COLLECTION AND COLLATION OF PERFORMANCE DATA FROM URBAN MASS TRANSIT BIODIESEL DEMONSTRATIONS

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ABSTRACT

Performance data has been collected from urban mass transit buses across the United States that have been fueled with blends of biodiesel and petroleum diesel. Approximately 30 demonstration projects were initiated through this effort. Data from one mass transit agency will become a part of the Alternative Fuels Data Center in Golden, Colorado. This project will provide real-world data that will be used for marketing and promotional purposes during the commercialization of biodiesel.

KEYWORDS

Biodiesel, soydiesel, transesterification, low sulfur diesel fuel, economics, fuel economy, National Renewable Energy Laboratory, and Alternative Fuels Data Center.

INTRODUCTION

The testing of biodiesel as a fuel for diesel powered transportation vehicles has been conducted in several locations across the United States since July, 1991. Little effort has been made to systematically, qualitatively, and quantitatively collect and record vehicle performance and operational characteristics. The collection of this information is essential to the market development of biodiesel in the United States.

OVERVIEW & OBJECTIVES

Vehicle performance, operation, and maintenance characteristics are used extensively during the market development of a transportation fuel. Information about the use of biodiesel as a transportation fuel is needed to provide legislators and agencies the knowledge needed to make informed decisions that will effect market development and impact the acceptance of biodiesel as a fuel for diesel engines.

Specific objectives of the project include:

1. Establish cooperative relationships and collect qualitative and quantitative vehicle performance and operational data from a mass transit district.

2. Summarize retrieved information and format appropriately for the National Renewable Energy Laboratory (NREL) Alternative Fuels Data Center (AFDC) database.

3. Transfer data (ASCII format) electronically to NREL and place in the AFDC database (weekly).

4. Develop cooperative relationships with other agencies to collect vehicle performance and operational data and submit these data to NREL (monthly).

METHODS & PROCEDURES

This project involved two separate data collection thrusts, referred to as Phase I and Phase II in this paper. Phase I involved data collection from biodiesel demonstrations that occurred in 30 different locations across the United States. Phase II involved tightly controlled data collection from one mass transit agency. Data from both Phase I and II were collected and compiled by researchers at the University of Missouri (MU).

Data collected from the transit properties was compiled and stored in Paradox, a relational database, and will be electronically transmitted to the Alternative Fuels Database Center (AFDC). The AFDC is an electronic database that is operated by NREL. The AFDC contains data collected from urban transit properties that are testing other alternative fuels such as compressed natural gas (CNG), methanol, and ethanol.

Site Selection:

Phase I

Fleishman Hillard, Inc., a marketing firm located in Kansas City, Missouri, conducted a market analysis to determine which locations across the United States would benefit the most by fueling with blends of soydiesel and petroleum diesel fuel. A promotional packet was developed by Fleishman Hillard, Inc., and later mailed to each of the agencies identified. A team of individuals from Mark VI, Interchem Industries, Fleishman Hillard, Inc., and the National Soydiesel Development board contacted these agencies to determine their level of commitment to fueling with a biodiesel/diesel fuel blend.

Phase II

As manager of the AFDC, NREL has outlined several criteria that are used when selecting a mass transit agency to serve as a site for controlled data collection. Initially, the new test fleet must provide "value added" data to the AFDC. The selected mass transit agency must be able to supply identical or comparable buses to insure that good control vehicles are available. Characteristics that must be similar include; length, engine model, mileage, transmission model, weight, year, etc. Mass transit agencies should have an accurate, acceptable means of recording data. Finally, site selection was based on the overall ability to collect reliable data on the part of the operators and the ability to implement in-house quality assurance programs.

