



Ingevity Net Product Benefits

Project Summary – Evotherm M1 Asphalt Additive

ERM conducted a third-party evaluation of Evotherm M1 asphalt additive manufactured by Ingevity. The use of this product allows for asphalt mixing to be done at a lower temperature, thus providing energy savings, and also eliminates the need for corrosive lime additives, thus improving the safety of the mixing process. The objective of this study was to develop a quantitative estimate of the greenhouse gas (GHG) impact associated with production and transportation, as well as the GHG benefit associated with use of the product. Our approach was consistent with ISO 14040 principles and framework for life cycle assessment (LCA).

- **Impacts:** We considered the life cycle impacts of raw material inputs to the manufacture of Evotherm M1.
 - Tall oil fatty acids (TOFA) derived from tree pulping are the primary raw material for this product. Data on impacts associated with TOFA production were obtained from the LCA study published by the American Chemistry Council (conducted by Franklin Associates).
 - GHG emissions from transportation of raw materials, intermediates, and finished products were also included. For the GHG impacts associated with energy use in the manufacturing process, we used Ingevity's calculated 2019 Scope 1 and Scope 2 GHG emissions from the relevant facilities, allocated according to the actual plant processes associated with Evotherm M1 production. In addition, we estimated Scope 3 emissions associated with energy (primary fuel extraction and processing, and electricity transmission & distribution losses), using globally accepted Scope 3 emission factors.
 - Finally, we estimated impacts arising from a small incremental increase in asphalt components (aggregate, bitumen) required to make the same weight of asphalt in compensation for the reduced amount of lime. (The weight of Evotherm is typically only about 2% of the weight of lime that it replaces.)
- **Benefits:** ERM used Ingevity research data, as well as publicly available sources, to calculate two types of GHG benefits associated with the use of Evotherm M1 manufactured in 2019:
 - Avoiding the use of lime – We calculated benefits based on an assumption of 1% lime in typical asphalt mix, replaced by Evotherm M1. The calculation used a life cycle emission factor for quicklime, obtained from the ecoinvent v3.5 database.
 - Enabling lower asphalt mixing temperature – We considered a range of fuel consumption savings when using warm mix rather than hot mix. Based on data from the National Asphalt Pavement Association (NAPA) and Ingevity, a reasonable range of energy savings is 15% to 27%.

Summary of Results

2019 GHG Impacts and Benefits (in metric tons CO₂-equivalent)

Activity	GHG Impact	GHG Benefit (15% fuel savings)	GHG Benefit (27% fuel savings)
Materials – TOFA and other inputs	17,519		
Energy Consumption from Manufacturing (Scopes 1 and 2)	404		
Energy Consumption from Manufacturing (estimated upstream impacts of energy sources)	64		
Incremental Increase in Asphalt Components	3,739		
Evotherm M1 Product Transportation	849		
Total Impact	22,575		
Avoidance of lime use		292,489	292,489
Reduction in fuel consumption		121,044	217,879
Total Benefit		413,533	510,368
NET BENEFIT		390,958	487,793

Impacts = 4.4 kg CO₂e per kg of Evotherm M1 manufactured

Benefits = range of 81.3 to 100.4 kg CO₂e per kg of Evotherm M1 manufactured

ERM's evaluation is based on the following assumptions and limitations:

- We relied upon Ingevity's data for 2019 raw material inputs, production figures, Scope 1 and Scope 2 GHG emissions, modes of transportation used, and distances travelled.
- The analysis accounts for the significant categories of Scope 3 GHG emissions associated with the products under consideration. GHG emissions associated with raw material input and transportation both upstream and downstream, and all fuel- and energy-related activities are included. Scope 3 categories that were not estimated include waste generation, business travel and employee commuting, and capital expenditures; none of these categories would be expected to contribute materially to the GHG impacts. Land use changes associated with tree harvesting are not included in the assessment.
- Gathering primary data on actual product application in the field was outside the scope of ERM's contracted work. Calculations of product benefits were based on Ingevity's research and recommended product mix ratios, as well as industry-wide LCA data on asphalt mixes published by NAPA. ERM's calculation of product benefits represents a reasonable estimate of GHG emissions avoided through the use of Evotherm M1 that was manufactured in 2019, but no field confirmation was conducted.
- ERM's analysis used published life cycle emission factors from the US LCI and ecoinvent 3 inventory databases. No LCA modelling was conducted; the emission factors were applied in spreadsheet calculations.