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ECONOMICAL POTENTIAL OF RECYCLED POLYVINYL BUTYRAL

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Abstract: The European Union is planning to significantly reduce the landfill of plastic waste from the year 2020. Measures in Slovakia should be launched today, especially in the building industry sector. It is necessary to prepare solutions for the recycling or energy utilization of used plastics materials, including plastic insulating materials. The building industry in Europe consumes up to 1/5 of the total volume of plastics production, it means up to 11 million tonnes. Waste plastics make up to a third of municipal waste in Europe, with nowadays ending in landfills. Up to 80% of plastic products are used once and then discarded. The landfills subsequently occupy a considerable area and inductive of air, water and soil pollution. This is why the measures should start as soon as possible.

Keywords: Economy, used plastics, recycled polyvinyl butyral

INTRODUCTION

One of the basic tasks before launching a new product is to assess its prospective development, in terms of participants and dynamics, to identify:

- key success factors,
- current trends,
- potential risks and
- opportunities. [1]

The starting point is to determine an estimate of the actual size of the market, through various statistics, publicly published financial documents, marketing agency research or own research.

Revenues of primary end-users of plastics waste are dependent on the performance of the general economy, especially for safety glass, which is very important in the automotive and construction industry and in architecture (Figure 1).

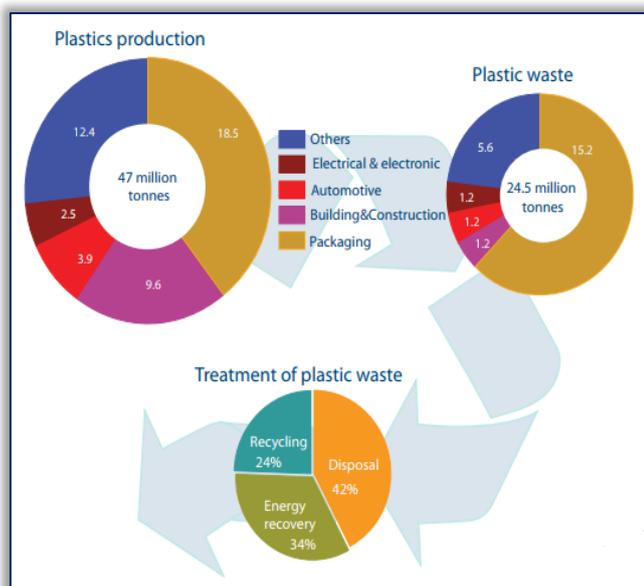


Figure 1. Total plastics waste in the Europe (year 2016) [2]

The European Commission report on the thematic strategy on the prevention and recycling of waste signals a move towards material-specific targets to meet the Europe 2020 objective of promoting a resource-efficient economy. However, an urgent revision, as much as better enforcement of the existing waste and packaging directives seems necessary, to address specific issues concerning plastic waste. Plastic waste could become a valuable resource if separate collection circuits were designed to ensure that single-use plastic packaging could be phased out through an effective roadmap towards the circular economy. In the market, polyvinyl butyral (PVB) resins are highly concentrated and are the domain of four companies - Eastman, Sekisui, DuPont and Kuraray. [2]

PVB is exported to countries with expanded car production. In most advanced countries, such as the United States, Western Europe and Japan, but also in the Middle East, demand for PVB is still high. In the context of the use of the security foil, PVB was especially preferred for architectural areas, such as laminated safety glass. PVB is a huge potential for the emerging market as a safety glass. [1], [2]

Figure 2 shows the location of the polyvinyl butyral sheet between the glass sheets and the safety glass.

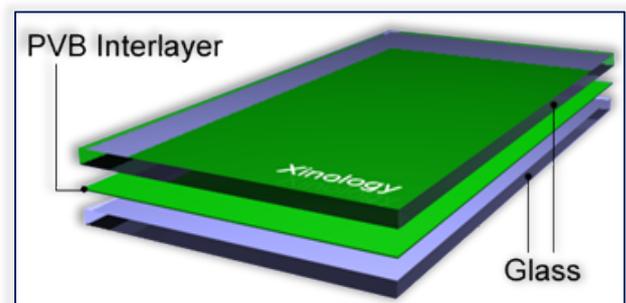


Figure 2. Polyvinyl butyral interlayer in the safety glass [3]
PVB film is one of the most important parts in the interlayer of a car glass or safety glass. Laminated glass, commonly used in architecture and the automotive industry, contains a

protective interlayer, most of which is a PVB that forms a fuse between two glass sheets. [3]

In terms of solar energy, there is a prediction that the fastest growing area of the PVB end-user, with regard to the compound annual growth rate, is projected to increase by more than 6% between 2015 and 2023. [1], [3], [5] In terms of volume of PVB produced, the Asian region in 2014 contributed to more than 35% of the share of PVB use in the global market. The use of PVB film on the market in Latin America, the Middle East and Africa is expected to increase significantly over the next 8 years, mainly due to the increase in land transport and construction as end users [6].

