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Wire and Cable Insulation and Jacketing: Life-Cycle Assessments For Selected Applications

Abstract

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This report presents comparative environmental life-cycle assessment (LCA) results, pursuant to International Organization for Standardization (ISO) 14040, for resin systems with alternative heat stabilizer formulations used in Category 6, riser-rated communication cable (CMR); Category 6, plenum-rated communication cable (CMP); and non-metallic-sheathed low-voltage cable (NM-B). Based on primary and secondary data that span the wire and cable life-cycle stages from upstream material extraction and processing to the product end-of-life (EOL), this report presents impact results for 14 environmental and human health categories. Monte Carlo-based uncertainty analyses, which attempt to model the major sources of uncertainty in the wire and cable life cycle, are presented, along with sensitivity analyses that investigate the proportion of impact category uncertainty attributable to each source.

For all three classes of cable, upstream material production and use, generation of electricity, and the recycling or disposal of used cable at the EOL (the last only being applicable to CMR and CMP) play important roles in overall environmental burden. Energy use during cable manufacturing and the leaching of lead from landfills are the most important sources of uncertainty in impact results and, in combination with the production of insulation and jacketing resins, are the top contributors to nearly all of the impact categories. Though this analysis does not attempt to present comparative assertions per ISO 14040, opportunities for improvement of environmental performance in wire and cable products are discussed, focusing primarily on energy-efficiency and upstream material production.

Due to the presence of lead in the baseline communication cables, the potential public noncancer and aquatic ecotoxicity impact categories showed the greatest difference in environmental burden between the baseline and alternative cable constructions. These differences were driven by the EOL disposition of the cables, particularly landfilling, because a fraction of the lead was assumed to leach from the landfill into groundwater. Encouraging further recycling of chopped cable resin could potentially reduce the environmental burden of the baseline cable; however, there are other tradeoffs that would then need to be considered (e.g., the energy required for the cable chopping process). These conclusions only apply to communication cables (CMR and CMP), for which EOL was included in the full life-cycle analysis.

When identifying opportunities for improvement, particularly with respect to communication cable materials, conclusions must be understood in the context of the comparison defined within the boundaries of this analysis. For example, the same gauge copper was used in the baseline and alternatives within a cable type and was thus excluded from the analysis. As energy use is a driver for many of the impact results, increasing energy efficiency in all parts of the wire and cable life cycles could reduce many impacts. The sensitivity of impact results is primarily due to producing the energy needed for CMR and CMP cable extrusion, thus reducing energy inputs during extrusion could lessen the environmental impacts for all cable types substantially. Cable materials that tend to contribute largely to impacts (in decreasing order of environmental burden) include lead stabilizers, jacket and insulation resins, phthalates, and filler materials (e.g., calcined clay, limestone).

Opportunities for improvement also exist in the reduction of the quantities of lead entering the landfills (while recognizing potential tradeoffs if alternatives are needed to replace the reduced amounts of lead) or management of municipal solid waste and construction and demolition landfills, by ensuring that permeation of lead-containing landfill leachate is minimized. EOL disposition choices for wire and cable products are complicated by the trade-offs inherent in the processes themselves. As mentioned in

the preceding paragraph, the sequestration of wire and cable waste by landfilling is not without its source of hazards; and incineration, while advantageous from a landfill space use perspective, creates airborne lead emissions, which are problematic from a public health standpoint. Thermoplastic recycling is energy-intensive and creates new waste streams, which must be landfilled. Thus, the choices are not straightforward, and depend, among other things, on economic incentives and the value placed on different environmental burdens.