



RECYCLING OF MIXED POLYOLEFIN WASTES

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Abstract

The mass of usage of secondary plastics are mostly determined by their quality and price. Therefore it was essentially to collect and evaluate the related aspects and expectations from the potential secondary-plastics users. To enable this in the frame of the W2Plastics EU7 project (Magnetic Sorting and Ultrasound Sensor Technologies for Production of High Purity Secondary Polyolefins from Waste) an adequate questionnaire was worked and sent out to automotive plastics end-product manufacturers. With the evaluation of these questionnaires basic parameters for the technology development in the frame of W2Plastics project were determined.

Key words: market analysis, mixed polyolefin waste, recycling of plastics

1. Introduction

The European consumption of plastics increased from 24.6 million tons in 1993 to 39.7 million tons in 2003 and its growth rate exceeds that of the economy as a whole. At the same time, polymer recyclers and manufacturing industries have a problem buying raw materials and secondary polymers of sufficient volume and quality, as a result of the increasing demand of China and India on all raw material resources. The alternative of using more primary plastics has a range of environmental impacts and needs more resources (about two kg oil for one kg plastic). The polymer resources in complex wastes, such as waste electrical and electronic equipment (WEEE), household waste and automobile shredder residue (ASR) (according to the European Automobile Manufacturers' Association (ACEA) there were 7.5 million tons of shredder residue in the EU17 in 2002), are largely unused, because of the problem to produce high-purity products from such sources at acceptable costs. Today just one million out of 14 million tons of polyolefin yearly sold in Europe is being recycled. W2Plastics aims to develop cost-effective and clean technology based on

magnetic density separation (MDS) (Bakker et al., 2009) and ultrasound process control to recover high-purity polyolefins from mixed wastes. A substantial effort is spent on making the new technologies fit in between the state-of-the-art technology of waste processors and the demands of the compounding and manufacturing industries by defining standards and best practices as well as effective quality-control tools (hyperspectral imaging) (Farcomeni et al., 2008). The integrated set of technologies and standards aims at changing the status of complex wastes to a resource of high-purity polyolefins for a wide range of industries. The development of such technology is in line with the European legislation (COM/2001/0031, 99/31/EC, 2000/53/EC, 2002/96/EC, 2003/108/EC) aiming at fostering the development of environmental-friendly technologies to reduce the environmental impact of human activities, to protect the environment, to minimize depletion of resources and to promote at the same time business opportunities and improved competitiveness of European industry and SMEs.

As a starting point of the project an adequate questionnaire has been worked about the use of the secondary plastics and sent to automotive plastics

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end-product manufacturers in order to determine the basic parameters for the technology development and upgrading possibilities (Keszei et al., 2005) of secondary raw materials.

2. Case Studies

Two questionnaires were compiled, one for plastic suppliers of the automotive industry and one for plastic processing companies. They were translated to the national languages of the participants and sent to their industrial partners.

The following questions were asked from the companies taking part in this survey:

2.1. Questions for plastic suppliers of the automotive industry

1. Did you perform any investigation concerning applications possibilities of recycled plastics in your primary products?

2. Do you use recycled plastics in the production of primary products?

If your answer for question 2 was YES, in the followings please ignore questions marked with b.

If your answer for question 2 was NO, in the followings please ignore questions marked with a.

3a. To which extent and to which products can you add recycled plastics?

3b. Could you use recycled thermoplastic plastic materials in any step of the production process as secondary raw material?

4a. In which components or component groups can you use recycled plastics?

4b. In which production process could you integrate the recycled plastics and how would you use it?

5. To which extent are you using secondary plastics in the production of the primary products? (%)

6. Do you use your own plastic waste in the production of the primary products?

7. Are you willing to accept plastic waste from external suppliers?

8. If you accept plastic waste from external suppliers, which quality expectations do you have and is there a specification system for this, approved by both partners?

9. Do you have own sorter, separator for the sorting of the received waste, or fulfilment of the quality requirements depends only on the supplier?

