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RECIRCULATION OF BEVERAGE CARTONS

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Abstract

In many countries collecting and sorting used packages for recycling have become a part of daily life. Various paper and board packages differ however in their potential use in recycling. Serious problems are caused by so called "combined packages". These are made of different materials (not only paper) or materials joined in layers. Materials of this kind bring about a lot of problems in processing and cause environmental burden to increase. In this paper, recycling and recovery methods for beverage cartons were presented. Beverage cartons are a typical example of combined packages (material in layers).

Keywords: *recycling, beverage cartons, recovery of paper, recovery of aluminium foil*

1. Introduction

With growing production of material goods increases environmental burden with used packages. It is estimated that packages contribution in total amount of municipal waste equals approximately 50% of its mass, or in respect of volume 70%. In the amount of used packages in turn, the most considerable position is paper and cardboard. Their contribution is calculated to be approximately 34% in respect of mass and 44% of volume. The result of this is that about 100÷200 kg a year of used packages falls to one single inhabitant in individual countries, in this from 34 to 70 kg of paper and board packages [6].

In order to limit the impact of the waste on natural environment it is necessary to introduce suitable legal regulations and acts: they should include the following criteria (four Re criteria) [4, 6]:

Reduction at source - Minimize packaging by weight and volume.

Reuse - The development of reusable packaging.

Recycling - The overall target is to recycle 25% to 45% of all packaging waste, by weigh. For individual materials, the minimum recycling level is 15%. Mills and converts must take into account materials and substances that are liable to create problems in:

- the recycling process,
- the collecting and sorting process,
- those which could have a negative influence on the quality of recycled material.

Recovery - The directive sets targets for 50% to 65% recovery of packaging waste by weight. Recovery includes energy recovery and composting and will be supported by two general standards. These will affect the manufactures and converts of packaging, who must take into account substances or materials, which have a negative impact on energy recovery or biodegradation.

The first two of above activity directions have very restricted use in the case of paper and board packages. Because of hygienic and sanitary reasons and some advertising and marketing aspects and also because it is necessary to insure the quality and durability of products we won`t get away from the packages [1, 10]. Moreover, paper and board are single use packages.

In this situation the most effective ways to limit environmental burden by packages are recycling and recovery. Most of paper and board packages are suitable for recycling. Their use as the waste paper grows up presently in many European countries. For example in Netherlands contribution of package wastepaper in paper and board production equals 70%. Not contaminated paper and board are very attractive materials for recycling. Through the use of wastepaper it is possible to save energy, raw materials and reduce environmental burden [2].

In many countries collecting and sorting of used packaging for recycling have become a part of daily routine. Various paper and board packages differ however in their potential use in recycling. Serious problems are caused by so called combined packages. These are made of different materials (not only of paper) or materials joined in layers. Materials of this kind bring about a lot of problems in processing and cause the environmental burden to increase.

In this paper full recycling and recovery model for beverage cartons is presented. Beverage cartons are typical example of combined packages (materials in layers).

2. Beverage carton packages

The most popular carton today, Tetra Brick Aseptic in the shape of brick, is an example of beverage package. Package material is made of laminate consisting of six layers [8, 10] (Fig. 1). The main component among them is paper which contributes to 75% of package mass. Board forms package frame giving it its rigidness and durability. Polyethylene composing 20% of package mass protects package wall against moisture penetration and also enables to close the package by sealing its walls with each other. Aluminium foil (5% of package mass) is additional barrier for light and oxygen (asepsis).

