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## RECYCLING OF AUTO GLASS FROM ASPECT OF TECHNOLOGICAL IMPACTS ON SOME PARTS OF RECYCLING PROCESS

**Abstract:** Glass is a significant component of the ELV which in a process of treatment poses a constructive challenge for equipment. The advantages of recycling auto glass are both, economic and environmental. The paper discusses about some parts of recycling process from aspect of technological impacts. In this paper also will be shown possibilities of using recycled auto glass and impact of recycling autoglass on the environment.

**Keywords:** recycling, auto glass, ELV, technology, environment

### 1. INTRODUCTION

Recycling of motor vehicles contains different procedures (manual separation, shredding and physical separation methods) which allows obtaining final products of similar materials (metals, plastics, rubber, glass, etc.). [5]

Glass is a transparent amorphous silicone dioxide, which has a properties:

- Strength,
  - transparency,
  - inertness and
  - biological inactivity. [1]
- The properties of glass depend on:
- chemical composition (relationships and type of components),
  - the procedure of obtaining,
  - processing methods and
  - method of additional processing.

All characteristics of glass can appear in different forms and combinations which results a large number of glass products. Depending on the chemical composition of glass can be lime and lead.

The ability of easy processing at higher temperatures, mechanical strength at room temperature, transparency, chemical stability, low thermal conductivity which allows the use of glass as an insulating material, as well as small electrical conductivity which allows the use of glass as the dielectric are characteristics which make glass widely used. [1]

Transport vehicles for auto glass mostly

use tempered glass, which has better mechanical characteristics. The firmness of tempered glass is 3-5 times higher on impact and has 5-8 times the tensile firmness of the bending than an ordinary flat glass. [1] One of characteristic of glass is bigger steadiness on temperature load and thermal shock.

### 2. GLASS IN MOTOR VEHICLES

Vehicle manufacturers are faced with many specific, and often conflicting, requirements when designing and constructing automobiles. Every component, and the material from which they are made, must adequately perform its primary function, must be durable, must contribute to the appearance, comfort and style of the vehicle, and above all must be safe. Recently, issues such as weight savings and recyclability of the component at the end of its useful life have become contentious. All these have to be attained within tight budgetary limitations. With regards to glass, it must satisfy all of the above criteria by having excellent impact resistance and breakage predictability, whilst being completely unobtrusive in terms of optical clarity.

Motor vehicles contain two different types of safety glass:

- toughened,
- laminated. [2]

Laminated glass is a type of safety glass that holds together when shattered. In the

event of breaking, it is held in place by an interlayer, typically of polyvinyl butyral (PVB) or ethylene-vinyl acetate (EVA), between its two or more layers of glass. The interlayer keeps the layers of glass bonded even when broken, and its high strength prevents the glass from breaking up into large sharp pieces. This produces a characteristic "spider web" cracking pattern when the impact is not enough to completely pierce the glass. In the case of the EVA, the thermoset EVA, offers a complete bonding (cross-linking) with the material whether it is glass, polycarbonate, P.E.T. or other types products.

Toughened or tempered glass is a type of safety glass processed by controlled thermal or chemical treatments to increase its strength compared with normal glass. Tempering puts the outer surfaces into compression and the inner surfaces into tension. Such stresses cause the glass, when broken, to crumble into small granular chunks instead of splintering into jagged shards as plate glass (aka: annealed glass) creates. The granular chunks are less likely to cause injury.

### 3. ENHANCED PROTECTIVE GLASS (EPG)

In recent years there have been significant technological advances in the production of auto-glass. The reasons for intensive progress on this development are certainly acting on the basic characteristics:

- weight reduction,
- improving the level of passive safety,
- protection from UV radiation,
- improving the level of protection from noise and vibration, etc. [3]

A new trend in the automotive industry is that the side windscreen and rear windscreen of a vehicle produced by a multilayer EPG (Enhanced Protective Glass) glass latest generation which significantly reduces the level of noise which penetrates into the vehicle.

This type of auto glass in big way decreases noise inside which comes from the flow of air and wind.

EPG sandwich is made from firm EPG sandwich napravljen je od cvrstog polyvinyl

butyral (PVB) which is placed between layers of glass under the high heat and pressure. PVB absorbs vibrations in the glass, which has a important impact on decrease a level of noise in vehicle. This type of glass has a same thickness as the classic glass but they are but are lighter and up to 10 %. The structure of the EPG "sandwich" is consisted from outside glass layers from which is the anti-UV layer separated with two layers of polyvinyl butyral. The total glass thickness is 3.8 mm. [3]

EPG glass produced as a sandwich with a middle layer of special plastic (polyvinyl butyral) it is extremely difficult to pierce or separate from the glass layer. Even when it breaks glass layer remains inextricably linked to the plastic layer, contrary to conventional glass that shatters into the thousands of pieces. This glass represents an important element of passive safety of passengers. with own characteristics which are similar to windshield they have important impact on reducing of aftermath traffic accidents.

