

Fuel Economy Effects of Cleaner-Burning Gasoline A Summary of Studies

Introduction

The Air Resources Board adopted the cleaner-burning gasoline regulation in November 1991 based upon studies relating fuel properties to emissions. These studies included the Auto/Oil Air Quality Improvement Research Program and studies conducted by individual oil and automobile companies. Fuel economy losses associated with cleaner-burning gasoline were estimated to average 3 percent when compared to conventional non-oxygenated gasoline. The lower fuel economy is related to the lower energy content of cleaner-burning gasoline. This is primarily due to the addition of oxygenated compounds and the reduced amount of heavy hydrocarbons in the fuel. These changes have been proven by many studies to reduce air pollution from gasoline combustion. These fuel economy results were published in 1993, and are summarized below.

In 1994, to address and study performance, fuel economy and other issues, the Air Resources Board formed an Advisory Committee to oversee the implementation of the cleaner-burning gasoline regulation. Members of the Advisory Committee and its Subcommittees included automobile and oil refining industry representatives, gasoline distributors and marketers, fleet administrators, and consumer and public interest groups. The Performance Subcommittee conducted a performance and compatibility test program involving over 800 vehicles. Fuel economy data was available for 131 vehicles from the test fleet. Evaluation of the fuel economy data from this program showed an average fuel economy loss of 2.4 percent.

Over the last several years, additional studies have been conducted which support the original evaluation of fuel economy effects and the results from the performance and compatibility study. These studies are identified and briefly summarized below.

Fuel Composition Effects on Automotive Fuel Economy - Auto Oil Air Quality Improvement Research Program. Society of Automotive Engineers Paper # 930138. 1993.

In this study variations in fuel properties were studied to learn their effects on fuel economy. The fleet tested included 34 vehicles ranging in model years from 1983 to 1989. Fuel economy was measured using three methods; the United States Environmental Protection Agency Fuel Economy Test Method, Volumetric Fuel Economy, and Energy Specific Fuel Economy. This study established the relationship between fuel energy content and fuel economy. The study also concluded that reducing aromatics, adding oxygenates, reducing T90 and reducing olefins lowered fuel economy in both current and older model vehicles.

Gasoline Reformulation and Vehicle Technology Effects on Exhaust Emissions. Auto/Oil Air Quality Improvement Research Program, Technical Bulletin Number 17. August 1995.

This test program encompassed three vehicle fleet types with a total of 23 vehicles. The fleets were broken down into older (model years 1983 to 1985), current (model year 1989), and Federal Tier 1 (model year 1994) engine groups. Fuel delivery systems included carbureted, throttle body injected, port fuel injected,

and sequential fuel injected. The program compared cleaner-burning gasoline to a national industry average reference fuel. Fuel economy was measured according to standard Federal Test Procedures. The average change in miles per gallon ranged from -1.9 to -3.6 percent for the different fleets.

Dynamometer Study of Off-Cycle Exhaust Emissions. Auto/Oil Air Quality Improvement Research Program, Technical Bulletin Number 19. April 1996.

Eight vehicles were tested using cleaner-burning gasoline in this program. The fleet was divided into 3 different fuel type groups; current gasoline, methanol flexible fuel vehicles, and ethanol flexible fuel vehicles. For all groups fuel economy was compared using cleaner-burning gasoline and a national industry average gasoline. The model years of vehicles tested ranged from 1989 to 1993. The test program was designed to study the difference in emissions using a driving cycle which includes higher driving speed, higher acceleration and deceleration (the REP05 driving cycle) compared to the standard test driving cycle (the FTP). Fuel economy changes associated with cleaner-burning gasoline were shown to be -2 percent on the FTP driving cycle. On the REP05 cycle, fuel economy was reduced 3 percent compared to the industry average gasoline.

Effects of California Phase 2 RFG on Exhaust Emissions and Vehicle Performance - Quarterly Technical Progress Report. BDM-Oklahoma, Inc. For the Department of Energy. January 1996.

This on-going study of long term effects of fuels on vehicles has a test fleet of five 1994 vehicles with California emissions equipment. These vehicles had 20,000 to 30,000 miles accumulated on them prior to the start of the test. The vehicles then accumulated an additional 30,000 miles of a mix of urban, suburban and highway driving cycles. The study compared cleaner-burning gasoline to a federal reformulated gasoline and a national industry average fuel. The study showed a -2 percent change from federal reformulated gasoline used in Southern California since 1995.

Exhaust Emissions of E85 Ethanol Fuel and Gasoline in Flexible/Variable Fuel Vehicles. Auto/Oil Air Quality Improvement Research Program, Technical Bulletin Number 16. July 1995.

Three flexible fuel vehicles were tested in this program which compared a national industry average fuel to cleaner-burning gasoline and to E85. E85 is an 85 percent blend of ethanol and 15 percent gasoline. The vehicles, designed to run on flexible fuels were equipped with either sequential port injection or port fuel injection fuel delivery systems. The model years ranged from 1992 to 1994. Fuel economy was measured by standard Federal Test Procedures (FTP). The comparison of the industry average fuel and cleaner-burning gasoline showed a reduction in fuel economy of 3.9 percent.

Air Resources Board Laboratory Dynamometer Test Program. California Air Resources Board, Mobile Source Division. 1995.

In this test program four 1995 vehicles were tested using the Federal Test Procedures (FTP) to represent city driving and the Highway Fuel Economy Test (HWFET) to represent highway driving. The test program showed a loss of miles per gallon of 3.5 percent comparing cleaner-burning gasoline to conventional gasoline. Comparing cleaner-burning gasoline to federal reformulated gasoline showed a 1.8 percent fuel economy loss.

The table below summarizes the results from these studies.

**Summary of Fuel Economy Studies
Cleaner-Burning Gasoline**

Study	Number of Vehicles	Model Years	Fuel Economy Results
Fuel Composition Effects on Automotive Fuel Economy - Auto Oil Air Quality Improvement Research Program. 1993	34	1983-1989	-1.5% ¹
Gasoline Reformulation and Vehicle Technology Effects on Exhaust Emissions. August 1995	23	1985-1994	-1.9% - Older Fleet -2.6% - Current Fleet -3.6% - Federal Tier 1 Fleet
Dynamometer Study of Off-Cycle Exhaust Emissions. April 1996	8	1989-1993	-2% - FTP Cycle -3% - REPO5 Cycle
Effects of California Phase 2 RFG on Exhaust Emissions and Vehicle Performance - Quarterly Technical Progress Report. January 1995	5	1994	-2% - Federal RFG ²
Exhaust Emissions of E85 Ethanol Fuel and Gasoline in Flexible/Variable Fuel Vehicles. July 1995	3	1992-1994	-3.9%
Air Resources Board Laboratory Dynamometer Test Program. 1995	4	1995	-3.5% - Conventional -1.8% - Federal RFG

1. This study compared a fuel similar to cleaner-burning gasoline to a national industry average gasoline.
2. Study also included results from a comparison of cleaner-burning gasoline compared to a conventional gasoline which had a higher than average energy content showing a fuel economy difference of -5 percent.