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THE "GREEN" IMAGE OF POLYOLEFINS

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Abstract: Polyolefins, because they are produced by non-toxic monomers such as ethylene and propylene and due to the minimum pollution impact during production and use and low-thermal capacity during processing, have achieved a recognized "Green image".
This environmentally friendly image is founded also on the ability of replacing a number of materials and the possibility of contributing to solve the growing problem of recycling plastic parts at the end of their life.

INTRODUCTION

As we move into the 21st century, the plastics industry, fueled by discussions in society about sustainability, reproducible natural resources and conservation of fossil resources, may will shift from an about all petroleum-based industrial economy to one that encompasses a broader base of "green" materials, including not only "green monomers", but also plant derived starches and fermentation by-products.
On the other hand, biodegradable plastics, also if the persistence of plastics in the environment, the shortage of landfill space and concerns over emission during incineration will spur efforts for additional research, currently and in the near future, seems likely to see applications primarily in the medical, agricultural and pharmaceutical fields.
In fact the replacement of conventional plastics in application such as building, construction, transportation, automotive, electronics, packaging and other industries using long life materials still remains the true challenge for biodegradable materials.

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In these application sectors it is necessary to design materials that exhibit structural and functional stability during storage and use, yet are susceptible to microbial and environmental degradation upon disposal, without any adverse environmental impact.

Performance issues may include mechanical integrity (over a range of temperature, relative humidity, time), adaptability (thermal property, rheology), and production-related factors (cost, availability of materials, plasticizer requirements, compatibilizers).

Maintime researchers achieve the ability of balancing degradability and performance of materials, the environmental problems arising from traditional plastics and other large volume materials (i.e. metal, glass and paper) must be managed improving production, process, design and recycling technologies to optimize the related eco-balance.

In fact the interaction of materials with environment is associated with their production stage, their conversion in semifinished or manufactured components, the use and disposal of components.

Polyolefins, considering these major stages of life-cycle and the ability of replacing a large number of materials, appear to be in line with the development of an environmental-friendly policy, aimed to the prevention of biological and chemical pollution, the conservation of natural resources and energy recovery.

Therefore this large family of products, showing not only a huge growth in terms of volumes but also a very large envelope of properties and performances, has improved his image in comparison with both the other polymers and the traditional materials.

The fact that the most recent environmental and ecological discussions concerning plastic materials have not involved polyolefins confirms that they have achieved a recognized "Green" image.

The following paragraphs are an attempt to demonstrate the reasons of this favorable reputation.

POLYOLEFINIC MATERIALS EVOLUTION

Polyolefins consist exclusively of carbon and hydrogen atoms which, through an ingenious process technology are rearranged from feedstock, derived from petroleum by-products, to form a highly versatile family of polymers which enjoys today a large range of applications.

Polyolefins (polyethylene and polypropylene), with an annual production of 40.5 million metric tons, account for almost 60% of the plastic market.

While polyethylene is the largest-volume polyolefin, polypropylene is the fastest-growing one with current consumption of about 14 million tons a year and annual growth rates of 6 to 8%.

Fig. 1 shows polyolefins share of global plastics consumption.

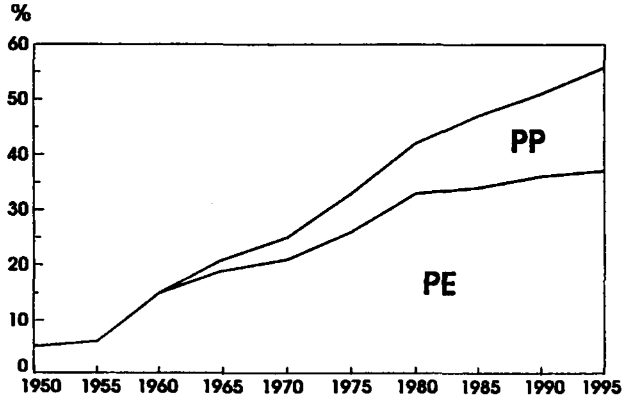


Fig. 1. Polyolefins share of global plastics consumption

Initially, polyolefin production technology was rather complex, difficult, costly, and limited, in terms of versatility and range of properties.

The processes were complicated, expensive, with no flexibility and with high pollution risks for the many operations, chemicals, solvents involved with many undesirable and expensive by products and effluents.

It was necessary to simplify the production processes, and to enable the polyolefin materials by broadening dramatically the property envelope, expanding the boundaries towards the areas dominated by other more sophisticated, expensive and often environmentally problematic materials.

Today, tanks to the continual research effort of Montedison, Himont and now Montell, polyolefin production process evolved from the conventional slurry process, using low yield catalyst to the very versatile, low energy consuming, and non-polluting close loop Spheripol process, using very high yelds catalysts.