EPG glass with built-in anti-UV coating reduces the impact of solar energy and up to 60 percent, and reduce the temperature inside the vehicle that is exposed to sunlight for 15 - 20 °C. [3]

The process of pulverization auto glass is a more complex process than ordinary glass pulverization, one of the reasons is protective film on it, which must be removed. Glass pass through the press where it breaks, and thereafter foil is separating into the rotary cylinder.

### 4. RECYCLING OF AUTO GLASS

From aspect of possibility repeating of recycling, glass presents one of the best recyclable materials. Beside characteristic that can be recycled countless times, glass is material which can be totally recycled, which means that from one ton glass splinter, with the addition of energy, we can produce one ton of a new glass, thereby is closing the circular flow of products. [1] This condition makes glass very recyclable material.

### 5. STRUCTURE OF RECYCLING WINDSHIELDS

The windshield is composed of two layers

of glass separated by a plastic film from PVB (polyvinyl butyral). In the event of a breakage, the pieces of glass will remain stuck to the plastic film to limit the risks of cuts or wounds. To recycle windshield glass, it is necessary to remove the plastic film from the glass. Year-to-date, the available resources to recycle the windshields are very limited and also very expensive. [2]

## **6. SAFENESS OF AUTO GLASS RECYCLING**

Recovering glass from ELVs is a labour and energy intensive activity. The question has to be asked considering the overall energy consumption and pollutant generation, is it environmentally beneficial to collect and process ELV glass from an extensive network of vehicle dismantlers? Clearly, recovering ELV glass within the existing vehicle dismantling infrastructure is not financially viable at present, and may not even be of significant environmental benefit.

Technically, ELV glass is almost certainly recyclable, but the cost penalty is so large at present as to render it unacceptable. Not only do relatively small amounts of glass have to be manually removed from a widely distributed ELV population, but the resultant material would then have to be stored, appropriately segregated with minimal contamination, until it can be transported to a reprocessing centre. There are additional technical problems with re-processing automotive glass. In heated rear windscreens the silver heating elements are fired into the glass. In addition, the trend away from the gasket sealing technique towards using direct bonding to fix glass into body apertures (an arrangement that contributes significantly towards car body strength and rigidity) has further ramifications. Here the glass is glued into place using a very strong polyurethane adhesive. This not only renders the glass extremely difficult to remove in one piece but under certain circumstances could lead to problems with adhesive contamination of the cullet. To further complicate matters, the thick layer of adhesive is hidden from view by the outer sections of the glass panes being ceramically printed to render them opaque. This introduces another contamination problem. These problems are not insurmountable but the downstream processing and sorting techniques

required are sophisticated and expensive. [2]

## **7. ENVIRONMENTAL IMPACT OF RECYCLING**

The recycling of glass can save more than 19% of energy compared to the production of natural materials. For every 10% of used glass splinters saves 2.5% of energy, and with each tone used splinters of glass saves 1.2% tonnes of natural raw materials. [1]

Of all the basic elements used in the production of glass from primary raw materials, soda most polluting environment. One ton of soda contained about 950 kg of sodium chloride (NaCl), which significantly increases the concentration of salts in the water. Increasing glass splinters in the preparation of the glass significantly improves the balance of the environment.

## **8. USE OF RECYCLED AUTO GLASS**

Glass that can not be reused for manufacturing the same, it is using in the construction industry as a concrete additive.

Recycled glass has been applied in the production of pellets, supersol that is using in construction, water treatment, the furniture industry, as well as insulating materials and others.

It is also applied in the production process of semi-finished products for television screens, in the production of ceramic products for medicine, for making glass asphalt, as well as abrasive.

Using glass as a medium for the filtration of water, we get an effective substitute for sand or diatomaceous earth, whereby there is the advantage that unclean glass can be easily cleaned and reused. [1]

Granulation of glass dust enables use of glass in construction. Waste glass is milling in a crusher, and then in the mill. The powder is mixed in a mixer with admixture and with the water, which produces obtaining a paste. The paste is supplied to the extruder where received a preform and dured. From the extruder glass falls into a rotating disk, where under the influence of circular movement occurs granules oval in shape, then granulate goes for further processing. [1]

## 9. CONCLUSION

With the development of science and technology, man is for his needs create a large number of materials of complex chemical composition. That types of materials, due to their complexity difficult or even not be degraded naturally or during their decomposition can be considered infinite. Deposition of that materials, regardless of

whether on a regulated or illegal dumps pose a potential risk of environmental pollution. The recycling of these materials, in addition to economic benefits, the man protects the environment, which results in higher quality and healthier life of the man himself. [4]

With the constant improvement of existing systems and with their response to the new problems it can affect on the recycling of ELV's.

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