Selection of Soydiesel Blend:

Research conducted by Fosseen Manufacturing and Development (1993) suggested that a 20/80 percent biodiesel/diesel fuel blend should be EPA certified for the 6V92 Detroit Diesel heavy duty engine. Based on this recommendation, a blend of 20/80 biodiesel/diesel fuel was the primary blend used to fuel the urban buses involved in Phase I and II of this project. Some of the Phase I cooperating agencies elected to fuel with a 30/70 biodiesel/diesel fuel blend. Only one Phase I cooperating agency selected a 40/60 biodiesel/diesel blend for fueling.

Information Collection Procedures

Phase I

This phase involved the collection and compilation of data from 30 separate mass transit agencies. Approximately 475 urban buses were fueled using 20/80 or 30/70 biodiesel/diesel fuel blends. Biodiesel was provided in enough quantity to operate vehicles at each respective location for either 50,000 or 1,000,000 miles. Data collection sheets, designed by NREL, MU, and Fleishman Hillard, Inc. with approval of the NSDB, were used to standardize the information collected from cooperating agencies during this phase of the investigation (see attached pages).

Visits and telephone calls were made to the cooperating mass transit agency to explain the data collection procedures and how to use the data collection sheets. The vehicle weekly log sheet, oil information sheet, basic powertrain data sheet, and basic vehicle data sheet were completed by the mass transit agency as needed. The agency then forwarded the data collection sheets to MU.

Fuel quality was monitored at the mass transit agency by sampling the fuel each time a new shipment of soydiesel was delivered. Tentative fuel standards established by Information Resources, Inc. (IRI) were used as a comparative measure. Engine oil samples were taken using approved sampling methods and analyzed by Fabick Power Systems in St. Louis, Missouri. The results were recorded in the relational database.

Phase II

This phase employed a rigorous data collection plan. One mass transit agency was selected to assist with this phase of the data collection project (Bi-State Development Agency). A total of 20 vehicles will be monitored at this mass transit agency; 10 - 6V92 TA Detroit Diesels will be fueled with a 20/80 soydiesel/diesel fuel blend and 10 - 6V92 Detroit Diesel control vehicles will be fueled on petroleum low sulfur diesel fuel.

Visits will be made to the cooperating mass transit agency to perform an initial vehicle inspection and explain both the importance of and how to accurately collect this information. Test and control buses will be used in normal daily service at the mass transit agency. Data will be collected to determine the actual impact of a Soydiesel blend

on maintenance, reliability, cost, engine exhaust emissions, fuel economy and safety (In-service Data Collection, Table I).

The mass transit agency will collect data using their existing operating, dispatching, maintenance and fueling systems. The data will be collected and reported weekly and forwarded by the mass transit agency directly to the University of Missouri.

Maintenance data will be coded according to type; scheduled, unscheduled, or road call. The work performed and parts replaced will be coded using a standard format (American Trucking Association) to facilitate data entry and allow the researchers to compare data from fleets that are testing other alternative fuels.

Vehicle performance problems will be monitored by the mass transit agency and forwarded to MU. Vehicle route information and safety data will also be forwarded to MU.

Fuel quality will be monitored at the mass transit agency by sampling the fuel each time a new shipment of soydiesel is delivered. Tentative fuel standards established by Information Resources, Inc. (IRI) will be used as a comparative measure. Engine oil samples will be taken using approved sampling. The oil sample will be analyzed and data reported utilizing parameters approved by NREL.

Vehicle operating costs, maintenance costs, initial purchase price and vehicle salvage value will be determined for each vehicle. This data will provide an accurate assessment of the vehicle operating costs in actual fleet conditions and allow for a comparison with other alternative fuels.

