Conclusions and Summary Brief

Environmental Life Cycle Assessment of

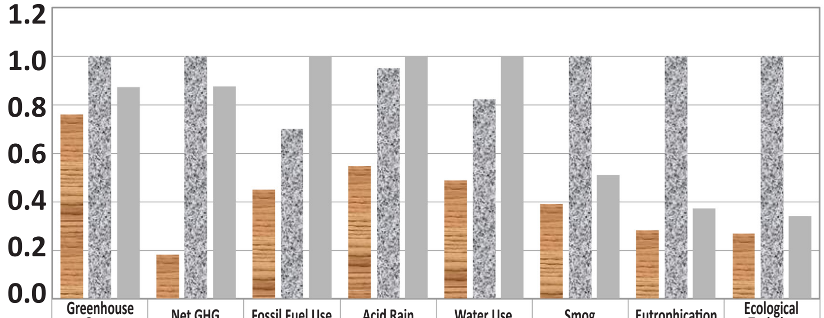
Ammoniacal Copper Zinc Arsenate-Treated Railroad Ties with Comparisons to Concrete and Plastic/Composite Railroad Ties

Arxada commissioned AquAeTer, Inc., an independent consulting firm, to prepare a quantitative evaluation of the environmental impacts associated with the national production, use, and disposition of ammoniacal copper zinc arsenate (ACZA)-treated, concrete, and plastic/composite (P/C)railroad ties, using life cycle assessment (LCA) methodologies and following ISO 14044 standards. The comparative results confirm:

- **Less Energy & Resource Use:** ACZA-treated wood railroad ties require less total energy, less fossil fuel use, and less water than concrete and P/C railroad ties.
- **Lower Environmental Impacts:** ACZA-treated wood railroad ties have lower environmental impacts in comparison to concrete and P/C railroad ties for all six impact indicator categories assessed: anthropogenic greenhouse gas, total greenhouse gas, acid rain, smog, eutrophication, and ecotoxicity-causing emissions.
- **Greenhouse Gas Levels:** Compared to annual GHG emissions from national railroad fuel use, the net GHG "footprint" resulting from the railroads' choice of tie materials is notable at 1.1% for ACZA-treated ties, 6.3% for concrete ties, and 5.5% for P/C ties.
- **Offsets Fossil Fuel Use:** Reuse of ACZA-treated railroad ties for energy recovery in permitted facilities with appropriate emission controls will further reduce greenhouse gas levels in the atmosphere, while offsetting the use of fossil fuel energy.

Impact indicator values were normalized to better support comparisons between products and to understand the quantitative significance of indicators. Product normalization sets the cradle-to-grave life cycle value of maximum impact to 1.0, and all other values are a fraction of 1.0. The normalized results are provided in Figure 1.

Figure 1.
Normalized impact indicator comparison (maximum impact = 1.0)



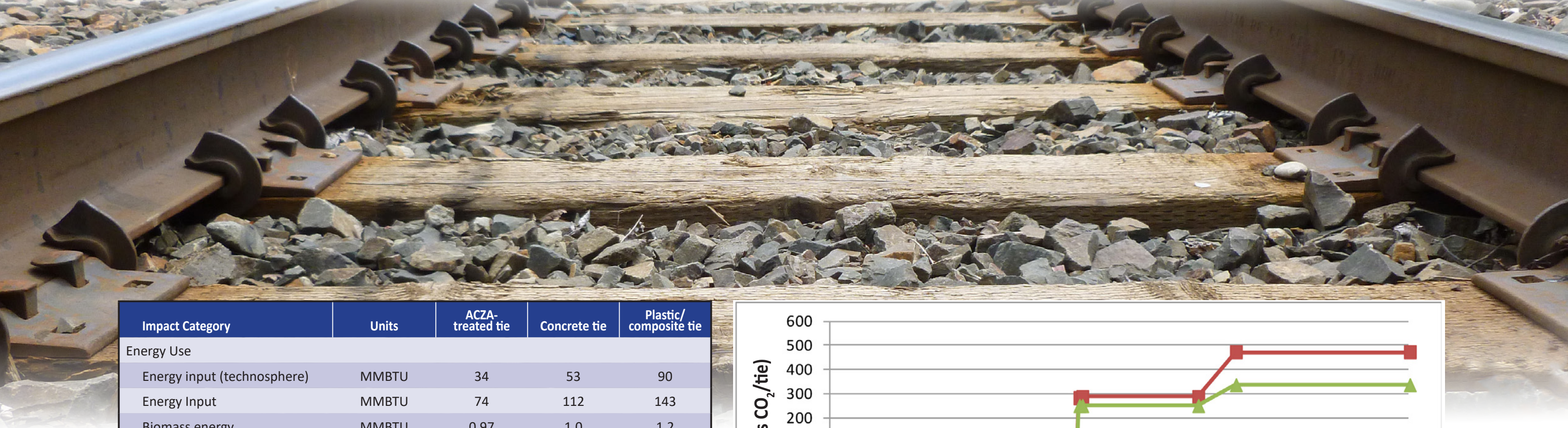
	Greenhouse Gases	Net GHG	Fossil Fuel Use	Acid Rain	Water Use	Smog	Eutrophication	Ecological Toxitcity
ACZA-Treated tie	0.76	0.18	0.45	0.55	0.49	0.39	0.28	0.27
Concrete tie	1.0	1.0	0.70	1.0	0.82	1.0	1.0	1.0
Plastic/composite tie	0.87	0.87	1.0	1.0	1.0	0.51	0.37	0.34

Scope

The scope of this study includes:

- A life cycle inventory of ACZA-treated, concrete, and P/C railroad ties modified from a life cycle inventory of creosote-treated railroad ties done for the Treated Wood Council.
- Calculation and comparison of life cycle impact assessment indicators: anthropogenic greenhouse gas, total greenhouse gas, acid rain, smog, ecotoxicity, and waterborne eutrophication impacts potentially resulting from life cycle air emissions.
- Calculation of energy, fossil fuel, and water use.