Fig. 2 shows schematic flow sheets of above mentioned production process.

The tremendous simplification occurred is evident, also by Fig. 3, showing the evolution of polypropylene process in terms of energy consumption and steam and cooling water needed.

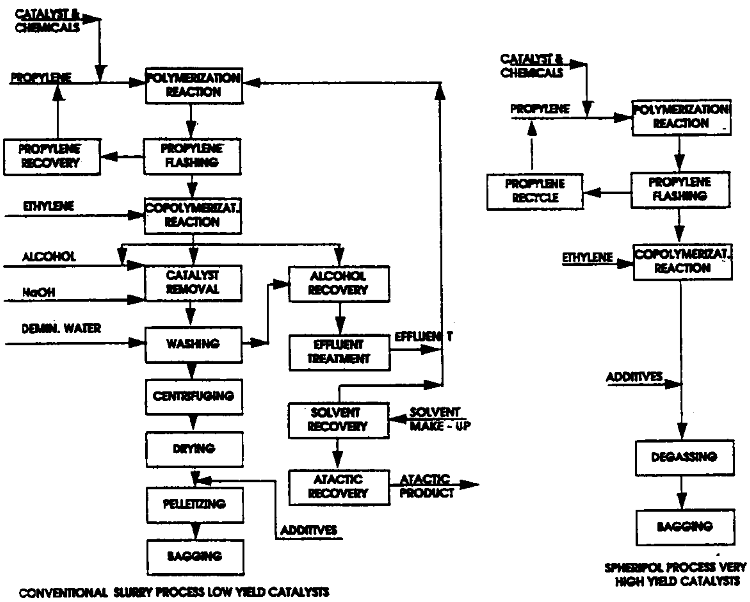


Fig. 2. Technological evolution of the PP production process

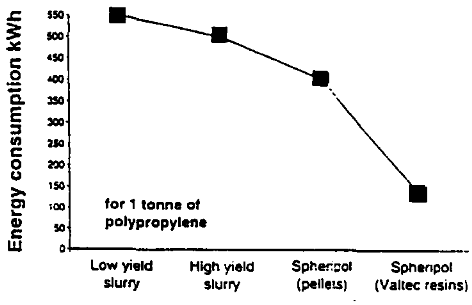
The Spheripol process was so successful and such a big leap forward in polypropylene polymerization that more than 50% of global production of polypropylene is now based on licenses from Montell.

The key of this success, still in progress, is the evolution in Ziegler-Natta catalysts, that, in addition to the production process simplification, allows the "replica phenomenon" resulting in a final polymer shape that is an exact copy of the original catalyst particle.

The shape industrially preferred is the spherical one, but the final structure can be reproducibly varied from a relatively uniform density to a layered and even hollow porous structure.

This granule of polymer can provide a solid reaction bed within which other monomers can be introduced and polymerized to form a polyolefinic alloy. The resulting technology, called "Reactor Granule Technology" (RGT), represents a real revolution in the Ziegler-Natta polymerization technology (Ref. 1).

It is so born the Montell's proprietary Catalloy process, designed to make maximum use of RGT by allowing the repeated introduction of different monomers during the polymerization of propane to generate a multiphase, multipolymer alloy directly in the reactor.



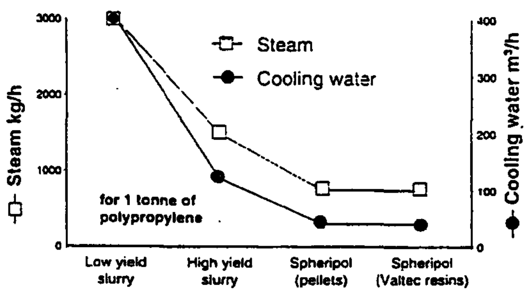


Fig. 3. Evolution of polypropylene process performance

With this process, it has been possible to produce polymers with the following characteristics:

- Broad molecular weight distribution, high molecular weight, and high stereoregularity.
- Random copolymers containing up to 15% of comonomers.
- Heterophasic alloys containing up to 70% of multi-monomers with the best balance of stiffness and impact resistance.
- Products with high rigidity (as high as 2400 MPa)
- Products with low modulus (80 MPa to 500 Mpa).

The extreme consequence of RGT is represented by the possibility of polymerizing inside the granule non-olefinic monomers.

This emerging technology is called Hivalloy and it makes possible to produce a family of new polyolefin-based materials expected to bridge the performance gap between polyolefin materials and engineering plastics (Ref. 2-3).

In this way the property envelope can be significantly increased, as shown by Fig. 4.

