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Treatment and disposal of tyres: Two EU approaches. A review

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ABSTRACT

The treatment and disposal of tyres from vehicles has long been of considerable environmental importance. The main problem lies in the mixed composition of the tyres. Studies have been undertaken to modify the structure of the tyres, especially with reference to the percentage of granulated rubber incorporated, in order to improve their performance, and also to reduce their environmental impact during normal functioning (noise, particulates, etc.) and facilitate recycling and final disposal. The aim of the present study is to review and compare how used tyres are treated and disposed of in two different EU countries. The first is Italy, which has been part of the European Union since its inception, and has important industrial traditions. The second is Romania, an emerging country which recently became part of the EU, and whose economic and industrial development has had a major boost in recent years, with a strong growth in waste production, together with consumption in urban areas.

The occasion was useful to consider the situation concerning the evolution of the different aspects related to the management of the end-of-life tyres. In particular, the paper considers the properties of tyre waste and their potential reuse, the enhancement of end-of-life tires and the various types of recovery, such as the reconstruction of tyres and the material recovery. The aspects related to the energy recovery and the use of the life cycle analysis, as a tool to support the choices of the best management system, were also taken into consideration, not forgetting that an adequate end-of-life planning is important when developing a sustainable product, since it can affect considerably its overall life cycle.

1. Introduction

Waste management systems can vary significantly; however the best solutions are those that maximize the environmental performance at an affordable cost (Byström, 2012; Rada et al., 2014; Eriksson et al., 2014; Torretta et al., 2014). The composition of municipal and special waste varies considerably, and globally the number of tyres produced and, consequently, to be disposed of as waste at the end of their life, has increased dramatically.

Currently the total production of tyres in the EU, which are manufactured in about 90 plants, is around 355 million per year, corresponding to 24% of the total world production (ETRMA, 2014).

The recent economic and financial crisis has severely hit the markets of recycled materials and used tyres. EU countries have witnessed a gradual decline in the domestic demand for rubber granules and dust, often due to the demise of firms that had developed. The cuts in public spending and the cost of uncollected receivables have decimated the number of businesses (not only in Italy) and, consequently, the consumption of recycled rubber.

This is not the case for Eastern Europe, thanks to the growing demand for rubber in the countries of the ex Russian Federation, where there are still end-of-life tyre (ELT) management systems and the increasing use of artificial turf football fields and roads paved with modified bitumen. This has led the local demand for recycled rubber to overcome the internal production capacity (Medvedev and Goncharov, 2001; Uruburu et al., 2013).

Similarly, scientific research has always tried to assess new and effective alternative to use the used tyres for energy recovery or for uses that would improve the performance of artifacts. The sectors related to the use of tyres in asphalt and bitumen, rather than in the pavement and cement, were those in which the applied research had more impulse (Lo Presti and Airey, 2013a; Gupta

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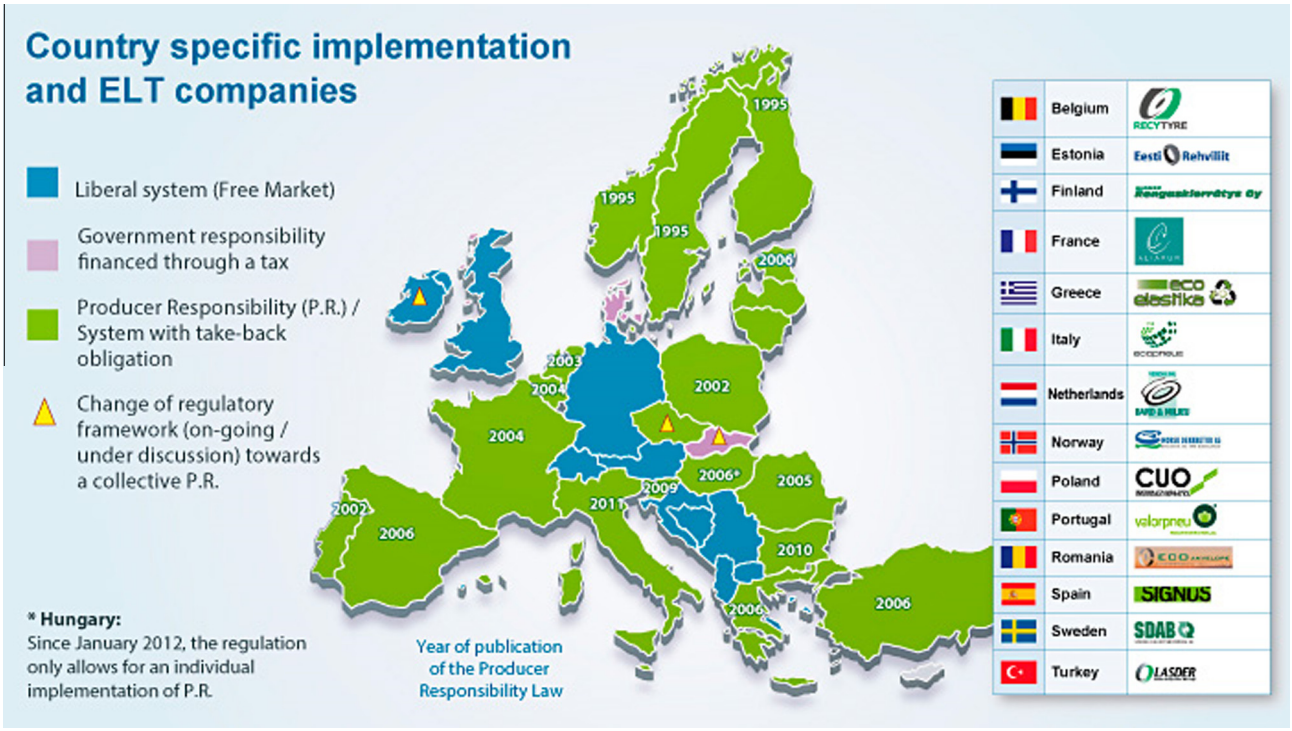

