NATIONAL SOYDIESEL DEVELOPMENT BOARD

FY 93 APPROVED RESEARCH PROJECTS

Pilot Ignition Natural Gas Engine With Soydiesel/Diesel Blends - Detroit Diesel Corporation

In this project seven different soydiesel/diesel blends were evaluated for transient emission benefits and compared to #1 and #2 diesel baselines. Each were subjected to a quick knock and tip plugging evaluation test that Detroit Diesel has developed. The best candidate fuel blend was chosen and run on a back-to-back test on DDC's certification engine at SwRI.

Methyl Soyate Evaluation of Various Diesel Blends in a DDC 6V-92 TA Engine - Fosseen-Ortech

Fosseen Manufacturing and Development (FMD), was contracted by NSDB to evaluate the effect of various blends of soy oil and diesel fuel on the emission of the DDC 6V-92 engine. The program objective was to test and record the emission results from the following methyl soyate/diesel blends over the EPA Heavy-Duty Transient Test Cycle. The following tests were completed: (1) Baseline Diesel, (2) 10% Methyl Soyate/90% Diesel, (3) 20% Methyl Soyate/80% Diesel, (4) 30% Methyl Soyate/70% Diesel, (5) 40% Methyl Soyate/60% Diesel, (6) xx% Methyl Soyate/yy% Diesel, with an exhaust oxidation catalyst. Where xx% and yy% is the optimum blend as determined from the preceding tests.

Evaluation of Biodiesel Fuel in a Detroit Diesel Corporation (DDC) 6V-92 - ABA-AARC-SwRI

This project developed a performance and emissions database for the target engine, a Detroit Diesel 6V-92. The engine model year was 1991 or later and was provided by Bi-State Development, St. Louis, Missouri at no cost. The engine was installed in a steady-state test cell equipped with typical engine controls and was instrumented for performance parameters including engine speed, power, air flow, and fuel consumption. Equipment for measurement of gaseous and particulate emissions was to be in place for monitoring the exhaust emission levels. The emissions of interest are Nox, HC, CO and particulate matter (PM). The engine was instrumented for cylinder pressure and a high-speed data acquisition system was used to record cylinder pressure as a function of crankangle. This data was used to analyze the combustion process and to calculate combustion parameters such as ignition delay, peak pressure, and the rate of combustion.

Commercialization of a Renewable Fuel and Control of NOx Emissions With Biodiesel Fuel - NIPER-DOE

This project, jointly sponsored by the U.S. Department of Energy and the National SoyDiesel Development Board, was designed to develop information to aid in the acceptance of SoyDiesel as a commercial transportation fuel. Particular emphasis was placed on the performance of the fuel in a heavy duty diesel engine, the Cummins L-10. Emissions (via the 13-mode emissions test) as a function of fuel blend ratio (SoyDiesel and standard low sulfur diesel) was determined and further blending and additive studies were conducted to optimize the performance of the fuel. The emissions studies included particulates and aldehydes which are not a standard part of the 13-mode test. An optimum fuel blend was compared with standard low sulfur diesel in the Heavy Duty Diesel Engine Emissions Certification Test, a transient duty test. The performance of critical engine parts was evaluated. These studies included injector fouling, wear of the top piston ring (fire ring), wear of fuel injectors and wear of the fuel pump.

Emissions tests of a 5.9 Cummins engine in a Dodge truck was run on a chassis dynamometer by the Federal Test Procedure (FTP). These tests determined emissions as a function of SoyDiesel/standard low sulfur diesel blend ratio.

Emissions Reduction Potential In A Mass Transit Application - THE ADEPT GROUP

This project evaluated from a commercial user's perspective the benefits and common use problems, of a "transition fuel" for diesel engines that would reduce emissions. This transition fuel, "bio-diesel", can be used in any existing diesel engine application (mass transit, trucking, ship, rail, back up power stations, construction equipment, etc). This project demonstrated how biodiesel can be immediately used in a practical mass transit application (as well as in any centrally fueled fleet) and provided data to better assess the maximum possible emissions reductions in a typical use scenario (demonstration with two City of Gardena buses on a regular transit route).

