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THEORETICAL METHODOLOGY FOR RECYCLING BEVERAGE CARTONS

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Abstract:

Ensuring sustainable development is key aspect in today's packaging industry. One of the biggest challenges of packaging waste management is recycling of the combined packaging materials. Separation of raw materials require high energy input and adequate technology background, thus in many cases, it can only be achieved by high costs. EU directives on packaging require 60% recovery of the packaging waste by 2012. In food industry beverage cartons are combined packaging. On one hand recycling is done by component separation of separately collected boxes or grinding without separation. Resulting waste is heat treated and formed by pressing, intermediate products are created and reused by furniture and construction industry.

The goal of our experiments series is to develop a cost- and energy efficient method for reuse, as well as to develop an application for new areas of beverage carton material recycling.

Keywords: *package recycling method, beverage cartons, recycling, sustainable*

1 INTRODUCTION

In the European Union, more than 100 million liter/day of liquid foods are packaged into beverage cartons. Composition of beverage carton raw materials for aseptic beverage cartons (UHT, Hosszanfriss), 75% paper, 20% polyethylene, 5% Aluminium. In case non-aseptic beverage carton contains 91% paper and 9% PE. Paper is responsible for the stiffness of the box, the PE prevents fluid intake of paper, Al protects the product from sunlight and from oxygen.

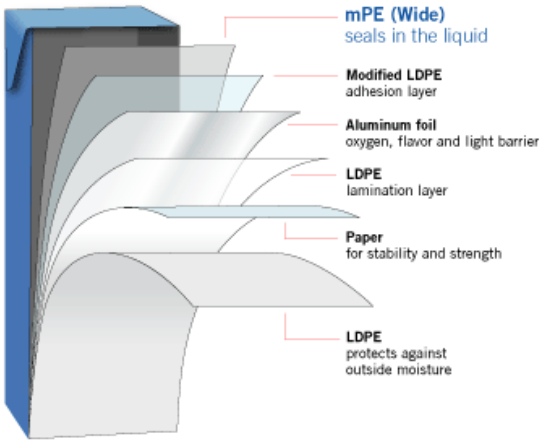

Figure 1: UHT Tetra Pak layers[1]

Combination of materials vary by product category and in each case the only material to touch the contents of the package is food grade polyethylene.

Beverage cartons make their journey through distribution chains from filling plants to the consumers. But what happens to packaging after use?

2 BEVERAGE CARTONS RECYCLING

The combined packaging, beverage cartons are returned as well. Proportion of collected cartons is constantly growing in the EU. The Alliance for Beverage Cartons and the Environment (ACE) reported, that return rates that Europe (EU-27, Norway and Switzerland) have reached 36% in 2010.

Recycling of beverage cartons in Europe has increased steadily over the last fifteen years, with around 350,000 tons (over 13 billion beverage cartons) recycled in 2010.

In Hungary 9,000 to 10,000 tons of beverage cartons are in circulation of which 17,000 tons are recycled.

From all cartons sold in Europe there is a rate of 36% being recycled, moreover some countries like Belgium or Germany have rates twice this average.

Combined recycling together with energy recovery rates for the European region reached approximately 650,000 tons (66% return rate). These figures reflect a steady long-term growth trend in beverage carton recycling since 1992, when there were only 6,000 tons recycled.

Recycling has definite role in landfill greenhouse gas emissions. In addition to avoiding the waste of valuable paper resources, the 350,000 tons of beverage cartons recycled in 2010 is equivalent to a prevention of emissions of around 310,000 tons of CO_2.

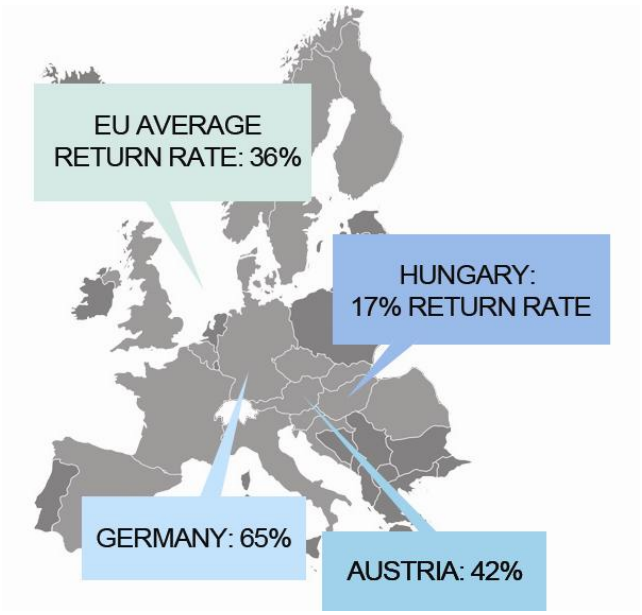

Figure 2: Beverage cartons used in packaging industry, 2010 [2]

2.1 Method for recycling

The two main types of beverage carton recycling are: component separation and recycling after grinding of combined materials without separation.

