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RESEARCH PROJECT TITLE

Evaluating Alternative Fuels for Snowplow/
Maintenance Vehicles and Identifying
Barriers to Adoption – Phase II

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Evaluating Alternative Fuels for Snowplow/Maintenance Vehicles and Identifying Barriers to Adoption

tech transfer summary

By understanding the benefits and challenges associated with using biodiesel in snowplows and other maintenance vehicles, agencies can make informed decisions about adopting biofuels in their vehicle fleets.

Objective

The objective of this research was to conduct an independent evaluation of the impact of adopting a 100% biodiesel blend (B100) on the performance of the Iowa Department of Transportation (Iowa DOT) snowplow fleet, including impacts on fuel economy, maintenance, carbon reduction, and driver/maintenance personnel concerns.

Background

Biodiesel is a sustainable fuel for use in any diesel engine and can be adopted in varying blends from 5% (B5) to 100% (B100). B5 and B20 are the most commonly used biodiesel blends, while B100 is less commonly used due to pricing, a lack of regulatory incentives, and performance concerns.

Biodiesel is domestically sourced and can reduce transportation energy costs and harmful emissions. However, it has a lower energy content than petroleum diesel, can gel in very cold temperatures, and at higher blends can act as a solvent that releases deposits accumulated from petroleum diesel, clogging filters.



City of Ames, Iowa

Iowa DOT snowplow running biodiesel

Blends up to B20 can be used in most diesel engines with minor or no modifications. For blends greater than 20%, advanced technologies can be integrated into existing vehicles to ensure compatibility and successful performance.

One upgrade involves a split tank with petroleum diesel on one side and biodiesel on the other. The regular diesel is used to start the engine, the engine switches to biodiesel once the fuel has been warmed, and the engine idles long enough after shutdown to replace the biodiesel in the fuel lines with regular diesel. Many fleets also install dedicated biodiesel fueling infrastructure.

Problem Statement

A number of agencies have expressed interest in evaluating the use of B100 in their maintenance vehicle fleets, but concerns with engine maintenance and performance have hampered adoption. An Iowa DOT pilot program starting in July 2020 that converted 10 new and existing snowplows to use B100 offered an opportunity to assess the fuel's performance in real-world conditions.

Research Description

In July 2020, the Iowa DOT equipped 10 existing or newly purchased snowplows at the Ames and Des Moines North garages with a split tank system from Optimus Technologies that allowed the trucks to run on both normal diesel and biodiesel blends up to 100%.

Engine data were reported by onboard diagnostic (OBD) systems, and radio frequency identification (RFID)

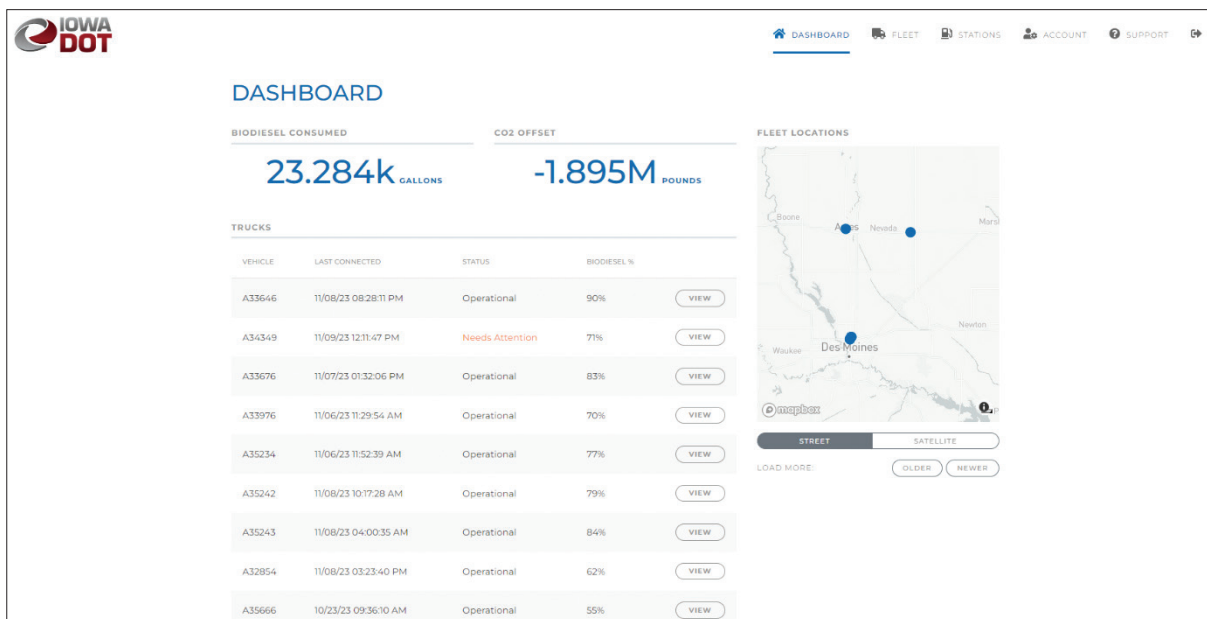
devices in the trucks and in B100 fueling infrastructure logged the amount of B100 used. Throughout the pilot program, each truck had an assigned route and was operated over that route most of the time.

