US Army TARDEC
Fuels and Lubricants Research Facility

U. S. Navy High-Speed Diesel Engine Performance Evaluation: Cummins NH-220G and Detroit Diesel 6V-53N

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Problem: A major goal of the Shipboard Mobility Fuels Research and Development program is to broaden the fuel procurement specifications for MIL-F-16884H to utilize all petroleum fuel sources and fuel refining processes. The Fuel Qualification Procedure project will define an overall approach for qualifying fuels and determine the necessary fuel property revisions to expand the MIL-F-16884H fuel specification to include a broader range of distillate fuels.

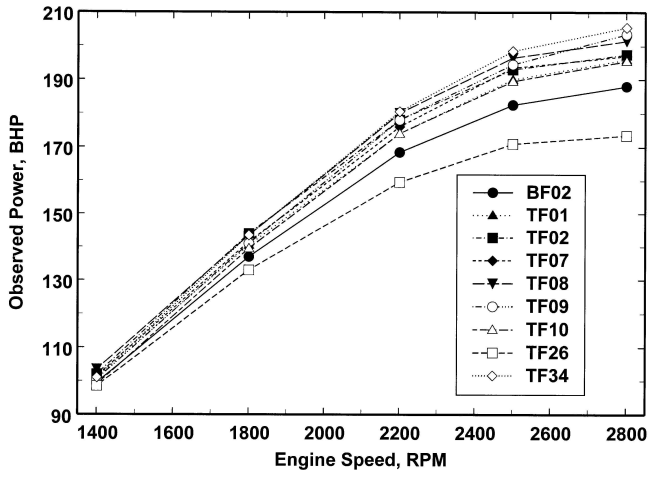
Objective: The High-Speed Diesel Engine Test Plan objective was to determine fuel property limitations on the performance and durability of Navy high-speed diesel engines (HSDE). The test plan was divided into five areas of study: fuel injection, cold startability, durability, thermal stability, and performance.

Importance of Project: The objective of the HSDE performance evaluations was to determine the limits of fuel properties that will provide fuels of acceptable performance in Navy HSDEs in terms of an engine's ability to dependably produce the necessary level of power required to accomplish its mission. The HSDE test plan was developed based on the following criteria:

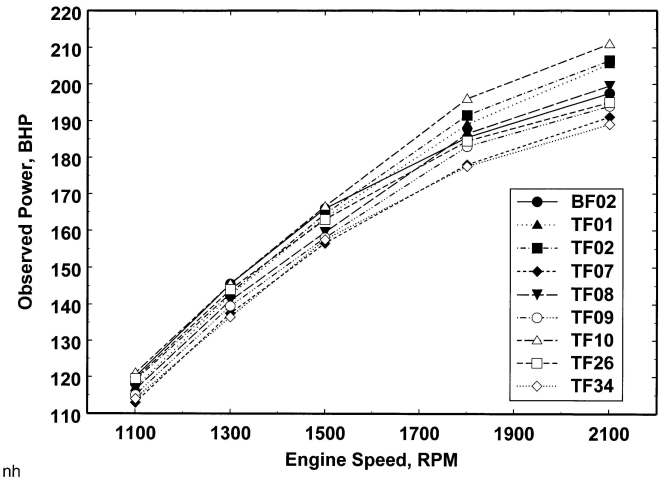
- Engine selection - equipment surveys
- Test fuels - worldwide fuel availability and property variations
- Lubricating oil - military specifications
- Test cycles - Navy equipment mission profiles

Technical Approach: Based on the population of high-speed diesel engines in the Navy's inventory, the five engines (or engine families) included in the test plan were the Detroit Diesel Corporation 53, 71, and 149 series engines, the Westerbeke 4-108, and the Cummins NH-220G. The injection/combustion systems on these engines are representative of approximately 94 percent of all Navy high-speed diesel engines.

Accomplishments: This report documents the performance evaluations of Detroit Diesel Corporation 6V-53N and Cummins NH-220G engines operating largely on broadened specification military diesel fuel, MIL-F-16884H. The performance evaluations also included a fundamental study of the relationship of fuel properties to various combustion phenomena measured in one cylinder of each test engine. Included are engine and test fuel specifications, engine performance analysis, engine operating data, and test fuel data. A multivariate analysis of fuel properties with engine performance variables revealed acceptable fuel property correlations with engine combustion variables. The power production and fuel consumption correlations were dominated by the test point variables' speed and load included as independent variables. Additional multivariate analyses performed utilizing a transformation of the independent variable load revealed acceptable fuel property correlations for power and fuel consumption. Kinematic viscosity, net heat of combustion, specific gravity, and hydrogen content influenced the power and fuel consumption of the Cummins NH-220G. The power and fuel consumption of the Detroit Diesel Corporation 6V-53N was influenced by kinematic viscosity, net heat of combustion, specific gravity, hydrogen content, aniline point, and boiling point distribution.



DDC 6V-53N Full Rack Brake Horsepower of Test Fuels



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Cummins NH-220G Full Rack Brake Horsepower of Test Fuels