In the first case, paper is sorted after return, than it is bulked, pulped and finally pulp is separated by filtration. PE and AL remain in the sieve, while paper pulp flows through it. From PE other plastic products can be made, from AL aluminum trays are created and unused parts become fuel. From pulp paper re-paper is manufactured.

The other option is to grind beverage carton without previous separation, than grind is heat treated at 170 °C and formed by pressing. Thus from the resulting grind an intermediate or final product of the furniture and construction industry is created.

3 EXPERIMENTS

The starting concept for recycling beverage cartons is to use dry grinding technology, without component separation. Furthermore by applying heat press an investigating present solutions finding for new form possibilities beyond present solutions. To investigate present solutions we had to create our own specimen plates.

Preceding grinding process, there was no chemical or physical modification (no freezing or bathing) applied during the preparation of test specimens.

No other material, than the beverage carton itself, nor any additional additive was used for making specimens. Material of first test specimens was created from 1 liter aseptic milk cartons.

3.1 Equipments

For cutting beverage cartons the FRITSCH Cutting Mill was used.

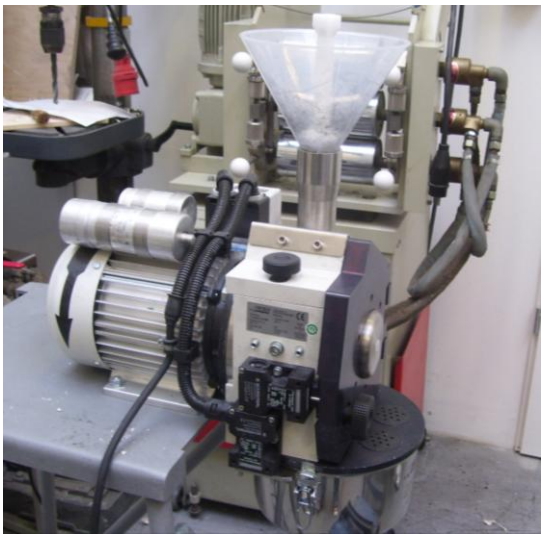

Figure 3: FRITSCH Cutting Mill

Working principle	Cutting
Optimal for material type	Medium-hard, soft, fibrous
Max. feed size (depending on the material and funnel)	70 x 70 mm
Max. throughput (depending on the material and sieve size)	50 l/h
Sieve inserts	0.25 – 6 mm
Feeding	Batchwise/continuous
Materials of the cutting tools	Tool steel, chromium-free steel
Rotor speed (depending on voltage and frequency)	2800 – 3400 rpm
Electrical details	400 V/3~, 50 Hz, 1900 watt 230-240 V/1~, 50 Hz, 2100 watt 100-120 V/1~, 60 Hz, 1850 watt
Motor shaft power in accordance with VDE 0530, EN 60034	1.5 kW for all motors, except 1.1 kW for 100-120 V/1~ motor
Weight	Net: 42 kg, gross: 72 kg
Dimensions w x d x h	Table-mounting or on stand: 42 x 48 x 69 cm
Packing details	Wooden case: 87 x 58 x 78 cm

Figure 4: Technical data of FRITSCH Cutting Mill

Heat forming was made by the Collin P 200 E heat press.

Figure 5: Collin P 200 Platen Press

Technical Data

		Typ P / M			
Nominale size		200	300	400	500
Usable surface	mm	196x196	296x296	396x396	496x496
Net daylight	mm	100	200	250	300
Pressing force					
	a (kN)	125	300	500	785
	b (kN)	200	500	785	1250
	c (kN)	300	785	1250	1810
Specific pressure					
	a (N/cm²)	327	350	320	319
	b (N/cm²)	511	574	500	498
	c (N/cm²)	798	896	783	735
Total power	kW	7 (10)	26	40	85
Heating power (300° C)	kW	2,5	11,6	12,7	35,7
Width (with cassette)	mm	1190	1510	1756	2190
Width (without cassette)	mm	1190	1510	1756	2190
Depth	mm	500	580	720	960
Height	mm	970 (1620)	1620	1680	1836
Weight	kg	300 (750)	1000	1700	3200

Design modifications reserved

Figure 6: Tecnical Data of Collin P 200 Platen Press

3.2 Preparation of test specimens

1 liter beverage cartons were cut and grinded into smaller pieces.