Two evaluations were carried out to assess the fuel economy of the B100 vehicles versus regular diesel vehicles. The first used logs kept by snowplow drivers. Due to limited participation, data were only available for two B100 trucks and two regular diesel trucks in February and March 2023.

The second assessed truck engine data downloaded from a dashboard maintained by Optimus Technologies. The analysis included data for seven trucks between December and February and between June and August in 2022 and 2023. Because comparable OBD data could not be obtained for regular diesel trucks, the assessment focused on factors affecting the fuel economy of the B100 vehicles.

Four tools were developed to help the Iowa DOT estimate the fuel economy and emissions of various biodiesel blends, with an emphasis on B20 and B100. The tools were designed to estimate the following:

- The change in various emissions resulting from the use of biodiesel
- The amount of soybeans needed to create a given quantity of biodiesel
- The reduction in CO₂ resulting from various amounts and blends of biodiesel
- The fuel economy of various biodiesel blends relative to regular diesel



Optimus Technologies dashboard showing fleet statistics

Key Findings

Fuel Economy Analyses

- Based on the logs kept by snowplow drivers, the average fuel economy was 4.23 mpg for the biodiesel trucks and 5.14 mpg for the regular diesel trucks, indicating an estimated 17.9% reduction in fuel economy for the biodiesel trucks.
- Note that this calculation is based on data for only four vehicles over two months. Additionally, the split tank system in the biodiesel trucks uses some fuel to purge the fuel lines, which might slightly impact their fuel economy.
- According to the analysis of truck engine data, the fuel economy of B100 snowplows is significantly influenced by vehicle speed, ambient temperature, and engine parameters. Fuel efficiency generally improves at moderate speeds (40 to 60 mph) and moderate ambient temperatures (50°F to 100°F).

Issues during the Iowa DOT Pilot Program

The B100 snowplows and infrastructure experienced numerous issues during the pilot program:

- In December 2022, operators began reporting low engine power (torque, horsepower, boost) in all trucks. As a result, all trucks began using only regular diesel during winter storms to ensure that sufficient power would be available to operate the plows.

- In early 2023, drivers began reporting instances of power loss and trucks shutting off while driving on the road. Several maintenance interventions did not resolve the issues.
- Due to the performance issues, the split tank system was removed from all trucks in October 2024, and all vehicles reverted to running only on regular diesel.
- The B100 fueling infrastructure repeatedly lost the power it needs to heat the tanks and dispense fuel, and the RFID sensors installed in the trucks and in the B100 fueling infrastructure occasionally lost connection.

Implementation Readiness and Benefits

Though numerous challenges arose during the pilot program, this research yielded some insights into the fuel economy of B100 vehicles. This information can assist agencies in decision-making regarding the adoption of biodiesel in their fleets.

Additionally, the four tools developed in this research can help the Iowa DOT understand the impacts of various biofuel blends on fuel economy, emissions, and Iowa's agricultural sector.