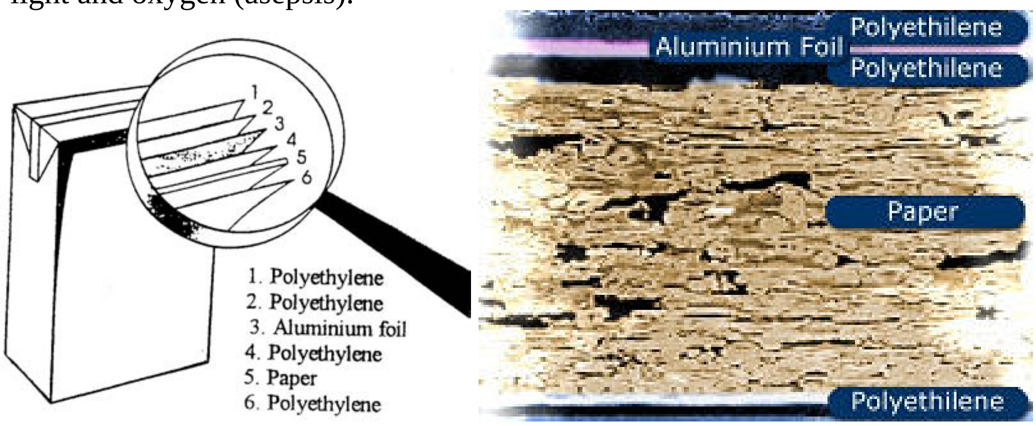

Fig. 1. Typical beverage carton configurations [8, 10]

Aseptic package market increases by 6% to 8% a year. Into such packages more and more liquid food is packed (in Europe about 70 mln liters of liquid food a day) [7]. That’s why it is necessary to manage rationally this kind of package waste.

3. Aseptic packages recycling

We come across quite a few problems while recovering raw materials from aseptic packages. Laminate doesn’t easily undergo the process as the secondary raw material [9]. It is necessary to sort out individual components (paper, aluminium foil, polyethylene). Another problem, which arises here, is the fact that used packages are mixed during collecting and delivery to the waste dump. Therefore before processing these wastes must be sorted. So there should be introduced paper waste collecting infrastructure. It is estimated that amount of such sorted package wastes surpasses 200000 tons worldwide [3].

There are possible various alternative ways of aseptic packages recycling which was shown at the diagram in Fig. 2.

