Laminated Car Windscreen Recycling

Case Study Background

The European Commission (DG XI) is currently drafting a Directive on End of Life Vehicles (ELVs) which will establish regulations for dismantling, recycling and disposal. This includes targets of 85% by weight of vehicles to be recovered and reused by 2002, rising to 95% by 2015. A similar EC project group is considering “demolition waste”.

Glass contributes between 4 and 5% to the total weight of a vehicle and also comprises around 5% of total building weight. Much of this glass is laminated and there is an increasing trend in both industries to increase this percentage due to enhanced safety and security requirements for vehicles and for hurricane, blast and vandal resistance in buildings. Commercial processes exist to crush laminated glass and separate it into cullet and plastic interlayer flakes. The glass is recycled, but there is a growing stockpile of used interlayer that is proving difficult to dispose of. There are no applications for reclaimed interlayer and current disposal options are incineration and landfill.

Faced with the situation of an increasing stockpile of waste interlayer from recycled glass laminate and no acceptable disposal option other than incineration with energy recovery, Pilkington is considering the economic case for the development of alternative, recyclable interlayers for laminated glass.

Objective

“Environmental comparison of alternative polymeric interlayers in car windshields for their potential to be recovered and recycled.”

Polymers Under Analysis

Currently polyvinyl butyral (PVB) is the interlayer used. This was compared to three other materials.

- Polyvinyl Chloride: Sekisui “S-LEC”
- Ethylene Vinyl Acetate where n ≈ approx 140
- Polyurethane: Morton “PE192”
- Polyvinyl Chloride: Sekisui “Neomute”

Background and Foreground System

The “foreground” system is the system under analysis; it exchanges material and energy with the background system. Foreground data has been generated from primary research, whilst all background data has been obtained from DEAM or other publicly available databases.

Summary and Conclusions

The results from the first life cycle indicate that glass is the main contributor to the environmental impact of the system studied. It is difficult to clearly identify one particular polymer interlayer that has a higher environmental impact than any of the others in this study. PVC shows less economic impact than other interlayers. PVC and EVA both show a greater potential for recycling within the first cascade and it is clear that the cascaded use of these materials lead to a reduction of both environmental and economic impacts.

First Life Cycle Results

Human Toxicity

Air Acidification

Economic Analysis

Nine impact categories were used to assess the life cycle impacts of the windshield. The two charts above highlight that float glass production is the greatest contributor to both human toxicity and air acidification. This operation is extremely energy intensive, with high acidification and toxicity due to the formation of SOx and NOx during fuel combustion. The impact of the windshield production is different for each of the interlayers due to the different autoclave temperatures needed to soften each of the polymers before they will adhere to the glass. The impact is mainly due to SOx and NOx formation, with some additional hydrogen chloride (HCl) formed from PVC during the autoclave operation.

The economic analysis chart indicates quite clearly that polyurethane is by far the most expensive polymer interlayer whilst polyvinyl chloride is the least expensive. The material cost, particularly of the polymers, is the greatest contributor to the overall economic burden. The costs of energy associated with production are minimal in comparison.

Cascaded System

The separation levels achieved during windshield dismantling and the purity specification required by the recyclate customers result in many of the original polymer properties being retained. These utilities were used during the comparison with the specification for alternative cascades of use. Both PVC and EVA were matched for applications such as cable sheathing and other soft coverings whilst no further use for PU or PVB were found. The glass was assumed to go to landfill. The results for cascaded use of PVC shown below highlight that a cost reduction of 8% was achieved in addition to a reduction in all impact categories studied.

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