RECYCLED POLYESTER FIBRES USED IN FURNITURE INDUSTRY

BY

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Abstract. Recycling plastics is a priority for most developed countries. One way of recycling the PET packaging, widely used in various types of bottled drinks, is to transform them into fibres. Recycled polyester fibres are used to obtain carpets, fabric for furniture, stuffing for sleeping bags, pillows, mattresses.

This paper presents the results of research conducted on several types of recycled polyester fibres. Were targeted in particular those characteristics in strict connection with the intended use of fibres – pillows for furniture industry.

Key words: recycled polyester fibre, furniture industry, fibre crimping, resilience, capacity of recovery from compression.

1. Introduction

Recycling is the collecting, sorting and processing of some waste components in order to transform them in useful products. Almost all materials contained in waste - paper, glass, plastic packaging, metal boxes - are subject to the recycling process. Among these, plastic materials have an important place.

Recycled plastics are used in the manufacture of a multitude of products, from soft drink bottles and jackets to railway sleepers and car components. Product development using recycled plastics is occurring at an unprecedented rate, driven by the need to reduce costs, increase market share or meet legislative requirements. In some case, it represents the best material at the best price, the recycled plastics being often sold by 20% - 25% below the cost of virgin plastic. The environmental factors are obviously very important [1]. The benefits of recycling process include:

- Reducing the quantity of raw materials and energy for new products;
- Reducing the quantities of waste material deposited in landfills;
- Reducing the health risks and the environment risks;
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− Reducing the pollution of the air and the water;
− Important volume of raw material is reintroduced in the economic circuit.

2. Recycled Fibres from PET Bottles

Nowadays, recycling of plastics is in a continuous development in many countries. Instead to pollute the rivers water or huge surface of land, PET bottles can be easy collected and recycled. Although there is no clear evidence yet, is estimated that the decomposition of plastics can take hundreds and even thousands of years.

PET is gaining an increasing share of the processing market; almost 900,000 t of bottles or 18% form PET consumption being recycled worldwide every year [1]. The main advantage of recycling PET bottles comes from the huge number of bottle used as containers for different kinds of drinks.

The following figures give a clearer picture on the importance and the impact of the recycling process of PET bottles:

− 5 PET bottle of 2l → 1 T-shirt;
− 20 PET bottle of 2l → 1 filter;
− 35 PET bottle of 2l → 1 slipping bag;
− 60 PET bottle of 2l → 1 m² carpet;
− 1 t of recycled bottle → 1.8 t oil.

The recycled PET can be used in different forms, for many applications:

a) Fibres for carpets, filling for cushion, mattress, slipping bags, clothes, upholstery;

b) Sheets and Plates for roof isolation, food boxes (used in refrigerator or microwave oven), various types of boxes or containers, packaging for toys;

c) Band for boxes fastening;

d) Injected forms: components for automotive industry (front radiator grille, door handles), household goods, flooring tiles.

e) PET flakes: admixture of recycled material to virgin PET, paints, mixture with other plastics (e.g. polycarbonate), and glass wool for industrial purposes.

The fibre industry in the United States and in Western Europe has been using recycled PET in fibre spinning for many decades. In USA, Wellman was one of the first companies that have used recycled PET in the manufacture of staple fibre, mainly for fibrefill applications. In Europe recycled PET is being spun into short and long staple fibres for end use as woven, nonwoven and pile fabrics. These fibres can be blended with other staple fibres, natural or synthetic, to produce textiles with the desired strength, texture and dyeing characteristics [2].

In the Eastern Europe, the custom of using PET bottle waste for producing high quality fibre has not been settled yet. In Romania, GreenFiber International S.A. Buzău, is the only company that produce recycled PET fibres. They products are applicable especially in nonwoven industry, but also in textile
industry and special fields as antibacterial or flame retardant. The main products, obtained from regenerated PET flakes, are: solid, solid siliconized, hollow siliconized, hollow conjugated siliconized polyester staple fibre [3].

3. PET Recycled Fibres Used as Filling for Cushions in Furniture Industry

The polyester recycled fibres produced by GreenFiber Buzău are intended to be used as filling for cushion in furniture industry at Taparo SRL Tg. Lăpuş. Therefore, several types of polyester fibres were analyzed at the “Textile Fibres” laboratory of Textile-Leather and Industrial Management Faculty, Iaşi. Fig. 1 shows some images of cross sections of the analyzed polyester fibres and Table 1 presents the fibres characteristics.

![Cross sections of polyester fibres](image)

**Fig. 1** − Cross sections of hollow polyester fibres.

<table>
<thead>
<tr>
<th>Fibre characteristics</th>
<th>7 den/1 hole</th>
<th>9 den/4 holes</th>
<th>10 den/9 holes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density, [g/cm³]</td>
<td>0.875</td>
<td>1.08</td>
<td>1.04</td>
</tr>
<tr>
<td>Crimping, [crimps/cm]</td>
<td>8.5</td>
<td>10.2</td>
<td>8.5</td>
</tr>
<tr>
<td>Crimp stability, [%]</td>
<td>72.8</td>
<td>78.8</td>
<td>56.3</td>
</tr>
<tr>
<td>Air volume, [%]</td>
<td>16</td>
<td>16.28</td>
<td>18.5</td>
</tr>
</tbody>
</table>
Materials used as filling for cushions in furniture industry must meet some characteristics such as lightweight and high resilience.