Cetane Number Engine Testing Compared to Calculated Cetane Index Number - Midwest Biofuels

Midwest Biofuels Incorporated through the use of qualified testing laboratories, performed a series of tests to determine the cetane number using a Cetane Engine and the calculated cetane index numbers for a range of biodiesel blends. The testing was in accordance with ASTM testing standards for the calculation of cetanes. This testing provided data on the quality of biodiesel with regarding cetane. Testing was done at Ethyl Corporation and Williams Pipeline.

Biodiesel Pour Point and Cold Flow Study - Midwest Biofuels

Midwest Biofuels Incorporated identified four commercial diesel additives and used qualified testing laboratories to perform a series of tests to determine the benefits of various cloud point depressants, cold flow improvers and pour point depressants (anti gelling agents) for winterization of biodiesel. The testing was done in accordance with ASTM D-97 (Standard Test Method for Pour Point of Petroleum Oils), ASTM-D 2500 (Standard Test Method for Cloud Point of Petroleum Products), and IP 309/80 (Cold Filter Plugging Point of Distillate Fuels). This testing provided data on the benefits of these additives to winterized biodiesel.

Emissions and Performance Characteristics of the Navistar T444E DI Diesel Engine Fueled with Blends of Biodiesel and Low Sulfur Diesel Fuel - FEV

The purpose of the engine development work was to evaluate the potential for using the unique characteristics of soybean methyl ester as a blending agent with low sulfur diesel fuel to optimize the performance and emissions characteristics of a direct injected, four stroke diesel engine. Achievement of this goal required a scientifically sound development program with various blends of low sulphur diesel fuel and soybean methyl ester. The goals of the program were to investigate the potential for achieving the lowest possible emissions in a diesel cycle engine, while maintaining the inherently low particulate emissions characteristics of the methyl ester. Furthermore, it was desirable to achieve the change in engine calibration strategy without hardware modification to the existing diesel engine. To achieve this goal, a diesel baseline engine was selected which featured full electronic control. This selection resulted in two distinct advantages in that (1) changes in engine calibration could be more easily achieved for test cell evaluation and (2) the choice of an electronically controlled engine ensured that the results of the engine development program would be applicable to future technology diesel engines.

NATIONAL SOYDIESEL DEVELOPMENT BOARD

FY 94 APPROVED RESEARCH PROJECTS

Durability and Compatibility Evaluation Using 20% Methyl/Soyate Blend With The DDEC Detroit Engine 6V-92TA. - Fosseen Manufacturing & Development

FMD transient exhaust emission testing has been completed for the 6V-92 TA engine and supports the 20% biodiesel blend as being capable of reducing all four EPA regulated emissions.

This task was performed under the same optimized engine settings and exact blend of biodiesel used in the completed testing. The engine, a Detroit Coach 6V-92 DDEC, was contracted and especially prepared for this test by DDC. All standard DDC and EPA durability and compatibility procedures were followed.

Emissions Characteristics of SoyMethyl Ester Fuels in an Underground Mining Diesel Engine with and without Diesel Oxidation Catalyst After Treatment. - U.S. BUREAU OF MINES

The emissions and combustion characteristics of methyl ester fuels were evaluated in an indirect injection diesel engine that is typical of engines used in underground mines. Three fuels were tested: 100% (neat) SME fuel, a commercially available, low sulfur, #2 diesel fuel (D2), and a blend of 30% SME and 70% D2 fuels. All fuels were tested with transient tests, where an engine's speed and load are constantly varied in a repeatable cycle, and with the International Organization for Standardization (ISO) 8178-C1 steady-state test, where an engine's speed and load are held constant and the engine is tested at several conditions.

Transient Emissions Testing of Biodiesel in a DDC 6V-92TA DDEC Engine - SOUTHWEST RESEARCH INSTITUTE

A test program was conducted at Southwest Research Institute (SwRI) to evaluate the use of biodiesel in a Detroit Diesel Corporation 6V-92TA electronically controlled transit bus engine in terms of its effects on the exhaust emissions of the engine. Biodiesel was blended with an emissions grade, low sulfur, 2-D diesel fuel at a ratio of 20/80 percent by volume respectively. This blend, referred to herein as B20, was examined in the engine both by itself, and in conjunction with other engine, fuel, and/or aftertreatment modifications to determine what combination achieved the best overall reductions in regulated exhaust emissions.