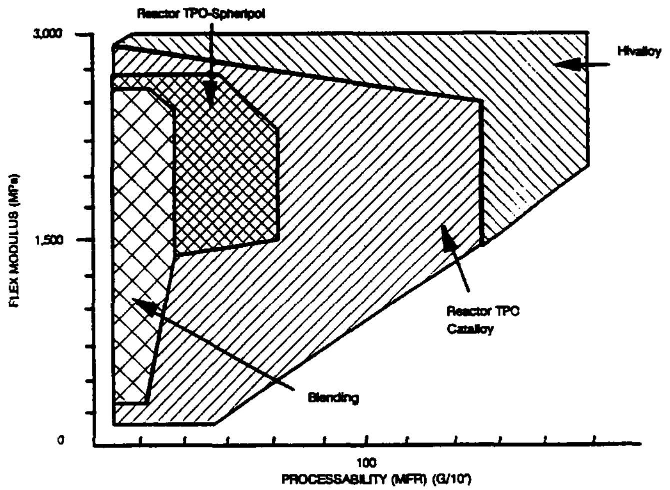


Fig.4. Montell Thermoplastic Materials Property Envelope Development

The very last advanced frontier followed by Montell is represented by the possibility of extending the RGT approach to metallocene catalysts (Ref. 4).

The positive results already obtained seem demonstrate that the polyolefinic-based materials will continue to provide the most cost-effective solution for a wide and ever-increasing range of applications in the global plastic market.

The ability to develop a wide range of properties from a family of polyolefin-based resins, however, is not just a cost-performance and economic advantage. It can also contribute to solve the growing problem in the wider acceptance of plastics: the environmental need of recycling plastic components at the end of their life.

In fact the RGT is able to produce, by non polluting processes, a homogeneous family of plastic alloys inherently compatible, so that these materials can be blended and recycled by melt extrusion without the need of separation to produce useful components.

Alternatively, being primarily hydrocarbons, they can provide a clean burning fuel source and can be incinerated without the pollution problems associated with burning of other polymers.

Montell use the term "Homalloy" to describe these unique family of materials hawing performances fully competitive with many different plastic resins in a wide variety of applications.

THE HOMOMATERIAL STRATEGY

The large number of plastics used to fit the complex mission of technical articles and the disproportionately high cost in the dismounting of different plastic components have a negative impact on the recycling process.

In addition, different polymers are, universally, incompatible and can only be recycled into an useful part or application if separated or mixed with a specifically designed compatibilizer.

Polyesters, Polyamides, Polycarbonates, Acrylonitrile/Butadiene/Styrene (ABS) and Acrylic polymers all require different compatibilizer systems if they are to be recycled and reprocessed without separation.

As a result of this, in a car, for instance, only the metallic fraction is recovered, while the plastic materials continue to be eliminated by deposition in refuse dumps.

Thanks to the availability of novel Montell's Homalloy materials and specifically studied conversion technologies, it is possible to contribute to the solution of this problem using, for all components of the plastic systems to be recycled at the life and, materials of the polyolefinic-based family.

This "homomaterial strategy" allows an easy and direct recycling of the scraps and the recovery of the whole homomaterial system.

Greater efficiency will be obtained if, through a planned design, an easier disassembly of the component is studied.

This concepts have been successfully applied to automotive industry (car interior trims and bumpers), tanks to the availability of polyolefinic eco-leather (made with Catalloy resins via extrusion, embossing, and thermoforming), and polypropylene foams made with High Melt Strength (HMS) polypropylene by extrusion.

The homomaterial strategy is now under extension to home appliances, packaging and construction sectors.

In implementing this strategy, of paramount importance is not only the availability of novel polyolefinic materials but also of specifically developed conversion technologies.

Among the last ones it is important to quote new laminating and forming techniques (exploiting the affinity of polyolefin-based materials in order to obtain, in one stage operation, multi-layered complex structures), new extrusion foaming and advanced steam sintering processes, improved blow molding and injection molding technologies.

Homomaterial components, in addition to direct recycling possibility, are economically convenient and, on the basis of a correct eco-balance analysis, have a lower environmental impact, if compared to the traditional ones (Ref. 5).

CONCLUSION

Waiting for future development of "green" polymers having a well balanced degradability and performances, the environmental issues arising from "petro" polymers, which indeniably contribute to our quality of life, can be managed selecting options in line with optimum eco-balance.

Polyolefins, thanks also to continual research effort of Montell, are at farefront of plastics technology and offer exceptional advantage in terms of product purity and pollution free, low energy consuming production.

In addition, their recyclability and over growing envelop of properties support their selection as a homomaterial option for most of industry sectors.

The benefits of polyolefins are well recognized and reflected by their consistent high growth over the years.

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