Grinded carton pieces were placed into a 100 X 100 mm frame, and then they were placed into the heat press that was preheated to 160 °C. Following the closure of the press and the 160 °C reheating - while heating is turned off – pressure was increased up to 100bar, and so we let it on this level for as long as 4 minutes. After this time, cooling was turned. At 30 °C we reduced pressure zero and got the the finished test specimen.

Figure 7: Grind before pressing

The resulting specimen is then taken out of the frame. The illustration shows that melted PE is holding together the sample, but the sides are easily damaged.

Figure 8: Grind after pressing process

On the microscopic picture molten PE between paper filaments, paint from the printing the carton (figure 8), and aluminum foil (figure 9) are well visible.

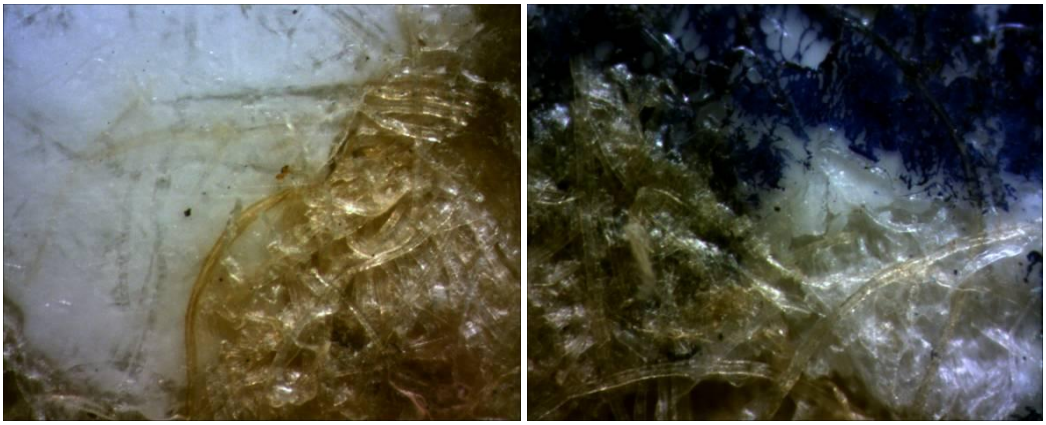

Figure 9: microscopic image showing pulp, PE and Al

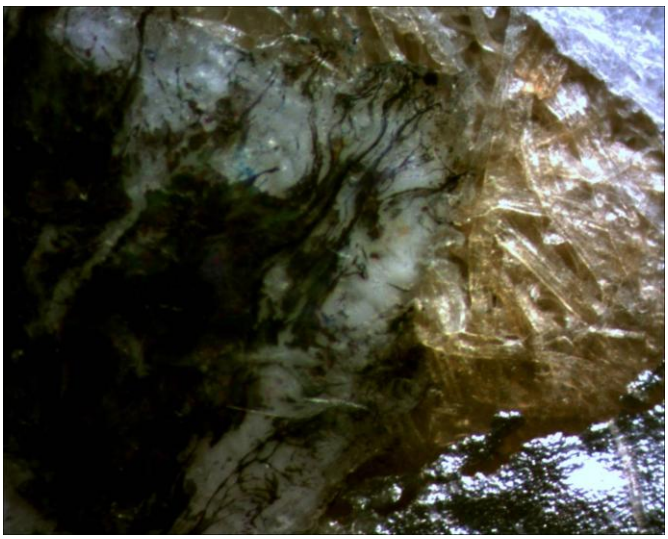

Figure 10: Microscopic image of carton grind after pressing

4 CONCLUSIONS

The experiments conducted up to now have shown, that combined beverage carton packaging without chemical and physical preparation (cutting stripes by hand not counted) can be grinded and heat pressed without additives. The test specimen remains in one piece, but further optimization experiments are required to achieve non-destructive edges and smooth surfaces as well.

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