The B20 blend was tested both in the baseline engine configuration, and again with injection timing retarded by one degree.

As an alternative to retarding the timing to reduce NOx, two fuel additives for use in B20 were tested. The two selected additives were both cetane improvers; 2-ethyl hexyl nitrate (EHN), and di-t-butyl peroxide (DTBP). The two additives were blended separately into B20, as recommended by the manufacturers.

Another strategy to reduce emissions was to use a diesel oxidation catalytic converter in conjunction with B20 fuel, to determine if the combination could achieve better emissions reductions than either the catalyst or B20 alone. This test was performed both at standard timing, and with the one degree retard of injection timing.

Transient Emissions Testing of Biodiesel and other Additives in a DDC Series 60 Engine. - SOUTHWEST RESEARCH INSTITUTE

A test program was conducted to evaluate the effects of several diesel fuel additives, including biodiesel, on exhaust emissions for a rebuilt, four-stroke 1991 Detroit Diesel Series 60 engine. Additized fuels were made from emission grade diesel fuel, and they were evaluated using hot-start testing over the EPA heavy-duty transient test cycle. Emissions data were generated using five different additized fuels (referred to as Fuels A, B, C, D, and E) and two "reference" fuels; an emissions grade, low-sulfur 2-D diesel fuel (R1), and a low sulfur, low aromatic diesel fuel intended to approximate a California reference diesel fuel (R2). Regulated emissions of HC, CO, NOx, and particulates were measured, as well as unregulated emissions of SOF and sulfates. On selected test runs, hydrocarbon speciation was performed to characterize the individual compounds that make up total gaseous HC emissions.

Emissions and Performance Characteristics of the Navistar T444E DI Diesel Engine fueled with a blend of Biodiesel and Low Sulfur Diesel Fuel. - FEV OF AMERICA

Testing was conducted to characterize the fuel consumption influence and exhaust emissions characteristics that were observed while running the Navistar T444 E diesel engine on a blend of 20% Soybean methyl ester and low sulfur diesel fuel.

Biodiesel Lubricity Field Test - MARC-IV Lubricity Study

The fuel funded through the 50,000 mile demonstration provided a little less than 10,000 miles of running time with a 20% biodiesel blend for each of the six buses tested.

Production and Testing of Ethyl and Methyl Esters. - UNIVERSITY OF IDAHO

Test quantities of ethyl and methyl esters of four renewable fuels were processed, characterized and performance tested. Canola, rapeseed, soybean oils, and beef tallow were the feedstocks for the methyl and ethyl esters. Previous results have shown methyl esters to be a suitable replacement for diesel fuel; however, much less has been known about the ethyl esters. Reported on was a complete set of fuel properties and a comparison of each fuel in engine performance tests. The study examined short term engine tests with both methyl and ethyl ester fuels compared to number 2 diesel fuel (D2). Three engine performance tests were conducted including an engine mapping procedure, an injector coking screening test, and an engine power study.

Optimizing the MUI Detroit Engine Timing for NOx Reduction and Evaluation of the DDC Catalyst - Fosseen Manufacturing & Development

This project with FMD provided studies for emissions and NOx reduction by reducing the timing on the DDC MUI 6V92TA coach upgrade.

An engine torque curve was generated on #2, low sulfur (9.05%) diesel from which the transient cycle was generated. Cycle performance was optimized to meet the EPA Cycle Performance Regression Analysis. A Baseline Transient Emission (1 cold/3 hot cycles) test was performed collecting the following emissions: (1) gaseous, (2) particulate, (3) CO, CO2, NOx, THC, (4) insoluble and soluble fraction.

Following the baseline, the prepared DDC owned catalyst was installed and "prepped" for the following day of testing (1 cold, 3 hot cycles). After completion of DDC catalyst testing the sequence of timing configurations was run to determine the optimum "trade-off" for emissions. The optimization process took several days. Once the timing configuration was determined, the engine was broke-in for 1 hour on the 20/80 methyl/soyate blend, followed by a 2 Point Power Check, to compare Biodiesel performance to neat diesel. An EPA transient cycle was then run (1 cold, 3 hot) collecting all gaseous and particulate emissions. The final day of testing combined the 20/80 biodiesel blend, the DDC optimized timing, and the DDC catalyst (1 cold, 3 hot cycles). The engine was returned to DDC for evaluation. Both the catalyst and engines mentioned are the sole property of DDC.