10. Which is the upper limit of the application of secondary plastics still acceptable? (%)

11. How important are the following aspects when selecting secondary raw materials?

(Please select from 1-5: 1 not at all, 2 not really important, 3 somewhat important, 4 important, 5 most important)

- hardness
- elasticity
- flexural modulus
- fibre reinforcement
- constant composition
- density

- processability
- flame retardancy
- (long term) heat resistance
- thermal properties like Vicat or HDT
- water barrier properties
- gas barrier properties
- UV-stability
- weathering resistance
- recyclability
- environmental issues (evolution of toxic species during degradation)

12. How important is keeping a stable composition ratio?

13. How would you process the secondary raw materials?

14. Which MFI value fluctuation is still acceptable for you?

15. Do you have own initiations to increase the application ratio of the recycled materials?

16. Do you perform R+D for your own or for others' purposes to facilitate the use of recycled plastics?

17. Is there a concrete demand from the car manufacturing companies to supply secondary materials or to increase their ratio?

18. Do the car manufacturing companies show resistance against the use of secondary raw materials?

19. If you have experienced resistance against the use of secondary raw materials, how do the car manufacturing companies decline their use?

20. According to you, which legal and economical facilitating steps could increase the ratio of recycled plastics used in the production of primary products?

21. What happens to the production waste, side products, industrial refuse?

22. Would it facilitate the application of recycled plastics in your case, if the price of the production waste would be deducted from the price of the secondary raw materials?

2.2. Questions for plastic processing companies

1. How much and which quality industrial and communal waste do you collect from your partners?

2. Do you qualify the recycled plastics to be applied?

If yes, with which methods?

3. What is the purity level of the collected waste (how contaminated, mixed it is)?

4. In which form do you use the received material?

5. Which technologies do you use to process the plastic waste?

6. Do you utilize mixed plastics?

If yes, which technology do you use?

7. Do you have own separator for the sorting of the mixed waste?

8. Do you perform (or let perform) R+D to facilitate the use of recycled plastics?

9. Do you have connections with car and plastic manufacturing companies, which would supply recycled plastics?

10. If you supply recycled plastics, do you have a written and approved specifications for these materials?

11. What is the ratio of material recovery, energetic recovery and deposit in your case?

12. According to you, which legal and economical facilitating steps could increase the ratio of material recovery?

13. Do you possess the necessary capacities (machines, HR, technical, technological) for the utilization?

3. Results and Discussion

Each partner (Transilvania University of Brasov, Urban (Romania), Budapest University of Technology and Economics, Alcufer Kft. (Hungary)) evaluated the results of their own industrial partners. Due to confidential industrial data only the overall conclusions are going to be discussed, the names and answers of each company are not going to be

3.1. Results from Transilvania University of Brasov

The Transilvania University of Brasov (UniTBv) team contacted 45 plastic industry companies and Association of owners from the plastic processing industry (ASPAPLAST). 4 companies returned the questionnaire.

Conclusions for the plastic suppliers of the automotive industry are summarized below:

- There are performed investigations concerning possibilities of using recycled plastics in the primary products.

- There are used recycled plastics in the production of primary products.

- Products where are added recycled plastics: non food products, especially for invisible parts, according customer specification, for thermo-blowing up to 100%, for injection up to 40%.

- There are used own recycled plastics and also recycled plastics received from customer.

- In some cases are accepted recycled plastics from external suppliers, they must be agreed by the car manufacturer.

- The material must fulfil the technical specification established at the validation and each lot is accompanied by the conformity certificate. The taking over of the lots is accompanied by analysis certificates based on technical specification.

- Only one plastic producer has his own sorter of materials inside company, only for the own plastic wastes after grinding.

- The supplier of recycled plastic must be responsible for the quality.

- The upper limit of the application of secondary plastics acceptable is 20...100%.

- It is very important: elasticity and constant composition.

- It is important: fibre reinforcement, processability, recyclability, environmental issues.

- The keeping of stable composition ratio is very important.

- The secondary raw materials are used together with virgin material, according the mixing formula.

- The MFI value fluctuation is according the technical specification and material type, in one case MFR 45 – 50.

