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Extending the Supply of Alcohol Fuels for Energy Security and Carbon Reduction



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Abstract

The paper critiques proposals for de-carbonizing transport and offers a potential solution which may be attained by the gradual evolution of the current fleet of predominantly low-cost vehicles via the development of carbon-neutral liquid fuels. The closed-carbon cycles which are possible using such fuels offer the prospect of maintaining current levels of mobility with affordable transport whilst neutralizing the threat posed by the high predicted growth of greenhouse gas emissions from this sector.

Approaches to de-carbonizing transport include electrification and the adoption of molecular hydrogen as an energy carrier. These two solutions result in very expensive vehicles for personal transport which mostly lie idle for 95% of their life time and are purchased with high-cost capital. The total cost of ownership of such vehicles is high and the impact of such vehicles in reducing greenhouse gas emissions from transport is therefore likely to be low due to their unaffordability for a large number of customers. Conversely, powertrains and fuel systems capable of using renewable alcohols in high concentrations have minimal additional cost over existing models as they are made from abundant materials with low embedded energy levels.

The use of ethanol and methanol in internal combustion engines is reviewed and it is found that the efficiency and performance of engines using these fuels exceeds that of their fossil fuel counterparts. Low-carbon-number alcohols and, where necessary, more energy-dense hydrocarbons can be supplied using feed stocks from the biosphere up to the biomass limit from biofuels and, beyond the biomass limit, from the atmosphere and oceans using captured CO₂ and hydrogen electrolysed from water. Using the hydrogen in a synthesized fuel rather than as an independent energy carrier can be thought of as a pragmatic implementation of the hydrogen economy. This avoids the extremely high infrastructure and distribution costs which accompany the use of molecular hydrogen.

The production of liquid fuels from CO₂ and water are reviewed in which fully-closed carbon cycles are theoretically possible with the development of large-scale renewable energy generation and CO₂ capture from the atmosphere. An approach to the latter problem where CO₂ concentration and release based on bipolar membrane electrodialysis, developed by the co-authors from PARC, is described in detail and initial results from a laboratory scale device are reported.

The development of a Tri-Flex-Fuel vehicle, capable of operating on any combination of gasoline, ethanol, and methanol, using a single fuel system is also described. The low additional technology and materials costs of such vehicles demonstrates that compatible, affordable transport can be developed which provides a feasible means of vehicle *evolution* towards decarbonized transport without the consequences of huge stranded assets which would be imposed on the automotive industry by the revolution which would be required to mass-produce hydrogen fuel cell vehicles and battery-electric vehicles.

Recommended Content

Technical Paper	Integrated Fuel Processor Development
Technical Paper	Societal Impacts of Fuel Options for Fuel Cell Vehicles
Technical Paper	Fuels for Fuel Cell Vehicles: Vehicle Design and Infrastructure Issues

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Topic

- Fuel cells
- Greenhouse gas emissions
- Hydrogen fuel
- Fuel cell vehicles
- Fuel systems
- Biofuels
- Gasoline
- Methanol
- Ethanol

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