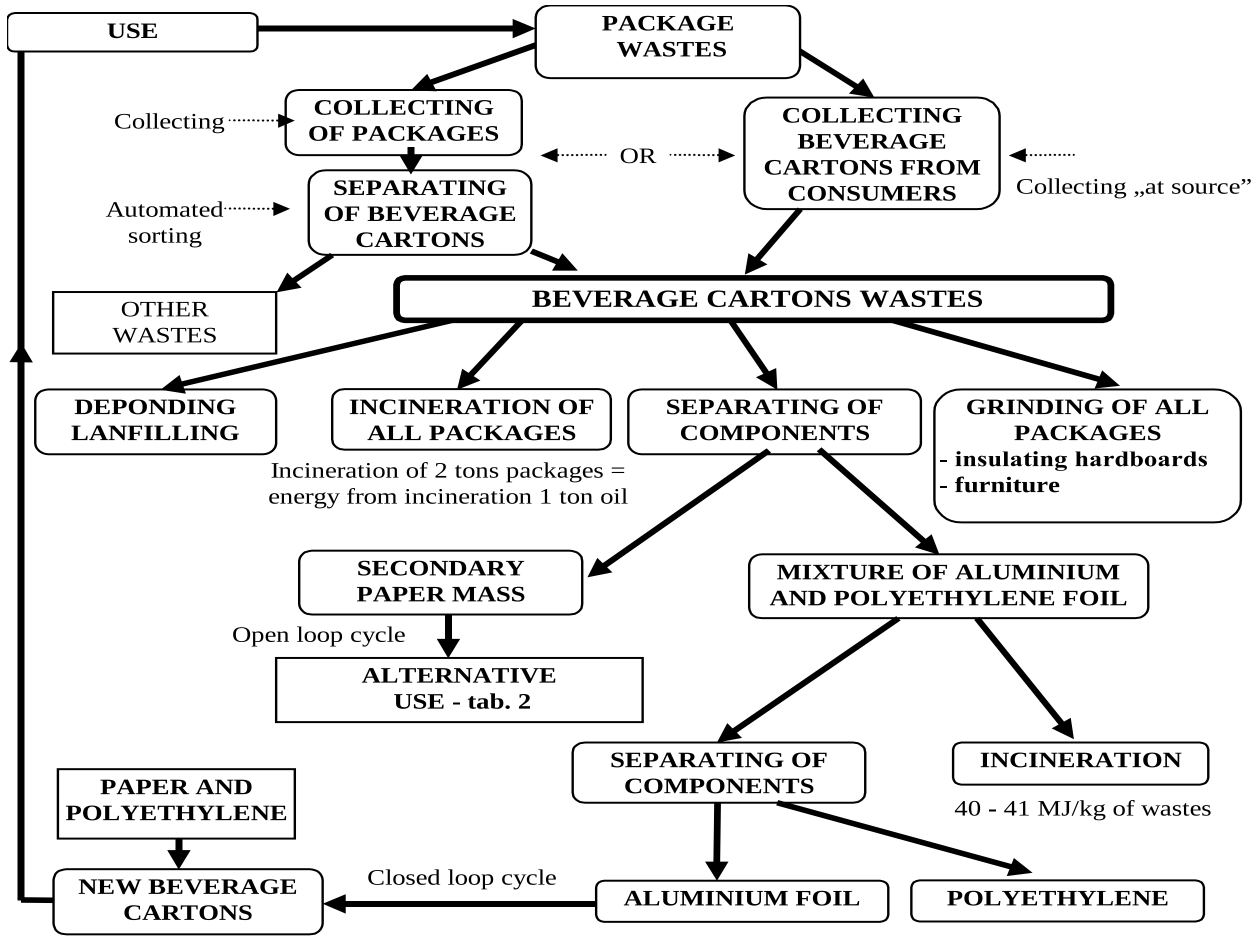

Fig. 2. Various alternative ways of aseptic packages recycling

3.1. Separating and recovery of components

Packages can be utilized as the whole (incineration) or with the separation of individual components. An example here can be Nesa paper mill in Spain where 80000 tons of cartons a year is processed in profitable way [8]. In the process hard pulp fibre is recovered which is suitable for production of sacks and paper bags needed for packing industrial products.

In German factory at Diez in 1990 manufacturing of water-resistant hardboard has began [8]. These boards possess very good mechanical, thermal, acoustic and insulating properties. They can be employed as parquet floor and for production of high quality furniture. They are formed in the heat press moulding of ground packages [3, 8].

For separating paper fiber there can’t be used typical hydropulper where grinding takes place. There are used machines which separate paper fiber by washing it out (Regenex system, FiberFlow system) [9, 11]. Aluminium and polyethylene foil are not crumbled in the process of separating paper fiber. They make so called reject.

Regenex system provides high-dilution fiber washing for deinking. It can also separate fiber from polyester film used in milk cartons, drink boxes, poly-coated cups, and similar items.

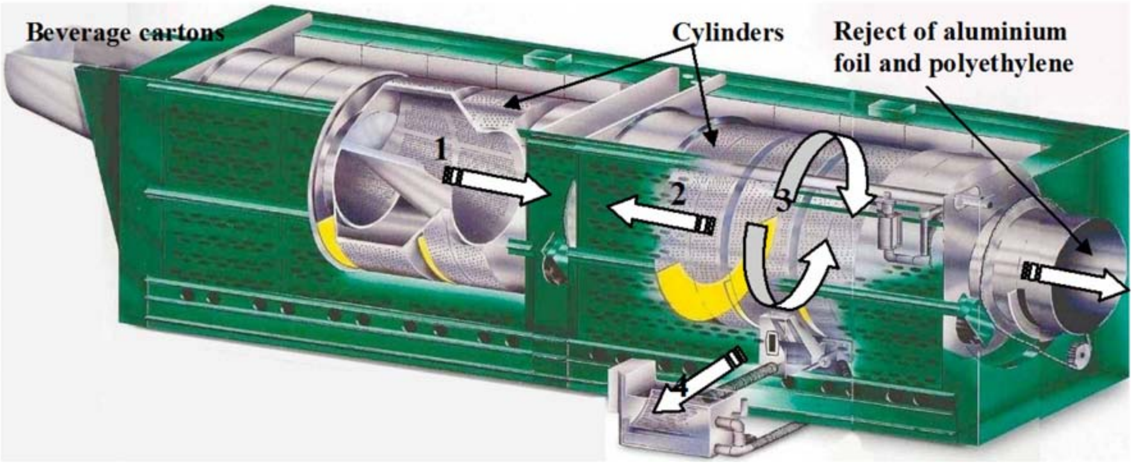

Fig. 3. Single module of Regenex system: 1 - stream of beverage carton mass (integrated perforated transfer scoop), 2 - stream of water (about 4 l/min), 3 - revolutions in both directions of perforated drums, 4 - paper fiber for continued treatment (washing, bleaching, dewatering) [11]

The outer shell of the Regenex system and its inner cylinder enable the machine to create two distinct material transfer paths: one for rejected poly film and the other for cleaned secondary fiber. Thus, the system solves one of the most difficult problems in processing poly-coated materials: separating poly film from fiber and breakdown wet-strength resins. Rejected poly film is removed in sheets or large pieces. The Regenex recovery system is modular. On the Fig. 3 single module of Regenex system was presented.