- The using of the recycled materials is possible only with customer's approval.

- The questioned companies don't perform R+D to facilitate the use of recycled plastics.

- Only one customer asks the using of secondary materials.

- The car manufacturing companies show resistance against the use of secondary raw materials.

- The car manufacturing companies decline their use of secondary raw materials because: gives non-homogeneities of the raw material, decreases the properties of the products, and influences the quality of products.

- To increase the ratio of recycled plastics used in the production of primary products is important the understanding between supplier and car manufacturing company and the decreasing of price.

- The production waste, side products and industrial refuse are recycled by specialised companies or are recycled inside company, with some limitations.

- The producer of plastic products must inform the customer about the increasing of secondary materials using. The decreasing of production's price increases the level of acceptance by the customer.

Conclusions for the plastic processing companies are summarized below:

- Companies do not collect from their partners, industrial and communal waste.

- The recycled plastics are applied. The methods are by grinding or according to their technology.

- 99% of the collected waste is contaminated with metallic particles.

- The received material is used as granules, grinded at specific size.

- To process the plastic waste the plastic producers use grinding technologies with special mills.

- For mixed plastics the plastic producers use manual mixing.

- The plastic producers didn't have their own separator for the sorting of the mixed waste.

- The plastic producers didn't perform (or let perform) R+D to facilitate the use of recycled plastics.

- Some plastic producers have connections with car and plastic manufacturing companies, which would supply recycled plastics.

- Some plastic producers have written and approved specifications for recycled plastics.

- The plastic producers recover their own waste plastics between 50% by blowing and extrusion and 2-5% by injection.

- The increase of the ratio of material recovery does not depend from legal and economical facilitating steps but depend on the market price.

- Most of plastic producers possess the necessary capacities (machines, HR, technical, technological) for the utilization.

3.2. Results from Urban

Urban sent 9 questionnaires to plastic suppliers for automotive industry and 5 questionnaires to plastic processing companies. Urban received only 3 answers from plastic suppliers for automotive industry and 1 answer from plastic processing companies. The plastic processing companies refused to send their answer because they consider confidential data.

Conclusions for the plastic suppliers of the automotive industry are summarized below:

- From the 3 plastic suppliers for automotive industry only one performed investigation concerning applications possibilities of recycled plastics in primary products and uses recycled plastics in the production of primary products.

- The rate of the used recycled plastics is currently 25% - mainly in building parts, spacers for double glazing windows, etc. - it could be increased up to 50%.

- The constant composition, maintained mechanical properties and low MFI value fluctuation (up to 5%) would be necessary to increase the ratio of the recycled plastics, furthermore subsidy of the products would be preferred.

- Currently some of the industrial refuse is grinded and reused, the rest is incinerated.

- The other 2 companies do not plan to use recycled plastics in primary products in the future, their plastic waste is treated by specialized companies.

Conclusions for the plastic processing companies are summarized below:

- The questioned company received 250 tons waste/month, 30% LDPE and 70% other waste.

- They qualify the incoming materials and have and own sorter.

- The plastic waste is currently re-granulated.

- The ratio of material recovery is 30%.

3.3. Results from Budapest University of Technology and Economics (BME) and Alcufer Kft.

BME and Alcufer Kft. sent out the questionnaire to 37 plastic suppliers of the automotive industry, members of Association of the Hungarian Vehicle Component Manufacturers.

From these 37 companies 10 companies and an independent plastic manufacturing expert returned the filled questionnaire and 2 companies reported, that they do not use recycled plastic and therefore they did not fill the questionnaire.

Conclusions for plastic suppliers of the automotive industry:

- 30% of the companies performed investigations concerning applications possibilities of recycled plastics in their primary products.

- 50% of the companies use recycled plastics in the production of primary products.

- The ratio of recycled plastics, which can be added to the product, depends from the technology, currently up to 50%.

- Recycled plastic materials can be used as secondary raw material mainly in non-visible, non-coloured, non load-bearing parts, when no further processing is done, in non-prestige brands.

