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Bioplastics: A Smart Approach to Waste Reduction

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Properties

Plastics is a very important class of materials, with numerous market applications, due to their unique combination of properties, such as:

- simple processing
- light weight
- chemical and corrosion resistance
- good mechanical properties per weight
- recyclability
- versatility
- incorporation of reinforcing fillers to produce composites with ultra high strength and stiffness
- low cost

Global impact

- In the second half of the 20th century, plastics became one of the most universally-used and multi-purpose materials in the global economy.
- Today, plastics are utilised in more and more applications.
- The plastics industry has benefited from many decades of growth, with an average yearly expansion of 8.7% from 1950 to 2012.
- Plastics have become an essential part of our modern lifestyle and economy.

Applications

- Packaging applications are the largest sector representing 39.4% of the total plastics demand.
- Building and construction is the second largest sector with 20.3%
- Automotive is the third largest sector with a share of 8.2%,

followed by:

- Electrical and electronic applications with a 5.5%
- Agricultural applications which have a share of 4.2%.
- Other application sectors, such as appliances, household and consumer products, furniture and medical products comprise a total of 22.4%.

Industry numbers

- In 2012, the European plastics industry, including producers, converters and machinery, employed more than 1.4 million people.
- Despite the global financial crisis, the labour force is now growing and approx. 30,000 new jobs have been created, which shows that the European plastics sector is slowly but steadily recovering.
- In terms of turnover, the European plastics industry has not yet reached pre-crisis level. In 2012 sales volumes showed a slight decrease for both sectors:
  - Producers by 87 billion euro
  - Converters by 202 billion euro in sales.

Industry challenges

- The continuing recession in Southern European countries as well as significant declines in manufacturing production lead to a 0.3% contraction in terms of GDP in the European economy.
- The competition in the industry is constantly growing and plastics markets are increasingly shifting towards Asia and specially China.
- This shift of the market combined with a stricter European regulatory framework adds to the challenges that the European plastics industry faces to maintain its level of competitiveness.

Environmental impacts

- Plastics are not considered toxic. However, they have been accused of potentially containing residual monomers, polymerisation chemicals, degradation products or additives with toxic properties.
- Hazardous substances and degradation products, may be released during the life cycle of a plastic product.
- Several of the chemicals used to produce plastics are considered hazardous.
- The management of plastic waste and especially disposal in landfills is another major criticism

Trends in plastic waste production

- Since 2009, the total amount of post-consumer plastics waste production has been increasing in Europe, but since 2011 it has remained at more or less the same level with 25.2 million tonnes generated in 2012.
- There is a positive trend in the recovery and recycling of plastics in the EU-27.
- In 2011, 59.6% of plastics were recovered, while in 2012 this increased to 61.9%.

Trends in plastic waste management practices

- Total Recovery increased by 4% and this growth shows a continuously strong trend.
- Collection for mechanical recycling shows a growth of 4.7%, while feedstock recycling even on a lower level of 86.000 tonnes increased by 19.4%.
- Energy recovery increased by 3.3%.
- Reduction of 5.5% of plastics disposed of in landfills, also shows a general positive development.

New Technologies

- Today's R&D focusses on the production of degradable polymers, under the combined action of UV radiation and atmospheric oxygen. Similar to those, are the biodegradable plastics, based on macromolecules with chemical structure that enables degradation by micro-organisms or enzymes.
- Composite materials (e.g. a plastic matrix containing starch) are considered as part of this class. Another approach to biodegradability is the growth of micro-organisms specified for degradation of commodity plastics.

Biodegradable plastics

- Polymers susceptible to biodegradation are aliphatic polyesters, polyethers and polyamides.
- Interestingly, copolymers of lactic acid with various aromatic hydroxyl acids were synthesized by simple polycondensation and studied together with homopolymers deriving from the same monomer (PLA).
- PLA shows good mechanical strength, thermal plasticity, fabricability and can undergo chain scission into the human body to give oligomers and finally monomeric units of lactic acid, which are fully resorbable as a natural product.

Biodegradable plastics

- One of the most positive aspect of PLA production, in comparison with other hydrocarbon-based polymers, is the decrease of CO_2 emissions, undoubtedly a highly important contributor to global climate change.
- Because CO_2 is absorbed from air when corn is grown, use of PLA has the potential to emit fewer greenhouse gases compared to competitive hydrocarbon-based polymers.
- “Net” or “residual” emissions are calculated as total emissions from the cradle to the factory gate minus CO_2 uptake that occurs during corn production. This amount is negative from present PLA production. It means the total CO_2 consumption from the cradle to factory is more than its emission to the environment.

Trends in the production and use of bioplastics

- The broader class of bioplastics was expected to show over 40% yearly growth in the five-year period 2010-15
- Because of the fragmentation in the market and ambiguous definitions, it is difficult to describe the total market size, but estimates put their usage in the US around 572,000 in 2010, and almost 1,460,000 tn in the EU.
- The global consumption of all flexible packaging is estimated at around 12.3 million tn, which suggests a huge market, capable of absorbing the new products as substitutes of the existing.
- Renewable resources, such as biomass, are now under consideration for this purpose.

The anticipated market share of Bioplastics

COPA (Committee of Agricultural Organisation in the European Union) and COGEGA (General Committee for the Agricultural Cooperation in the European Union) have made the following assessment of the potential of bioplastics in different sectors of the European economy:

- Catering products: 450,000 tn/y
- Organic waste bags: 100,000 tn/y
- Biodegradable mulch foils: 130,000 tn/y
- Biodegradable foils for diapers 80,000 tn/y
- Diapers, 100% biodegradable: 240,000 tn/y
- Foil packaging: 400,000 tn/y
- Vegetable packaging: 400,000 tn/y
- Tyre components: 200,000 tn/y

Total: 2,000,000 tn/y

Conclusions

- Bioplastics might prove to be a smart solution to waste reduction and are expected to show over 40% yearly growth in the five-year period ending 2015.
- From 2000 to 2008, the worldwide consumption of biodegradable plastics based on starch, sugar and cellulose has increased by 600%.
- With the global consumption of all flexible packaging in the proximity of 12.3 million tn, estimates put their usage in the US at about 572,000 and almost 1,460,000 tn in the EU for the year 2010 .
- COPA and COGEGA assessed the potential of bioplastics in European economy at a total of 2,000,000 tn/y.