Pulping and washing processes occur in multiple, connected cylinders, which rotate in synchronization. As the cylinder rotates, stock is lifted from the process water and dropped back into the solution. The resulting mechanical action enhances contaminant separation. Each “batch” moves from module to module by an integrated transfer scoop. On the Fig. 4, an example of all systems of paper fibre separated was presented.

Recovered fiber is not used for production of aseptic packages again because in their production in 80% primary fibre is used [7, 8]. Therefore in case of paper mass we can activate only open loop recycling, where recycled fibres serves as the component for production of the products different from input products. Alternative uses of recycled fibres outside the paper and paperboard industry are presented in Table 2.

Separated foil can be incinerated with energy recovery. Energy value of aluminium foil is the same as burning of coal and energy value of polyethylene is even higher [3].

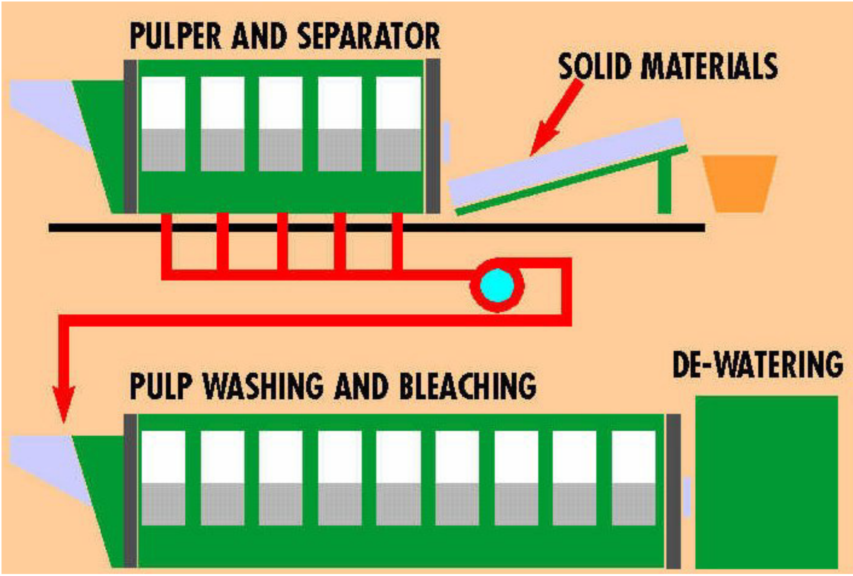

Fig. 4. Example of all systems for paper fibers separated

Tab.1. Examples of alternative uses of paper recycled fibres

ALTERNATIVE USES OF RECYCLED PAPER FIBRE OUTSIDE THE PAPER AND PAPERBOARD INDUSTRY
• MOULDED PULP AND WET-LAID PRODUCTS - egg cartons, fruit trays etc. • INSULATION - cellulose insulation blown into ceilings + additives, moistened fibres (water/glues) - building boards • ASPHALT/FIBRE ROOFING FELT AND GIPSUM WALLBOARD • FILLER - paints, mastics etc. • LOOSE FILL FOR INTERIOR PACKAGING - cushioning and void filling • GROUND COVER, FARMING - boards, shredded • ANIMAL FODDER • CHEMICAL DERIVATIVES - complex carbonhydrate fraction, single carbonhydrate fraction, lignin fraction • COMPOSTING • HOME & SMALL BUSINESS USE - making fire, wrapping & packaging, hobby uses, covering • OTHER SPECIAL USES - pencils, art works etc.

Separating both kinds of foil from the mixture is an alternative for incineration (joint development programme Gränges Eurofoil and Tetra Pak) [3]. In this way it is possible to realize the closed loop recycling for aluminium foil. In the process of aluminium foil recovering processed mixture is sorted gravitationally and magnetically after the separation of paper fiber (Fig. 5) [3, 8].