From Table 1 can be noted that the values obtained for fibres density are close to or less than 1.0 g/cm$^3$. Density of the polyethylene terephthalate used for manufacturing polyester fibres ranges between 1.38 - 1.39 g/cm$^3$. The lower values of the analyzed fibres are due to their internal hollows, which can be observed in Fig. 1. Therefore, using these fibres as filling for cushions in furniture industry will provide lightweight products.

Resiliency, commonly used as criterion to measure the quality of filling materials, is the ability to spring back or return to the original shape after being compressed or depressed by a form of pressure.

It is recognized that after repeated use or multiple compression there is a quantitative loss in the resiliency of the filling. A variety of factors may affect how much resiliency displays a particular filling. Two contributing factors are whether the fibres are “dry” or siliconized and whether are crimped or smooth.

When a cushion filled with crimped PET fibres material is compressed and the load is subsequently removed, the crimped fibres and consequently the cushion will tend to return to its original dimensions. Moreover, the crimped fibres will tend to entangle and cling one-to-another, serving to reduce the migration of fibres out of the cushion. From this point of view, the analyzed polyester fibres show a high degree of crimping (8.5-10.2 crimps/cm) and good crimping stability.

![Fig. 2 − The principle scheme for assessing recovery from compression:](image)

| 1 | outer cylinder (fixed) |
| 2 | inner cylinder (mobile) |
| 3 | fibre sample |
| 4 | weight |

The recycled PET fibres resiliency may be assessed by studying the ability of an amount of filling material to recover its original thickness after the application and removal of a certain load. In one such test (Fig. 2), an amount of crimped PET fibre (3) is placed in a cylinder with perforated bottom (1) and its thickness - $d_0$ is measured. A compressive load, which depends on the weight (4) placed on the second cylinder (2) is then apply evenly across the top surface
of the loose fibres, for a certain period of time and the sample thickness - $a_1$ is measured. Weight value is calculated so that the pressure on the fibre sample is equivalent to the pressure of a human body in sitting position, on a product (eg. furniture cushion) filled with the analyzed fibres. After the removal of compressive load, the sample thickness - $a_2$ is measured again.

The sample thickness before compression, after compression and after relaxation is determined by measuring the segments shown in Fig. 3.

![Fig. 3 − Deformation of fibre sample: $l_0$ – original size; $l_1$ – size after compression; $l_2$ – size after relaxation.]

The following relationship can be used to calculate the capacity of recovery from compression $C_{rev}$:

$$C_{rev} = \frac{\varepsilon_{rev}}{\varepsilon_{tot}} = \frac{a_2 - a_1}{a_0 - a_1} \cdot 100$$

where: $\varepsilon_{rev}$ – recovered deformation; $\varepsilon_{tot}$ – total compression deformation; $a_0$, $a_1$, $a_2$ – sample thickness before and after compression and after relaxation;

As can be seen in Fig. 3, the relationships between dimensions $a$ and $l$, are as follows:

$$a_0 = l - l_0; \quad a_1 = l - l_1; \quad a_2 = l - l_2$$

By replacing these expressions into relation (1), the following relation for the capacity of recovery from compression is obtained:

$$C_{rev} = \frac{l_1 - l_2}{l_1 - l_0} \cdot 100$$

The results obtained from tests carried out on four lots of polyester fibre produced in China and two lots of fibre produced by GreenFiber Buzău are presented in Table 2.
Table 2

<table>
<thead>
<tr>
<th>Fibre source</th>
<th>China 1</th>
<th>China 2</th>
<th>China 3</th>
<th>China 4</th>
<th>HCS/32 mm</th>
<th>HCS/64 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>l₀, [mm]</td>
<td>19</td>
<td>15</td>
<td>13</td>
<td>15</td>
<td>16</td>
<td>17</td>
</tr>
<tr>
<td>l₁, [mm]</td>
<td>15</td>
<td>13</td>
<td>10.5</td>
<td>12</td>
<td>13</td>
<td>12</td>
</tr>
<tr>
<td>l₂, [mm]</td>
<td>17</td>
<td>12</td>
<td>12</td>
<td>13</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>C_{rev}, [%]</td>
<td>50</td>
<td>50</td>
<td>60</td>
<td>33.33</td>
<td>66.66</td>
<td>60</td>
</tr>
</tbody>
</table>

As it emphasised by the experimental results, the recycled polyester fibres produced by GreenFiber Buzău presents the best resiliency, expressed by the capacity of recovery from compression [4]. For this behaviour may explain the degree of crimping and the surface treatment (the fibre are siliconized).

4. Conclusions

The recycled polyester fibres represent a valuable resource both for textile industry and for furniture industry. Markets for these fibres include clothing, carpet, nonwoven textile and also filling for cushion, mattresses, slipping bags.

The polyester fibres produced by GreenFiber Buzău can be successfully used as filling for cushions in furniture industry.

Received: September 29, 2009

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REFERENCES


FIBRE DE POLIESTER RECICLAT PENTRU INDUSTRIA MOBILEI

(Rezumat)

Reciclarea materialelor plastice constituie o prioritate pentru majoritatea țărilor dezvoltate. Una dintre varientele de reciclare a ambalajelor din PET, utilizate pe scară
Fibrele de poliester reciclat sunt folosite la obținerea de covoare, stofe pentru mobilă, umpluturi pentru saci de dormit, perne, saltele.

În lucrare sunt prezentate rezultatele obținute în urma cercetărilor efectuate asupra mai multor tipuri de fibre din poliester reciclat. Au fost vizate în mod special acele caracteristici aflate în legătură cu destinația fibrelor – tapițerie pentru mobilă.