Fig. 1. ELT management in Europe (ETRMA, 2014).

et al., 2014a, 2014b; Martínez et al., 2014; Meddah et al., 2014; Moreno-Navarro et al., 2014; Shu and Huang, 2014).

According to the European Tyre and Rubber Manufacturers Association (ETRMA) since 1999 more than 24 million tons of ELTs were recovered both by energy and material recovery, and in 2010 only 4% of the ELT products ended up in landfills, compared with 96% recovered (38% recovery of energy, 40% recycling of materials, 8% reconstruction, and 10% reuse/export) (ETRMA, 2014). Although the EU promotes three types of tyre management (Sienkiewicz et al., 2012; Clauzade et al., 2010), there are no specific EU standards for the recovery of used tyres. Each member state is free to choose its management system: producer responsibility, taxation, and the free market system. According to the ETRMA report, the annual cost of handling ELTs is around 600 million euros (ETRMA, 2014).

In a free market system, the law defines the legal structure and gives manufacturers the responsibility for organizing the management of ELTs. It is also possible to set up a non-profit corporation to manage ELTs through cost-effective solutions (e.g. Ecopneus in Italy). The producers are obliged to monitor and report to national authorities. Fig. 1 shows the end-of-life management systems of tyres in the EU (ETRMA, 2014).

Romania is often compared to Italy in waste studies (Torretta et al., 2013) because of their common Latin origin and the strong cooperation in industrial and commercial activities (in particular in the last decade). This paper wants to be a contribution to this comparison.

2. Used tyres characteristics and valorisation

2.1. Properties of tyre waste and reuse

Tyres have a mixed composition of carbon black, elastomer compounds, steel cord, in addition to several other organic and inorganic components. Fig. 2 shows a view of this composition (ETRMA, 2014). Tyres are made up of four main parts as follows:

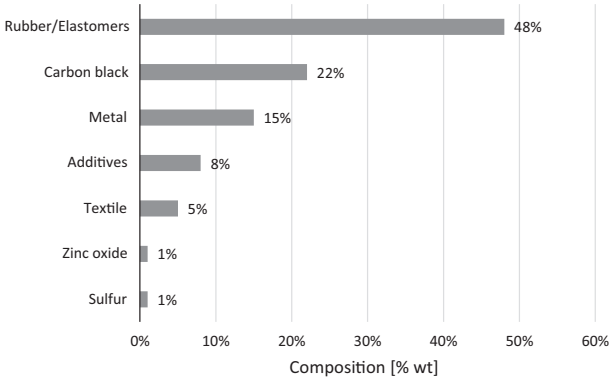

Fig. 2. Average composition of a tyre.

- the tread – designed for contact with the ground and to ensure the proper friction;
- the carcass – the structural part of the tyre on which the tread is vulcanised;
- the shoulder – minimizes the effects of irregularities of the terrain and transfers the load due to braking and oversteering under acceleration;
- the heels – to fit the casing to the rim.

Each compound contributes to the particular characteristics of the tyre, so as to promote longer life and a particular level of friction (Wei et al., 2005; Tuononen, 2008; Yang and He, 2013). An untreated gum is relatively weak and soft. To give the crude rubber robustness and elasticity, it has to be vulcanized in order to create bonds between the molecules.

The rubber thus becomes resistant to abrasion and water, as well as unresponsive to exposure to chemicals, heat and electricity. Another consequence of these treatments is the high resistance to the action of microorganisms, which take more than 100 years