Conversion of Glycerol From SoyDiesel Production to 1.3 Propanediol - University of Wisconsin

The overall goal of this project was to develop a fermentation process for the production of 1,3-propanediol from the crude glycerol stream of a biodiesel facility. The project focused on the identification of a microbial strains for

1.3 PD production, fermentation optimization, process development, process economics, market analysis, and polymer product development.

The Economics of Engine Replacement/Repair for Biodiesel Fuels. - UNIVERSITY OF GEORGIA

Four alternative fuels, diesel, biodiesel, methanol, and compressed natural gas were investigated in a regenerative optimal stopping model for engine rebuilds with data on mileage and rebuilt costs for municipal bus operations. The model for this bus engine optimal rebuilt problems was a nested fixed point maximum

likelihood algorithm which avoided many of the limitations which depend critically on the existence of an analytic solution. Results indicated that biodiesel buses at prices as high as $3.00 per gallon for biodiesel are competitive with other alternative fuels.

Engine Evaluation with Biodiesel Blend - Fosseen Manufacturing & Development

During this project FMD obtained a fresh 6V92-MUI coach upgrade from DDC and broke it in according to DDC procedures. This project provided documentation of a 20/80 blend and a 30/70 blend in 3 different configurations.

NATIONAL BIODIESEL BOARD

FY95 FUNDED RESEARCH PROJECTS

Field Research Trials of Methyl Soyate for Underground Mine Equipment - U.S. Bureau Of Mines

The goal of this investigation was to determine if methyl soyate fuel with the addition of a diesel oxidation catalyst exhaust aftertreatment device can reduce exhaust pollutants from heavy-duty, diesel powered, underground mining equipment sufficient to economically replace expensive, complicated exhaust aftertreatment devices used for particulate reduction. The U.S. Bureau of Mines, Twin Cities Research Center, Minneapolis, Minnesota, met the following research objectives:

(1) The U.S. Bureau of Mines conducted field trials at an underground metal or nonmetal mine to measure and compare the concentrations of diesel particulate and exhaust gases present in the mine when operating diesel equipment on methyl soyate and on petroleum diesel fuel.

(2) The U.S. Bureau of Mines performed laboratory screening tests of methyl soyate fuel using a diesel engine and exhaust scrubber system of the type necessary for certification by the Mine Safety and Health Administration for use by underground coal mine or gassy noncoal mine face equipment.

Production and Testing of Ethyl & Methyl Esters Part II - EMA Test Cycles University of Idaho

This project was the second phase of the project submitted in 1993. Part II: (1) Produce sufficient quantities of Ethyl and Methyl esters of rapeseed oil, soybean oil, canola and tallow using the procedures developed in Part I, for conducting 200 hour EMA test cycles. (2) Conduct EMA test cycles in 3 cylinder, Direct Injection engines fueling the engines with 100% of the test fuels.

Evaluation and Optimization of 110-HP Volvo Outboard Engine University of Tennessee

The overall objective was to evaluate and optimize the performance of a 110-hp Volvo diesel outboard engine fueled with soydiesel for operation in environmentally-pristine waters. Specific objectives included determining: 1) engine emissions and effects on water quality, (2) engine performance, and (3) engine endurance.

The Physical Characterization of Biodiesel/Low-Sulfur Diesel Fuel Blends - University of Missouri

The objectives of this project were to (1) Analyze fuel related variables, as outlined by the fuels division of the EPA, for blends of 20, 30, 50 and 70 percent biodiesel/diesel fuel. (2) Determine if the fuel analysis yields a linear response when compared to 100 percent biodiesel and 100 percent diesel fuel. (3) Identify a range of values that can be expected for various fuel related variables when analyzing blends of biodiesel and diesel fuel. (4) Evaluate the accuracy of various analytical procedures when analyzing blends of biodiesel and diesel fuel.

Performance of Biodiesel-Fuel Engines for Generation of Electricity - USDA-Agricultural Research Service

The objectives of this project were to (1) Determine the performance (fuel consumption, power, speed regulation, etc.) of biodiesel-fueled engines for

electrical generation used in remote areas. (2) Measure the emissions of prime power diesels when operating at variable loads and fueled with biodiesel. (3) Determine the level of wear of prime power diesel engines when fueled by biodiesel and operated at variable loads.

