from the varied composition of input waste materials.

Use as an alternative raw material in cement

The ash content of paper rejects contributes to the clinker as raw material. Ashes may be abundant in aluminium (see Tables 1 and 4) thus serving as aluminium source for adjusting the aluminium modules. Rejects may also be abundant in silica, thus contributing to the adjustment of the silica modules.

Economic value

Paper rejects contain a high volume of water meaning that their calorific value is quite low. On the other hand, the respective relation of these properties with regard to beverage cartons as they are is converse. Table 5 provides a substitution calculation based on calorific values.

Below: Sludge containing mechanically-separated paper rejects is taken out of the Alier paper pulper at the company's paper plant in Roselló, Spain. Such material has traditionally been viewed as a waste stream by companies, but its high aluminium content as well as its ability to be used as an alternative fuel, can make it attractive for the cement industry.

Summary

The cement industry can offer a reliable and sustainable solution for the recycling of paper rejects from paper mills, especially if they are employing used beverage cartons.

References

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2. Agrantiotis, M., Atsonios, K., Grammelis, P., Panopoulos, K., Vounatsos, P. *Report on RDF/SRF Gasification Properties. Life Project Number Life09 ENV/GR/000307, Life Project Name – Energy Waste,* Greece, 15 January 2012.

3. Coda, B., *'PhD studies on ash behavior during co-combustion of paper sludge in fluidized bed boilers,'* Institut fuer Verfahrenstechnik und Dampfkesselwesen, University Stuttgart, Germany, 2004.

Parameter	Unit	Value
Moisture	%	55.1
Calorific value	MJ/kg as received	1.7
Ash	% dry matter	38.4

Above - Table 3: Excerpt of AFR analysis (example).

	De-inking sludge	Paper sludge	Recovered paper
SiO_2	29.4	35.6	29-32
Al_2O_3	9.9	6.1	12-18
Fe_2O_3	1.0	1.6	1.4-1.2
CaO	35.1	17.2	37-48
MgO	5.9	4.5	3.8-6.6
LOI	-	-	-
SO_3	-	-	0.5-0.8
K_2O	0.3	1.25	0.5-0.6
Na_2O	0.2	4.8	0.2-0.5
TiO_2	-	-	-
Cl^-	0.06	0.3	-

Above - Table 4: Ash composition of sludges and paper.[3]

	Cal. value (MJ/kg)	Substitution factor vs. Coal	Substitution factor vs. Petcoke
Paper rejects	1.7	15.0	20.2
Beverage cartons as received	16.9	1.51	2.03
Coal, typical	25.5		
Petcoke, typical	34.3		

Above - Table 5: Substitution calculation based on calorific values.