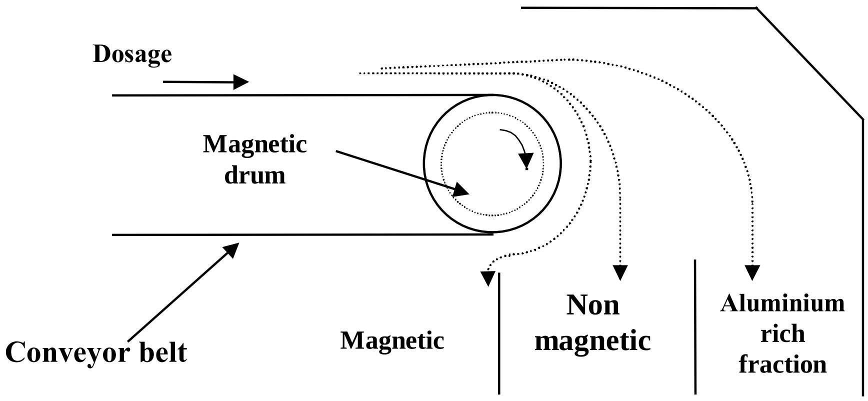

Fig. 5. Eddy current separation

What follows next is thermal separation of aluminium. In the process, the remaining components are incinerated. Obtained aluminium is used for production of foil, which can be used for manufacturing of new beverage cartons. Recovery efficiency of the process is considerable because it reaches to 30 – 35% of foil mass input (In a single one-litre beverage package there are 7g of aluminium foil).

3.2. Incineration with energy recovery

The most popular way of beverage packages recycling is incineration with energy recovery. One typical package weighs 25g. Incineration of 2 tons of used packages brings as much energy as 1 ton of oil [8]. Incineration of the waste, which is left after separation of paper fiber, has also very high energy value, about 40 - 41 MJ per kilogram of wastes. Incineration energy can be applied to many purposes and in this way mineral fuel can be saved.

Incineration process of package waste must take place in strictly defined conditions because of limits of poisonous substances, which can be emitted. European Union recommended the following incineration parameters [1, 2]:

- incineration temperature - higher than 850 ^{0}C,
- incineration time - longer than 2 sec.,
- minimal amount of oxygen - over 6% in the relation to incinerated mass.

Obeying this rules enables to limit emission of pollution (poisonous gasses). Under existing strict requirements defining the highest permissible concentration of poisonous substances in gasses it is necessary to incinerate segregated wastes. The point is to sort out the goods that contain substances which, when incinerated, cause highly poisonous emissions. These are mainly the goods made of polyvinyl chloride, the goods containing compounds of chlorine and also containing lead and mercury. In the case of beverage packages we can state that there doesn't occur high emission of poisonous substances.

In Table 3, there are presented ways of utilizing packages in individual countries of Western Europe. Presented data show that there is considerable contribution of wastes stored at waste dumps. Yet one should notice that there also takes place development of alternative methods of waste utilization (close to 40% of waste mass) [6, 7].

Tab.2. Ways of utilization of packages in individual countries of Western Europe [2, 3, 6]

Country	Mass of wastes in tons	Incineration	Deponding	Composting	Recycling
		%			
Austria	2800	11	65	18	6
Belgium	3500	54	43	0	3
Switzerland	3700	59	12	7	22
Germany	25000	36	46	2	16
Denmark	2600	48	29	4	19
Spain	13300	6	65	17	13
France	20000	42	45	10	3
Italy	17500	16	74	7	3
Norway	2000	22	67	5	6
Holand	7700	35	45	5	15
Sweden	3200	47	34	3	16
England	30000	8	90	0	2
West Europe	1400880	24	63	5	8

4. Summary

Collecting and sorting of used packages has been nearly a daily experience in many countries. Specialists estimate that in 2008 about 25% of beverage packages were recycled. It is significant because of the technological problems, which arise during their sorting and utilization [5, 6].

In the process of beverage cartons recycling it is possible to follow different ways of processing and to choose the optimal one it is necessary to do economic and ecological analyses. An optimal solution will be always the one with minimal financial outlays and maximal limitation of environmental burden. Economic profitability of chosen recycling method will depend on the possible market of recovered materials and on organization of collecting of used packages.

An important requirement for any method of utilization is necessity to sort wastes. One should take into consideration selective collecting of packages “at source” (at customer’s house) or sorting after the collecting stage.

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