Operation of Cummins N14 Diesel on Biofuels: Performance, Emissions and Durability - ORTECH

ORTECH assembled a program focusing on the Cummins N14 series diesel engine. This engine is used in larger buses (e.g. articulated configurations), in trucks and in farm tractors. The program was structured in two phases, with the objectives being:

Phase I: Generate emissions data on baseline diesel, B20 and with a catalyst, using the full EPA transient test cycle and the FTP smoke test schedule.

Phase II: Conduct a 1000 hour test sequence documenting engine performance and deterioration.

The work was initiated by the Ministry of Transportation, Province of Ontario (MTO) and the Canadian Federal Government, represented through Environment Canada (EC). ORTECH was able to assure involvement of the engine manufacturer, Cummins Engine Company.

Biodiesel Technical Fuel Quality Laboratory Analysis - BRABMIJ

The objective of this project was to (a) Provide complete analysis and characterization for biodiesel being used in biodiesel field trials or research. (2) Provide sufficient replication of sample results to obtain statistically valid analysis and compare that analysis against existing specifications. (3) Use data to assist the NBB and others in gathering performance based information which can be used in the updating of existing biodiesel specifications.

The American Society of Agricultural Engineers recently approved an engineering practice, ASAE EP X552, listing the analysis that should be conducted on every lot of biodiesel being used for research activities. The purpose of the engineering practice is to provide detailed engineering information in order to correlate research findings with biodiesel properties and attributes, provide accurate comparisons of research findings between differing projects and investigators, and to troubleshoot any problems which may occur. This engineering practice is not to be construed as a specification for biodiesel, since many more items are being tracked than would be expected in a specification, but the data will be used as a source of information feeding into specification development.

Investigation of Potential Exhaust Emission Reductions Through The Use of Methyl Soyate as a Low Level Blend Additive With Highway Diesel Fuel in a Heavy Duty Diesel Engine (1988 DDECII 6V92 TA) - Environment Canada

Testing on a 40' urban transit bus 1988 DDECII 6V92 TA powered, over three repeats of the ADB cycles.

EPA approved engine emissions test was run on the following fuel characteristics (1) Low Sulfur, (2) Low Sulfur/20% Biodiesel, (3) Low Sulfur/20% Biodiesel/Timing retard, (4) Low Sulfur/20% Biodiesel/ENG CMX, (5) Low Sulfur/20% Biodiesel/ENG CMX/Timing retard. Determined emissions include: THC (55), NMHC, CO, CO2, NOx, PM, SOF, (11) Aldehydes.

Investigation of Potential Exhaust Emission Reductions Through The Use of Methyl Soyate as a Low Level Blend Additive With Highway Diesel Fuel in a Heavy Duty Diesel Engine (DDC 8V71) - Environment Canada

Testing on a 60' urban transit bus, DDC 8V71 powered, over three repeats of the ADB cycles.

EPA approved engine emissions test will be run on the following fuel characteristics (1) Low Sulfur, (2) Low Sulfur/20% Biodiesel, (3) Low Sulfur/20% Biodiesel/Timing retard, (4) Low Sulfur/20% Biodiesel/ENG CMX, (5) Low Sulfur/20% Biodiesel/ENG CMX/Timing retard. Emissions to be determined include: THC (55), NMHC, CO, CO2, NOx, PM, SOF, (11) Aldehydes.

Transient Emission Testing Biodiesel Fuel On DDC 6V-92TA Engine/Cummins L10 Mechanical Engine - Engineering Test Services

This project (1) Characterized baseline emissions from a mechanical controlled DDC 6V-92TA and Cummins L10 transit bus engine using #2 low sulfur diesel fuel. (2) repeated an experiment using 20 volume and biodiesel in #2 low sulfur diesel fuel. (3) Repeated using a timing retard with NOx at least 3% below baseline levels. (4) Repeated with an oxidation catalyst.

Biodiesel Emissions Testing On Cummins L-10 Electronic Engine - NIPER

This project provided FTP emissions testing on a Cummins L-10 electronically controlled engine for the following configurations: (1) B20 + Timing Change, (2) B20 + Catalyst, (3) Diesel Fuel + Catalyst, (4) B20 + Catalyst + Timing Change.