- Currently the ratio of the applied secondary plastics in the production of the primary products varies between 5 and 25%.

- 80% of the companies use their own plastic waste in the production of the primary products.

- 30% of the companies are willing to accept plastic waste from external suppliers.

- The plastic waste should have properties similar to the material to be replaced (mechanical, rheological properties, MFI), there is no specification system for the accepted waste.

- The standard UL 746D (UL Standard for Safety Polymeric Materials - Fabricated Parts) declares that if the amount of the added grinded material to the base material is not more than 25%, then the properties are not decreasing in such way, that it would need additional analysis; the biggest problem is caused by the not melting particles, which can cause jamming and damage in the machines.

- 10% of the companies have own sorter, separator for the sorting of the received waste, 30% thinks that the fulfilment of the quality requirements depends only on the supplier.

- The upper limit of the application of secondary plastics depends from the product specification; in case of the questioned companies it varies between 20-50-100%.

- From the 16 mentioned properties the 5 most important are in the order of importance:

- constant composition
- hardness
- UV-stability
- (long)-term heat resistance
- recyclability.

- The recycled plastic material is mainly intended to be processed by injection moulding.

- Maximum of still acceptable MFI value fluctuation is 5-10%.

- Only 1 company has own initiations to increase the application ratio of the recycled materials.

- 2 companies perform R+D for your own or for others' purposes to facilitate the use of recycled plastics.

- There is no concrete demand from the car manufacturing companies to supply secondary materials or to increase their ratio, they only request the suppliers to lower the price.

- The resistance against the use of secondary raw materials on behalf of car manufacturing companies

depends from the type of the product; mainly they only accept the primary materials. The car manufacturers insist on the existing documentation and when denying the use of the recycled plastics, they refer to the standard ISO/TS 16949:2002-Quality management systems -- Particular requirements for the application of ISO 9001:2000 for automotive production and relevant service part organizations.

- Concerning the legal and economical steps facilitating the increase the ratio of recycled plastics used in the production of primary products, the suggestion was to force the producers to take back their products and reuse them or let other companies reuse them.

- In 70% of the companies some part of the production waste, side products and industrial refuse is reused after grinding. Otherwise other company handles it or it is sold, disposed as dangerous waste or is incinerated.

4. Conclusions

This market analysis is based on the results of Romanian and Hungarian companies, however it should be concluded that due to the globalization of the automotive industry it reflects the Europe-wide current state of the sector.

Concerning the attitude of the companies, it can be concluded, that although the ratio of companies answering and/or returning the questionnaire is not very high (14% in Romania and 30% in Hungary), the attitude of the companies about the use of the recycled plastics is rather supportive and positive, even if they do not use them. When they refused to fill the questionnaire, the main reasons were, that they do not use recycled plastics, because their partners do not allow them. Lack of time and other duties as introduction of REACH were also named as reasons.

As general summary, it can be stated that usually the plastic supplier companies only reuse their own waste, only a few companies accept waste from external sources. Generally there is no specification

system for the external plastic waste, it should meet certain agreed parameters, which are controlled by the accepting company or sometimes by the waste supplier.

Currently the ratio of the applied secondary plastics in the production of the primary products varies between 5 and 25%. The ratio of recycled plastics, which can be added to the product, depends from the technology, currently it can be up to 50%. Recycled plastic materials can be used as secondary raw material mainly in non-visible, non-coloured, non load-bearing parts, when no further processing is done, in non-prestige brands.

Constant composition, hardness, elasticity, UV-stability, (long)-term heat resistance, recyclability were the most important parameters, which should be considered in order to increase the ratio of the secondary plastics.

As for the legal and economical steps facilitating the spread of the secondary plastics, many companies declared that even if the most important driving force remains the possibly lower price of waste, it would be considerable take measures to force the producers to take back their products and reuse them or let other companies reuse them. Also it was stated that many automotive companies have unjustified requirements (i.e. they overinsure themselves using only primary raw materials not even allowing the reuse of own plastic waste), which may be altered taking the necessary legal measures.

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