The key producers of PVB are Eastman Chemical Company, Kuraray CO., LTD., Sekisui Chemical Co., Ltd., Li & Fung Group Co., Ltd., Kingboard Chemical Holdings Ltd., Huakai Plastic (Chongqing) Co., Ltd., Zhejiang Decent Plastic Co., Ltd., Tiantai Kanglai Industrial Co., Ltd., and Zhejiang Pulijin Plastic Co., Ltd. [4] These companies are working to actively research and develop new applications for the usability of PVB films and also to improve polyvinyl butyral itself, which are the composition and the subsequent properties. General areas of application are:

- coatings and primers
- printing inks for packaging
- films for laminated safety glass
- binders for ceramics and metal powders
- adhesives
- retroreflective coatings for traffic signs and road markings
- binders for a wide range of special applications
- use in thermoplastic applications

Polyvinyl butyrals meet the requirements for an enormous number of applications, e.g. interlayers for safety glass, paints, lacquers, varnishes, printing inks, temporary binder for ceramics and adhesives.

The PVB [8] application is mainly implemented in automotive industry, building industry - in architecture, solar energy and other areas.

RECYCLED POLYVINYL BUTYRAL

Polyvinyl butyral, which forms a safety interlayer in windscreens or building glasses, by material recovery takes the form of flakes having a size of 2-20 mm and a thickness of 0.5 mm to 1.5 mm (see Figure 3).



Figure 3. Recycled polyvinyl butyral [8]

The granulate form is a more convenient alternative to the preparation for the next usability. Polyvinyl butyral, as thermoplastic material, is soluble in ethanol, butanol, ethyl acetate, butyl acetate, in a mixture of chlorinated hydrocarbons and insoluble in aliphatic hydrocarbons (in gasoline). The density of polyvinyl butyral is about 1.07 g.cm³, and the recyclable sales price is 0.25 € to 0.50 € per kilogram.

— Application of recycled polyvinyl butyral

The laboratory preparation of recycled polyvinyl butyral is an important step to the successful end of the stated goal. Since polyvinyl butyral is loosely stored in big bags after recycling, there is of course the absorption of ambient moisture by the material itself. Recycled polyvinyl butyral contains impurities that are still present at the end of the recycling process, due to processing, packaging, storage. [5], [7] It is therefore necessary to get the material to the most suitable processing state before starting the process.

— Recycled Polyvinyl butyral used by laboratory experiments

Recycled polyvinyl butyral used in research has the following parameters (Table 1).

Table 1. Basic characterization of recycled polyvinyl butyral

Recycled polyvinyl butyral (PVB)	
Form	flakes
Colour	clear
Size	20-30 mm
Purity	more as 97%
Impurities	less as 3%
Humidity	ca. 2%
Glass particle	less as 2%
Fire point	-
Softening temperature	130 °C - 170°C
Viscosity (dynamic)	100 – 175 m Pa*s (DIN 53015)
MVR (Melt Volume Rate)	6 – 7 cm ³ / 10 min
MFR (Melt Flow Rate)	5 – 6 g / 10 min

CONCLUSIONS

From the economic point of view, the use of this raw material is advantageous compared to the use of the primary raw material, since the price per kilogram ranges from 0.25€ to 0.50€ per kilogram. From a technological point of view, the consumer's properties of the material are not diminished (with the respect of selected application).

From the environmental point of view, minimization of waste material and its accumulation in waste dumps was achieved. In the area of exploring new materials, it is first and foremost important to understand and respond to the basic economic issues:

- What to produce?
- How to produce?
- For whom to produce?
- Why manufacture?
- What price to produce?

If these questions are answered and the solution options are worked out, then the work is successful. Nowadays, this is

evidenced by companies that have been on the market for decades.

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