Emissions Evaluation of Catalyst Equipped Detroit Diesel 6V-92TA Engines - NIPER/

West Virginia University

The global objective of the proposed study was to evaluate exhaust emissions and the performance of a Detroit Diesel 6V-92TA engine operating on a blend of biodiesel and No. 2 low sulfur diesel fuel. The data would be used as part of an application for certification of 20% blend of biodiesel as an option under the U.S. EPA Rebuild/Retrofit Program for urban buses. The Transportable Heavy Duty Vehicle Emissions Laboratory designed and operated by West Virginia University was employed to evaluate the vehicles at their site of location. The chassis dynamometer based laboratory was used to conduct transient tests on vehicles powered by DDC-6V-92TA engine equipped with and without an oxidation catalyst. Mass emission rates of carbon monoxide, carbon dioxide, unburned hydrocarbons, oxides of nitrogen, smoke density and fuel efficiency were reported.

Analytical Methodologies For The Determination of Biodiesel Ester Purity - R. W. Heiden

The proposed work entails a detailed review of existing literature about the analytical characterization of methyl esters of oils and fats of biological origin, followed by a laboratory study of selected methods. The objective was to lay the foundation for a standardized procedure for routinely determining the ester purity. In the first phase of the work, a thorough review was done of the most commonly used methods in the U.S. Sources listed in the RFP's were searched, as well as other accessible literature materials. The methodology candidates for detailed laboratory study were identified. The focus was on spectroscopic, chromatographic and chemical methods. In the second phase, chosen methods were studied in the laboratory to confirm earlier findings, investigate possible issues associated with bias, interferences, additional information obtainable by the methods, and costs. A procedure was developed, refined, and then submitted for review for standardization process.

Chemical and Biological Characterization of Emissions from a Biodiesel-Fueled Underground Mining Engine - Michigan Technological University

This project measured the unregulated emissions, particularly PAH, micro-PAH, carbon number analysis, and mutagenic activity in the particle and vapor phase samples obtained from an underground mining engine operated under transient conditions with three fuels (neat diesel, neat biodiesel and a 30%/70% biodiesel/diesel blend) with and without two types of oxidation catalytic converters as control devices. Work was done with personnel from the US Bureau of Mines - Twin Cities Research Center to analyze all of the data obtained as part of this project in order to evaluate the effectiveness of the biodiesel fuels and control devices for potential use in the underground mine environment.

Evaluation of the Effects of Biodiesel and Ceramic Coating on Diesel Exhaust Emissions In A Research Engine - Southwest Research Institute

The test program was divided into two phases. Both phases were conducted using the single-cylinder research engine described below. The biodiesel test fuel used was an 80-20 blend by volume of emissions grade 2-D diesel fuel and biodiesel. The first phase involved evaluation of biodiesel in the engine using an un-coated set of parts. Data was generated at different injection pressures, and injection timing set-points as described below. The second phase consisted of a testing of biodiesel in conjunction with the GPX-4 coating system, provided by Engelhard, which was examined over the same matrix of tests as the un-coated engine.

Fueling Direct Injected Diesel Engines with 100% Neat Biodiesel - University of Missouri

The primary goal for this research was to investigate the long-term real-world impact of fueling modern direct injected on-road diesel engines with B100. Specific research objectives included:

1. Operating a 5.9L D1 diesel engine 50,000 miles or until the engine has exceeded 100,000 miles of operation.

2. Recording of engine operating parameters including fuel economy, engine oil analysis, parts replaced, and miles driven.

3. Measuring engine power using a chasis dynamometer at 12,000 mile intervals.

4. Recording of NOx, CO, CO2, HC, and opacity by respectively using NOVA portable analyzer and a Telonic Berkley opacity meter.

5. Entering the data into Paradox, a relational database for analysis.

6. Performing a complete tear-down of the engine at Cummins Engine Company, Columbus, Indiana.

Biodiesel Flexible Fueled Vehicle Market Penetration Evaluation - University of Illinois at Chicago

The purpose of this study was to discover just how many light duty alternative

fueled vehicles state fleet managers would be required to purchase starting in MY 1996.

