DEVELOPMENT OF RECYCLING TECHNOLOGY OF XLPE

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ABSTRACT

Recently, to reduce environmental damage, various studies on recycling technologies of various materials have been examined. Those of poly-ethylene and PVC are well-known within the construction materials of wires and cables, while that of cross-linked polyethylene (XLPE) has not yet been done, since it is very difficult to be thermo-plasticized because of its chemical cross-linking structure. We have studied solid-state grinding by mill and thermo-plasticization by twin-screw extruder as recycling treatments. Prototype insulation wires using the recycled materials were manufactured by production machine and evaluated. The results show that they work well as insulation wire.

KEYWORDS

XLPE, Recycling technology, Thermo-plasticization

1. INTRODUCTION

Recently, as it has become more and more important to reduce environmental damage, various studies on recycling technologies of cable construction materials have been examined. Up to now, efficiently recycling metallic materials as valuable resources by collecting wire and cable scraps and techniques to separate metallic materials from others have been well developed in Japan, while a recycling method of XLPE was less studied[1].

XLPE is an excellent material as insulation for wires and cables, but very difficult to be thermo-plasticized because of its chemical cross-linking structure. Therefore, most XLPE waste has been thrown away or thermally recycled as fuel. For material recycling of XLPE waste, we are studying solid-state grinding by mill and thermo-plasticization by twin-screw extruder as recycling methods[3][4].

2. ABOUT XLPE

As detailed below, the difference between two types of cross-linking bonds causes different results of thermo-plasticization by the molten state shearing method. The variety of XLPE should first be described.

Chemical structure of XLPE

XLPE is commonly applied as insulation for wires and cables, in which two types of cross-linked polyethylene are used. One is peroxide XLPE, the other is silane XLPE.

(1) Peroxide XLPE

Additives such as antioxidant and peroxide, and polyethylene is first compounded, then the compound is extruded as wire or cable and heated in a continuous vulcanizer such as CCV and VCV. By heating, peroxides generate alkyl-oxy radicals which act as initiators of cross-linking reactions. Electrons are transposed from alkyl-oxy radical to polyethylene chains, then form radicals on molecular chains of polyethylene. Two radicals on polyethylene form a new carbon-carbon bond which acts as cross-linking. (See Fig.1 (a)) Peroxide XLPE is abbreviated to 'P-XLPE'.

(2) Silane XLPE

Silane coupling agents are first graft polimerized to molecular chains of polyethylene, then silane grafted polyethylene is extruded as wire or cable. Instead of heating, a catalyst induces cross-linking between two silane coupling agents. (See Fig.1 (b)) Silane XLPE is abbreviated to 'S-XLPE'.

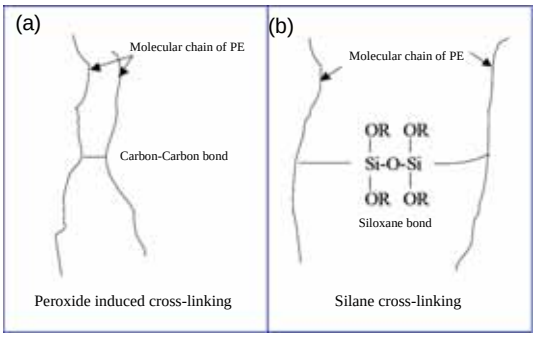

Figure 1: Types of cross-linking of XLPE

3. RECYCLING METHODS OF XLPE

Fig.2 shows the flow of recycling of wires and cables. To collect copper and aluminium as valuable materials, collection routes and methods are well developed, then XLPE waste is also collected using the same route. We have been studying (1) a solid-state shearing method, and (2) a molten state shearing method, as recycling methods for XLPE.

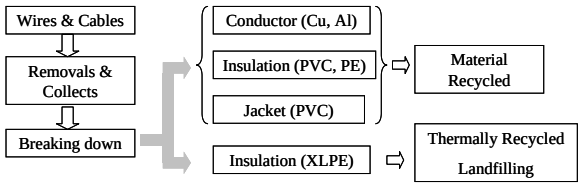

Figure 2: Recycle flow of wire and cable