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Role of Blending Technology in Polyethylene Recycling

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1. INTRODUCTION

World production of plastics has increased from 1×10^6 tons to 1000×10^6 tons over the last half-century. The current concern regarding the disposal of industrial and postconsumer waste in diminishing landfill sites and the general impact of waste on the environment have drawn attention to the need to develop effective reclamation and recycling policies. The high visibility of waste products arising from plastics packaging, which accounts for about 30% of total plastics consumption, has contributed to the perception of plastics as a major environmental problem [1].

The world population at large is rapidly developing a growing sensitivity to the burgeoning problem of what to do with solid wastes. The growing movement to recycle plastics waste into new products holds a dual benefit for the consumer society. First, plastics are less expensive than most other materials. Second, the conversion of used plastics into new longer-life products reduces the volume of plastics in the ever-growing municipal solid waste stream. As a contributor to the waste stream, the plastics industry fully recognizes the role of its products as part of the problem. However, with active recycling and development of new uses for plastics waste products, the plastics industry can decisively commit to be part of the solution [2]. Additionally, plastics recycling has the potential to offer the advantages of material recovery, feedstock recovery, and energy recovery [3, 4].

Therefore, the plastics industry, including resin suppliers, equipment manufacturers, processors, and distributors, must pay attention to this situation. The recycling of plastics is at an embryonic stage. Hence, the development of appropriate collection and separation infrastructures, recycling techniques, and markets for recycled products will be required in the future to meet the current recycling targets [5, 6].

As both the industrial and municipal solid waste crisis worsens with further industrial growth and population expansion, and new studies continue to demonstrate the adverse environmental impact of old-fashioned dumping methods, postconsumer plastics must be recycled for transforming into useful applications [7, 8]. However, for the recycling of plastics to succeed, four distinct phases need to be considered [2, 9]: collection of postconsumer plastics, sorting by type, reclamation (recovery of material into salvaged and usable form), and end-use (a way for the recovered material to be used again).

Of the above four interrelated phases, from the technical viewpoint, reclamation is the most important. In this regard, polymer blending technology holds bright promise because of the following factors [10–14]:

1. Blends are more economical to produce and generally have a lower technical risk than developing a new polymer or polymeric grade. They offer a cost-effective means to fill the gap in performance of existing materials.
2. Blends usually improve the critical properties required for end-use. New materials, with properties either unique or intermediate between those of the blend components, are produced. Table 1 includes a selected list of the plastics properties that have been improved, in general, by blending technology.
3. Blends often increase revenue/sales without major expenditure or capital investment.
4. Blends offer commodity plastics producers an easy way to enter the lucrative specialty segment of the business.
5. Waste plastics materials (both primary and secondary) may be turned into useful products by blending them with similar or different resins/plastics [3, 5].
6. Polymer blending technology has the potential to produce plastics with various degrees of stability [15, 16].

TABLE 1

A Selective List of Plastics Properties Improved Using Polymer Blending Technology

Processability	Strength, toughness, and dimensional stability
Ductility	Impact strength
Tack/lubricity	Aging, abrasion, and chemical resistance
Heat deflection temperature	Low-temperature impact/flexibility
Flame retardance	Permeability
Environmental stress cracking	UV/biodegradability

Despite the above advantages, if polymers (virgin or postconsumer) are blended based on operational experience, but not following scientific study, both product qualities and effective recycling will suffer.

2. THERMOPLASTIC BLENDS

The commodity thermoplastics are polyethylenes (LDPE, LLDPE, and HDPE), polypropylene, polyvinyl chloride, polystyrene and polyethylene terephthalate. It has already been mentioned that polyethylenes rank at the top of postconsumer thermoplastics [17, 18].

Blending LLDPE with LDPE and HDPE has achieved several remarkable applications in plastics manufacturing technology [19, 20]. The greatest effect has been on the reduction of overall resin cost in the film and bag industries. The physical properties of the film and drawdown capabilities have been improved over those of LDPE and LLDPE using LLDPE/LDPE blends. Such blends have also improved optical property, processing equipment output rate, and bubble stability without modifying already existing film-blowing equipment. However, the tear strength of these blends has