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Developing an indicator for material selection based on durability and environmental footprint: A Circular Economy perspective

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Abstract

The Circular Economy comprises several strategies to enhance the sustainability of products. However, most of the research in this area has focused on Recycling, Recovering and final disposal. Strategies for lifespan extension such as Reuse, Repair, Refurbish, Remanufacture and Repurpose lead to higher circularity and value throughout the lifecycle but are less studied. Here we propose a single generic indicator based on durability and environmental footprint for material selection as an early step in the design process towards extending product lifespan. The material durability indicator or MDI integrates into a single calculation chemical and mechanical durability, together with environmental impacts associated with the material. The proposed indicator incorporates parameters such as flammability resistance, resistance to ultraviolet radiation, resistance to water, resistance to organic solvents, mechanical strength, energy consumption, and carbon footprint, among others. A case study based on polymer materials selection demonstrates the usefulness of the MDI indicator, providing a holistic calculation and comparison of selection alternatives, including conventional and multicriteria approaches. The proposed indicator offers a balanced and technical measurement of durability and environmental burdens in the material selection process and can potentially be applied to any engineering material.