Model for the Part Manufacturing and Vehicle Assembly Component of the Vehicle Life Cycle Inventory

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Abstract

A model is presented for calculating the environmental burdens of the part manufacturing and vehicle assembly (VMA) stage of the vehicle life cycle. The model is based on a process-level approach, accounting for all significant materials by their transformation processes (aluminum castings, polyethylene blow molding; etc.) and plant operation activities (painting; heating, ventilation, and air conditioning [HVAC], etc.) germane to VMA. Using quantitative results for these material/transformation process pairings, a percent-by-weight material/transformation distribution (MTD) function was developed that permits the model to be applied to a range of vehicles, both conventional and advanced (e.g., hybrid electric, light weight, aluminum intensive). Upon consolidation of all inputs, the model reduces to two terms: one proportional to vehicle mass and a plant overhead per vehicle term. When the model is applied to a materially well-characterized conventional vehicle, reliable estimates of cumulative energy consumption (34 gigajoules/vehicle) and carbon dioxide (CO_2) emissions (2 tonnes/vehicle) with coefficients of variation are computed for the VMA life cycle stage. Due to the more comprehensive coverage of manufacturing operations, our energy estimates are on the higher end of previously published values. Nonetheless, they are still somewhat underestimated due to a lack of data on overhead operations in part manufacturing facilities and transportation of parts and materials between suppliers and vehicle manufacturing operations. For advanced vehicles, the material/transformation process distribution developed above needs some adjusting for different materials and components. Overall, energy use and CO_2 emissions from the VMA stage are about 3.5% to 4.5% of total life cycle values for vehicles.

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