EDITORIAL OPEN ACCESS

If the buildings were made of bottles...

Mariaenrica Frigione

Due to their unique, tailorable and diverse combination of properties, such as good mechanical properties, low density, rather low cost, ease of processing, resistance to most chemicals, *polymers* are nowadays the most widely used materials in diverse different fields.

The world plastic production in 2013 achieved 299 million tonnes, and from Europe 57 million tonnes, the latter level being similar to those in 2012 (Source: PlasticsEurope (PEMRG) / Consultic).

In 2012, 25.2 million tonnes of post-consumer plastics waste ended up in the waste upstream.

Even though recycling and energy recovery processes have increased since 2006, in 2012 around 62% of waste was recovered through recycling (26%) and energy recovery processes (36%), 38% of plastic waste still goes to landfill.

Part of the plastic waste can even find the way into the natural environment, where it represents a source of organic pollution and hazard for animals that can accidentally ingest it, entangle themselves in it, or suffocate from it.

Today, almost all plastics (80%) are synthesized from raw materials which derive from fossil fuels via the petrochemical industry. Thus, their waste represents a loss of precious non-renewable resource of materials.

Nevertheless, an efficient, complete and feasible treatment for any kind of waste polymers remains a difficult challenge: thus, landfilling is still the 1st option in many EU countries! Year 2016 has been fixed as the deadline for the landfill ban.

Compared with other sectors, the packaging sector remains the largest consumer of plastics. In Europe, packaging applications are the largest segment for the plastics industry and represent 39.6% of the total plastics demand, i.e. 46.3 million tonnes (year 2013, Source: PlasticsEurope (PEMRG) / Consultic / ECEBD). Containers and packaging plastics (bags, sacks and wraps, other packaging, other containers and soft drink, milk and water containers) represent the highest tonnage. Plastics' versatility enables an almost infinite variety of thick, thin, rigid or flexible packaging solutions, allowing for maximum protectionof goods with minimum economic material.

Polyethylene (PE) dominates the packaging market, accounting for 56% by weight of all produced packaging, followed by other plastics – polypropylene (PP), polyethylene terephthalate (PET), polystyrene (PS), polyvinyl chloride (PVC) and expanded polystyrene (EPS) – covering most of the remaining 44% (Source: Packforsk – Report no. 194, 2000).

For plastics packaging waste, several recovery methods are available, i.e.:

(i) Mechanical recycling (material reprocessing of waste plastics by physical means into new plastic products; but the collection, cleaning and separation costs can be high, recycling cannot run indefinitely and plastics quality is decreased progressively).

(ii) Feedstock recycling (material reprocessing into basic chemicals, monomers for plastics or use as reductant in blast furnaces; but expensive processes, mainly developed to handled homogeneous streams, such as PET bottles).

(iii) Alternative fuel replacing fossil fuels in production processes (e.g., cement kilns) or for power generation; but waste of non-renewable resource.

(iv) Direct energy use, as an example from municipal waste incinerators, generating heat and electricity; but loss of resources and raw materials, polymers can release toxic substances

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into the environment, possibly contributing to acid rain (Greenpeace actively worked on these issues). Optimum recovery is often achieved by using a combination of these.

The availability of several recovery methods provides a flexibility of options which, combined with continuous improvements in waste collection methods and separation techniques, has meant that approximately 40% of plastics packaging waste is being recovered in Western Europe. This means, however, that 60% of plastic waste is still lost in landfill.

The search for alternative means of packaging recycling is an "evergreen" research challenge.

Polyethylene terephthalate (PET) is one of the most common consumer plastics used and is widely employed as a raw material to realize products such as blown bottles for soft-drink use and containers for the packaging of food and other consumer goods. PET bottles, in particular, have taken the place of glass bottles as storing vessel of beverages due to its lightweight and easiness of handling and storage.

If in 2007 a world's annual consumption of PET drink containers of approximately 10 million tonnes was reported, which shows perhaps 250 million bottles. A recent report from an ongoing series of packaging market forecasts from SmithersPira predicts that by 2019 global consumption of PET packaging will grow to over 20 million tonnes. On the other hand, the number of recycled or returned bottles is still very low: the empty PET packaging is generally discarded by the consumer after use and becomes PET waste (WPET).

The exponential growth in plastic waste from packaging incited a search for alternative means of recycling.

So why not to re-use the PET bottles in an apparently quite far area, such as construction industry?

Total annual production of concrete is approximately 15 billion tons. If PET bottle scraps could be industrially and systematic employed as raw materials for the production of concrete this would benefit the environment in many different ways. It has been proven, in fact, that PET bottle (short dispersed) particles can satisfactorily replace the fine aggregates, enhancing somehow the final properties of concrete. This solution will be also able to reduce the waste of natural resources, such as mineral aggregates. Furthermore, plastic wastes often have less weight per unit volume than concrete aggregates. Therefore, if they replace concrete aggregates, the unit mass of concrete structures will decrease.

Nowadays, research is very active in this field, lots of experimental studies are present in literature, not always concordantly each other. As few examples, some authors report that the PET-concretes are very resistant in both compression and flexure compared to conventional Portland cement concrete [1, 2], others report that the compressive strength and elasticity modulus of concrete are reduced after the direct inclusion of plastic [3]; the tensile strength has been found generally increased, due to the bridging action of fibers in concrete; referring to workability of fresh concrete, some literature reported an increase in workability with the addition of some percentage of waste PET while others reported an opposite influence, probably due to the different shape, size, mechanical properties and origin of waste plastics. It is generally recognized, however, that if a proper mix design is identified, improvements of mechanical and physical properties can be achieved in PET-modified concrete.

The cost of producing polymer concrete from waste plastics, however, is still high. Nevertheless, from an ecological point of view, economic and energy-conserving benefits are possible from the incorporation of waste PET in concrete without any particular treatment. The main advantage of recycling PET in concrete is, in fact, that this plastic material does not have to be purified, nor the removal of colors is required, like in other PET recycling applications.

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Authors declare no conflict of interest.

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REFERENCES

1. Siddique R, Khatib J, Kaur I. Use of recycled plastic in concrete: a review. Waste Manag 2008;28(10):1835–52.
2. Frigione M. Recycling of PET bottles as fine aggregate in concrete. Waste Manag 2010 Jun;30(6):1101–6.
3. Kim SB, Yi NH, Kim HY, Kim JHJ, S YC. Material and structural performance evaluation of recycled PET fiber reinforced concrete. Cement & Concrete Composites 2010;32(3):232–40.

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