Sustainable Polyethylene Cable Jacket Compounds Containing Recycled Material

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ABSTRACT

The trend for more sustainable, circular solutions continues to be a driver in the wire & cable industry. One approach has been incorporation of recycled plastic as a partial or complete replacement of virgin polyethylene resins in jackets. This paper presents performance of compounds containing different types and sources of recycled streams in virgin polyethylene systems. The compounds shown meet most critical jacket application requirements such as mechanical properties and environmental stress crack resistance.

KEYWORDS

Fiber optic, cable, jacket, sustainability, polyethylene, post-consumer, post-industrial, recycled plastic.

INTRODUCTION

The trend for more sustainable and circular solutions continues to be a driver in the wire & cable industry. There are many different aspects of sustainability including more sustainable, safer materials, decarbonization, reduced environmental impact, and conservation of resources. For example, one approach has been incorporation of recycled plastic as a partial or complete replacement of the virgin polyethylene resins for cable jackets. It has been shown that jacketing compounds based entirely on post-consumer recycle (PCR) feedstock are known to have wide variability in quality and can be deficient on some key properties such as long-term aging performance [1, 2]. Due to their high installed investment costs, telecom cables are expected to last for 25+ years, the carbon footprint/kilometer/year of cable installed already represents great sustainable value. At the same time, the industry is looking for ways to further enhance this great sustainable value by further incorporating recycled plastic content without sacrificing the long-term performance of the cable.

In general, there are broadly two types of recycled plastic waste. Post-consumer recycled (PCR) materials are products that have been used by consumers, then collected, sorted, and processed into new raw materials to make new products [3]. Post-industrial recycled (PIR) materials, on the other hand, are scrap materials that are generated during the manufacturing process [4]. It is important to note that both PIR and PCR polyolefin-based waste streams have advantages and disadvantages related to potential contamination and maintaining product quality. Therefore, during the preselection phase, it is crucial to consider these factors when identifying a suitable source for the mechanical recycling process. For W&C and similarly demanding applications, it is necessary to perform rigorous screening to evaluate batch-to-batch variations in properties such as oxidative induction time (OIT), melt flow index (MFI), and contamination levels. This step is important to ensure that the final compound containing the recycled stream meets the required specifications and can be used effectively in the desired application.

In a recent study, the feasibility of jacket compounds based on PCR and blends with high quality virgin polyethylene resins was considered [5]. The results suggested that up to at least 25 wt% natural or mixed color high density polyethylene (HDPE) PCR could potentially be utilized to achieve reasonable performance and meet critical telecom jacket application requirements when blended with virgin medium density polyethylene (MDPE). When using enhanced performance virgin HDPE and MDPE, up to 50 wt% PCR could be incorporated with acceptable performance. Alternatively, low levels of enhanced performance resin could be introduced in a majority PCR compound to boost the mechanical, ESCR, and thermal aging resistance in certain regions and jacket applications allowing a balance of minimized cost while maximizing recycled content and performance.

In this work, data was presented on the performance of compounds containing different types and sources of recycled streams in virgin polyethylene resins systems. This work evaluated the performance of both PCR and PIR. The compounds shown were considered to meet most critical telecom jacket application requirements such as mechanical, environmental stress crack resistance, and thermal aging resistance. The focus of this work was a balance of overall system performance with sustainability impact.

EXPERIMENTAL DETAILS

Materials

Three different recycled plastic materials obtained from different sources were considered in this study; (A) is a HDPE-based PIR with up to 3 wt% EVOH contamination (HDPE PIR), (B) is a LLDPE-based PCR (LLDPE PCR), and (C) is LDPE-based PCR (LDPE PCR).

Two commercially available, black virgin polyethylene cable jacket compounds were used for the blends with the different PCR loading levels; high-quality HDPE-based compound and LLDPE-based compound. Each PCR type was blended at 10, 20 and 30 wt% loading in (1) HDPE and (2) LLDPE. In total, 18 blends were produced. In each case, an adequate amount of carbon black masterbatch was added to compensate for dilution and maintain required carbon black concentration at 2.5 wt% as per general purpose cable jacket requirements. The density, melt flow index (MFI) and oxidative induction time (OIT) at 200 °C of