ISO 14044 Compliant Prepared by: AquAeTer, Inc.



Impact Category	Units	ACZA-treated tie	Concrete tie	Plastic/composite tie
Energy Use				
Energy input (technosphere)	MMBTU	34	53	90
Energy Input	MMBTU	74	112	143
Biomass energy	MMBTU	0.97	1.0	1.2
Environmental indicators				
Anthropogenic greenhouse gas	lb-CO_2-eq	23,486	30,928	26,978
Total greenhouse gas	lb-CO_2-eq	5,662	31,175	27,268
Acid rain air emissions	lb-H+ mole-eq	5,615	9,783	10,277
Smog potential	g NOx/m	22	58	29
Ecotoxicity air emissions	lb-2,4-D-eq	51	188	64
Eutrophication air emissions	lb-N-eq	1.0	3.7	1.4
Resource use				
Fossil fuel use	MMBTU	100	154	220
Water use	gal	3,313	5,571	6,771

Table 1. Environmental performance of railroad ties (per mile of track/year of railroad service)

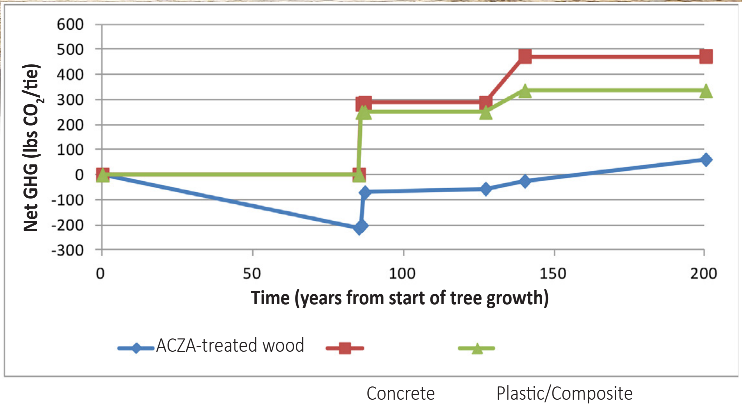


Figure 3. Carbon balance for tie products (per tie)

Environmental Performance

The assessment phase of the LCA uses the inventory results to calculate total energy use, impact indicators of interest, and resource use. For environmental indicators, USEPA's Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts (TRACI) is used to assess anthropogenic and total greenhouse gas, acid rain, smog potential, ecotoxicity, and eutrophication impacts potentially resulting from air emissions. The categorized energy use, resource use, and impact indicators provide general, but quantifiable, indications of environmental performance. The results of this impact assessment are used for comparison of railroad tie products as shown in Table 1.

Wood products begin their life cycles removing carbon from the atmosphere (as carbon dioxide) and atmospheric carbon removal continues as trees grow during their approximate 80-year growth cycle, providing an initial life cycle carbon credit. Approximately half the mass of dry wood fiber is carbon. Transportation and treating operations are the primary sources of carbon emissions in the manufacture of treated wood products.

The concrete and plastic/composite ties begin their life cycles either as raw materials or with the recycling of products. Both processes result in carbon emissions. Burdens associated with recycling, including transportation, sorting, cleaning, and melting, must be included in the manufacturing stage.

Minimal impacts are required for both treated wood, concrete, and P/C ties in the service life stage. Following the service life stage, ACZA-treated wood ties are recycled for secondary uses or disposed in landfills. Non-wood material ties are recycled or disposed in landfills. The carbon balance of railroad ties, through the life cycle stages, is shown in Figure 3. ACZA-treated wood products currently are not used as a combustion fuel for energy recovery; however, future procedures might make such recovery feasible.

Quality Criteria

This study was done as an extension of work performed by the Treated Wood Council and is not intended as a stand-alone LCA. The study includes most elements required for an LCA meeting the International Organization for Standardization (ISO) guidelines as defined in standards ISO/DIS 14040 "Environmental Management – Life Cycle Assessment – Principles and Framework" and ISO/DIS 14044 "Environmental Management – Life Cycle Assessment – Requirements and Guidelines". However, there was no external peer review of the ACZA components of this LCA.

Additional Information

This study is further detailed in a Life Cycle Assessment Report completed in April 2013 and is available upon request from Arxada at 1200 Bluegrass Lakes Parkway, Alpharetta, GA 30004 (WolmanizedWood.com).

This study is based on data collection and analysis done as part of an LCA on creosote-treated railroad ties. A manuscript of the creosote-treated railroad ties findings was published in the peer-reviewed Journal of Transportation Technologies (Vol. 3 No. 2, April 2013, pp 149-161) and is available at http://www.scirp.org/journal/jtts.