Table 1. In-service Data Collection

Type of data	Frequency Recorded	Data Items
Maintenance data	For each work order	Shop order number
		Repair description
		Type of Maintenance -scheduled
		-unscheduled
		-road call
		Labor hours
		Date of repair
		Odometer reading
		Parts replaced

		Parts cost
		Work done
		Removed from service
		Date returned to service
Fuel Data	Each time a bus is fueled	Type and amount of fuel
		Odometer reading
		Date
	Each Month	One sample of Soydiesel and diesel fuel analyzed
Oil Data	Each time oil is added	Make, type, viscosity of oil
		Amount of oil
		Odometer reading
	Each time oil is changed	Make, type, viscosity of oil
		Amount of oil
		Odometer reading
		Oil sample
Vehicle Deficiency report	At each problem occurrence	Standard reporting
Bus Route and operating cycle data	Each day	Daily route assignments for each bus
Safety Data	As needed	Number and nature of each accident

Treatment of Data:

MU researchers used the same software package that was used by Battelle Labs to input vehicle performance and operational data. Macros were written to check discrepancies within the data. Mass transit agencies were consulted concerning each of these discrepancies and any inaccurate data that were found were removed or replaced.

Results of Phase I:

A total of 32 mass transit companies have fueled approximately 450 urban buses across the United States using blends of biodiesel and petroleum diesel. The following chart illustrates the sites and duration of each biodiesel demonstration:

Table 2. 1993 National Soydiesel Development Board Demonstrations.

State	City	Buses	Duration	Demo	Blend
CA	Davis	42	4 wks	50k	20/80
CA	Marin County	17	4 wks	50k	20/80
CA	Riverside	14	10 wks	50k	20/80
CA	Ukiah	10	8 wks	50k	20/80
CA	Santa Clarita	5	12 wks	50k	20/80
CA	Yosemite	7	8 wks	50k	20/80
CO	Denver	5	10 wks	50k	20/80
CO	Denver	16	8 wks	50k	20/80
CO	Vail	6	12 wks	50k	20/80
FL	Jacksonville	2	24 wks	50k	20/80
ID	Coer d'Alene	6	12 wks	50k	20/80
IN	Indianapolis	5	8 wks	50k	20/80
KY	Louisville	6	12 wks	50k	20/80
LA	New Orleans	2	24 wks	50k	20/80
MA	Worcester	10	6 wks	50k	20/80

MD	Baltimore	250	6 wks	1 mm	20/80
ME	Portland	3	24 wks	50k	20/80
MI	Flint	2	24 wks	50k	20/80
MO	St. Louis	6	22 wks	50k	20/80
NC	Charlotte	10	8 wks	50k	20/80
NE	Lincoln	2	24 wks	50k	20/80
OH	Cincinnati	250	12 wks	1 mm	20/80
OH	Dayton	10	8 wks	50k	20/80
PA	Erie	3	24 wks	50k	20/80
PA	Philadelphia	10	4 wks	50k	20/80
TX	Crosby	36	6 wks	50k	20/80
VA	Alexandria	2	24 wks	50k	20/80
WA	Wenatchee	37	6wks	50k	20/80
VA	Richmond	6	8wks	50k	20/80
WA	Olympia	2	24wks	50k	20/80
WI	Madison	6	8wks	50k	20/80
WI	Sparta	4	TBD	50k	20/80

Five of the sites have completed their data collection activities. These data were forwarded to MU. These data will be summarized and presented in this part of the paper when the final copy is submitted for printing.

Progress of Phase II (NREL):

Researchers have traveled to NREL and Battelle Labs to learn first-hand how the AFDC database was designed and how to operate/access different parts of the database.

The site for Phase II will be selected within the next three weeks.

Supporting Testing:

In order to collect all of the data requested by NREL for Phase II of this project, chassis dynamometer testing of the buses will be conducted. The DOE Mobile Emissions Lab mobile chassis dynamometer testing facility coordinated by West Virginia University will be utilized to collect these data. Emissions tests will be conducted at least once during the project. Wheel horsepower and fuel rate will be recorded at rated speed and peak torque speed during the chassis dynamometer tests. Test results will be recorded in grams per mile for the following: hydrocarbons, carbon monoxide, carbon dioxide, oxides of nitrogen, particulates, total aldehydes, and formaldehyde.

Summary:

A complete summary of the data collected will be included in the section of this paper. As mentioned earlier, only five mass transit demonstrations have completed their fueling activities.

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