NATIONAL BIODIESEL BOARD

FY96 FUNDED RESEARCH PROJECTS

MECHANISMS OF EMISSIONS REDUCTION USING BIODIESEL FUELS - UNIVERSITY OF WISCONSIN

A combined experimental and modeling study to determine the mechanisms of increased NOx and soluble organic fraction (SOF) that can occur with the use of biodiesel fuels in heavy-duty diesel engines.

ASTM Standards Development and Industry Acceptance - MARC-IV

The objectives of this project were to maintain the chairmanship of the ASTM Biodiesel Task Force; obtain in-depth feedback on the draft ASTM specification from OEM's, producers, distributors, users, and researchers; recommend the proper analytical methods for the draft ASTM specification based on NBB and other research projects; presentation of these findings to ASTM; determination of actions needed to gain agreement on the specification within the ASTM process; execution of the actions developed by the ASTM process and review of the specification; development of the final ASTM biodiesel specifications on sound scientific methods and upon the requirements of customers, engine manufacturers, and producers; and use of the process for developing the specification to build and enhance industrial acceptance of biodiesel.

Guide For The Transportation and Handling of Biodiesel and Biodiesel Blends - University of Missouri

This project allowed for review of biodiesel research available from the National Biodiesel Board and other biodiesel related research that has produced real world experience in the transportation and handling of biodiesel or biodiesel blends; review of literature related to transportation and handling of biodiesel and biodiesel blends; and production of a guide to the efficient handling and transportation of biodiesel and biodiesel blends.

Research Strategy and Coordination - MARC-IV

Objectives of this project included advisory briefings on developing and implementing a comprehensive research program to evaluate biodiesel fuel

performance, fuel characteristics, fuel cost analysis, fuel improvements and alternative uses for biodiesel and its by-products; providing NBB with a sound research strategy to enhance the development of the biodiesel industry through meeting the needs of fuel users, engine manufacturers, regulators, and biodiesel producers and distributors; use of this strategy as a means of coordination and cooperation with government agencies, universities and academia, industry, and others in order to maximize the value of research accomplished for biodiesel.

Engine Oil Impact Literature Search and Summary - University of Missouri

During this project the researchers reviewed biodiesel research available from the National Biodiesel Board and other biodiesel-related research that analyzed engine lubricating oil while fueled on biodiesel or biodiesel blends; worked cooperatively with engine oil analysis laboratories to determine the appropriate methodology to analyze engine lubricating oil that had been diluted with biodiesel fuel; made comparisons among the data reported in the literature to determine if previously reported oil analysis data had been analyzed properly; and the researchers collected and analyzed engine lubricating oil samples taken during NBB-sponsored research/demonstrations.

Identifying and Evaluating Non-Fuel Products From Biodiesel - Development Systems/Applications International

The overall objective of this project was to identify and evaluate industrial products that can be made from soybean methyl esters in addition to biodiesel fuels - plus determining and prioritizing those uses that have the best opportunity for commercialization. Specific objectives included conducting a thorough examination of products and product uses for methyl esters derived from soybean oil; physically testing methyl esters in the most promising selected uses; and identifying those products that have the greatest potential for commercialization.

Troubleshooting Field Problems With Biodiesel - Schumacher Consulting

The objectives of this project were to develop an "NBB Troubleshooting Team" consisting of biodiesel researchers, industry representatives and research technicians; develop an "NBB Troubleshooting Team Response Plan" that could be used as a model when responding to problems that surface during biodiesel and biodiesel blend fueling; develop and utilize a "troubleshooting log" that documents the efforts of the NBB Troubleshooting team; secure the services of consultants to visit the site of the problem and gather additional information about the problem; secure and mail sample containers to biodiesel users as

appropriate; analyze the sample (if possible) using basic analytical techniques and photograph each sample, determine the laboratory best suited to analyze samples; sample analysis review of the findings, and submission of recommendations to NBB concerning the problem.

Biodiesel Fuels Laboratory Evaluation Using Commercial Materials/Chemical Testing Laboratories - BRABMIJ

This project continued chemical testing and evaluation per the NBB specification; provided statistical data on the accuracy and precision of the selected testing laboratories; and provided data to assist the NBB and others in gathering performance-based information for use in updating the existing biodiesel specifications.

OEM Acceptance - MARC-IV

This project provided existing data on biodiesel properties, emissions, and durability to the major Original Equipment Manufacturers (OEM's); ensured proposed testing and research data needed by the OEM's for evaluation of biodiesel; shared new data with OEM's as it became available through NBB research and research completed by cooperators.

Diesel Fuel Pump Evaluation and Analysis - Williams Pipe Line Company, System Lab Services

This project characterized the operation and performance of diesel fueling systems and transfer pumps, with laboratory type pump stand apparatus, using biodiesel of varying properties (both as neat fuel and as a B20 blend) and neat petrodiesel, and determine any performance degradation that may occur with time.

Injector Deposits - Engineering Test Services

This project investigated the detergency effects of biodiesel. Two (2) Cummins '88 L10 engines joined in tandem were used. Each test was run for 125 hours on a cycle that alternated between driving and motoring of each engine. The pass/fail criteria for this test was based on carbon and lacquer deposits (CRC rating) on the injector plunger, as well as a flow loss specification of the complete injector.

Thermal and Oxidative Stability - Williams Pipeline Company

This project investigated several facets of biodiesel stability and presented a summary of past research concerning diesel fuel stability. Biodiesel stability relative to petroleum-based diesel fuel, appropriateness of testing biodiesel by selected stability test methods used in the petroleum industry, and efficacies of petroleum additives and a food-grade stabilizer were explored. Results from this project provide information regarding what instruments can be used to further evaluate the stability of biodiesel and additive efficacies.

Additive Compatibility - Williams Pipeline Company

This project analyzed the effectiveness of conventional petroleum product additives on neat biodiesel and biodiesel blends. The additives were analyzed singularly, and as a group. The additives studied included cetane, stability, conductivity, and corrosion improvers.

Sample Analysis From Biodiesel Test -- UMC

The overall purpose of this project was to analyze samples taken during a NBB 1000 hour durability test. Specifically, the following objectives: (1) determine fuel properties/contaminants so as to make it possible to duplicate the fuel conditions that cause the filter to plug and the residues to be formed; (2) determine the chain length of the residue samples in an effort to determine whether the deposits are of biodiesel or of petroleum origin; and (3) determine the elemental composition and compounds present in the fuel and residue sample. Based on these analyses, the fuel additives and contaminants that were most likely present should be determined.

Soy-Derived Diesel Fuel Additives

The objective of this project was to identify suitable derivatives of soybean oil for possible application as fuel additives. Minimum fuel additive application areas included diesel fuel cetane improvers, diesel fuel detergents, gasoline detergents, and diesel fuel lubricity/corrosion inhibitors.

Determination of Biocide Efficacy and Microbial Activity on Biodiesel - BDM Petroleum

The objective of this project was to determine the microbial growth characteristics that can contaminate biodiesel and blends of biodiesel/petrodiesel and to determine the efficacy of selected biocides and microbial agents, commonly used for petrodiesel, in controlling these growths. The results of the research

will be used to make recommendations on storage of biodiesel and use of effective biocides to prevent their contamination.

Biodiesel Lubricity - Williams Pipeline Company

The objective of the proposed study was to define the effects of increasing concentrations of biodiesel on the lubricity of low-sulfur and low-aromatic fuels. The effect of commercially available lubricity additives in identical fuels was also refined and compared to biodiesel and compared to historical lubricity information on diesel fuel before the change to low sulfur diesel.

Customer Parts Assistance - UMC

The main objective of this project was to respond to "frequently asked questions" from researchers, clients, and other individuals or companies researching biodiesel. The following specific objectives were approved to accomplish this broad objective - develop and maintain a responsive customer parts assistance site on the Internet, allowing end users to seek answers to FAQ about the use and commercialization of biodiesel; respond to customer parts assistance questions raised by individuals interested in biodiesel and its commercialization via fax, phone, and the Internet; and interact with relevant agencies to stimulate interest and develop support for biodiesel research via the Internet.

Long-Term Storage - BDM Oklahoma

The objective of this project was to determine the stability of biodiesel and biodiesel/petrodiesel blends over an extended storage period with varying quantities of mono-di-tri-glycerides and evaluate the efficacy of stabilizing additives in extending their storage life.