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16. ABSTRACT

NRG #1 is a fuel additive developed and marketed by NRG International Inc. of Clayville, New York. A representative of NRG supplied EPA with results of tests conducted by Scott Environmental Technology, Inc. which showed that use of the additive resulted in increased fuel economy as well as significant reductions in HC and CO emissions. On the basis of this data, EPA decided to conduct confirmatory tests.

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Carbon monoxide			
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Evaluation of NRG #1, A Fuel Additive

February 1978

Technology Assessment and Evaluation Branch
Emission Control Technology Division
Office of Mobile Source Air Pollution Control
Environmental Protection Agency

Background

The Environmental Protection Agency receives information about many systems which appear to offer potential for emission reduction or fuel economy improvement compared to conventional engines and vehicles. EPA's Emission Control Technology Division is interested in evaluating all such systems, because of the obvious benefits to the Nation from the identification of systems that can reduce emissions, improve fuel economy, or both. EPA invites developers of such systems to provide complete technical data on the system's principle of operation, together with available test data on the system. In those cases for which review by EPA technical staff suggests that the data available show promise, attempts are made to schedule tests at the EPA Motor Vehicle Emission Laboratory at Ann Arbor, Michigan. The results of all such test projects are set forth in a series of Technology Assessment and Evaluation Reports, of which this report is one.

NRG #1 is a fuel additive developed and marketed by NRG International Inc. of Clayville, New York. A representative of NRG supplied EPA with results of tests conducted by Scott Environmental Technology, Inc. which showed that use of the additive resulted in increased fuel economy as well as significant reductions in HC and CO emissions. On the basis of this data, EPA decided to conduct confirmatory tests.

The conclusions drawn from the EPA evaluation tests are necessarily of limited applicability. A complete evaluation of the effectiveness of an emission control system in achieving performance improvements on the many different types of vehicles that are in actual use requires a much larger sample of test vehicles than is economically feasible in the evaluation test projects conducted by EPA. For promising systems it is necessary that more extensive test programs be carried out.

The conclusions from the EPA evaluation test can be considered to be quantitatively valid only for the specific test car used; however, it is reasonable to extrapolate the results from the EPA test to other types of vehicles in a directional manner, i.e., to suggest that similar results are likely to be achieved on other types of vehicles.

Description

NRG #1 is recommended by the manufacturer for use with all grades of gasoline and diesel fuel used in internal combustion engines. It is mixed directly with fuel in the vehicle's tank in a ratio of 1:1600 (0.08 fl. oz. additive per gallon fuel). The following benefits are claimed by the manufacturer when the additive is used in an automotive gasoline engine:

-Increased fuel economy of 10-25%

-Decreased exhaust emissions

-Increased engine power

-Decreased starting time in cold weather

-Decreased dieseling tendency

-Decreased carbon buildup inside engine

Test Procedure

Exhaust emission tests were conducted according to the 1977 Federal Test Procedure (FTP), described in the Federal Register of June 28, 1977, and the EPA Highway Fuel Economy Test (HFET), described in the Federal Register of September 10, 1976. Steady state and Federal Short Cycle tests were also conducted. Evaporative emissions were not tested.

Prior to baseline testing the vehicle, described in Table 1, was tuned to Chevrolet's specifications for ignition timing, idle speed, and spark plug gap. One spark plug was found to be fouled with oil, so it was replaced. Compression in all cylinders was also checked and found to be within specification. To precondition the vehicle, it was driven on the dyno for two cycles of the Urban Dynamometer Driving Schedule (UDDS), one HFET cycle, and another UDDS cycle.

The vehicle was tested in three different conditions:

1) Baseline

2) With NRG #1

3) After 500 miles with NRG #1

At each test condition duplicate tests of each type (FTP, HFET, Steady States, Federal Short Cycle) were conducted. The accumulation of 500 miles was made up of 400 miles AMA durability on a test track and 100 miles of highway driving to and from the test track.

Test Results

Table 2 gives a comparison between average results of baseline (before addition of NRG #1) and final (after 500 miles with NRG #1) test conditions. In general, emission levels remained the same or increased with NRG #1 in the fuel. In particular, use of the additive resulted in the following:

- Increased NOx emissions in all test procedures
- Reduced HC emissions (approximately 15%) for steady state tests at 40 and 50 mph
- Increased HC emissions for all other test procedures
- Increased CO emissions (approximately 23%) for the FTP
- Decreased CO emissions (100%) for the Federal Short Cycle
- No measurable change in CO emissions for other tests

CO emissions for HFET and steady state tests were less than 0.1 gram/mile. This is due to the effectiveness of the catalytic converter once it is warmed up.

Changes in average fuel economy were small. Most tests showed a decrease in fuel economy with NRG #1 in the fuel, but the HFET, 40 mph, and 50 mph tests showed slight (less than 3%) increases in fuel economy with the additive.

Conclusions

Although a few EPA tests of NRG #1 showed slight improvements in either fuel economy or emissions, the majority of tests indicated that use of the additive decreased fuel economy while increasing emissions. This leads to the conclusion that there is neither a general increase in fuel economy nor a decrease in emissions associated with the addition of NRG #1 to the fuel.

Table 1
TEST VEHICLE DESCRIPTION

Chassis model year/make - 1975 Chevrolet Nova
Emission control system - EGR, Catalyst, Air Injection
(California calibration)

Engine

type	V-8, OHV
bore x stroke	4.00 x 3.48 in. (101.6 x 88.4 mm)
displacement	350 cu. in. (5735 cc)
compression ratio	9.0
maximum power @ rpm	200 hp @ 5200 rpm (150 kW)
fuel metering	Carburetor, 4V
fuel requirement	Unleaded regular, tested with Indolene HO unleaded 100 octane

Drive Train

transmission type	Automatic 3-speed
final drive ratio	3.08

Chassis

type	Sedan, 2 door
tire size	ER78 x 14
curb weight	3585 lb. (1626 kg)
inertia weight	4000 lb.
passenger capacity	six

Emission Control System

basic type	EGR, Catalyst, Air Injection

Table 2
Comparison of Baseline and Final Test Averages

Test Procedure		Baseline	500 Miles With Additive	% Change
FTP	HC (g/mi)	.62	.81	+ 31
	CO (g/mi)	4.8	5.9	+ 23
	NOx (g/mi)	1.86	2.01	+ 8.1
	F.E. (mpg)	12.7	12.5	- 1.6
HFET	HC	.13	.14	+ 7.7
	CO	0.0	0.0	0.0
	NOx	2.69	2.94	+ 9.3
	F.E.	17.3	17.7	+ 2.3
Steady State 20 mph	HC	.15	.24	+ 60
	CO	0.0	0.0	0.0
	NOx	.30	.32	+ 6.7
	F.E.	20.2	16.2	- 20
30 mph	HC	.09	.11	+ 22
	CO	0.0	0.0	0.0
	NOx	.42	.47	+ 12
	F.E.	19.8	19.3	- 2.5
40 mph	HC	.08	.07	- 13
	CO	0.0	0.0	0.0
	NOx	.88	.97	+ 10
	F.E.	19.7	19.8	+ 0.5
50 mph	HC	.11	.09	- 18
	CO	0.0	0.0	0.0
	NOx	1.74	2.08	+ 20
	F.E.	18.7	19.1	+ 2.1
Idle Neutral	HC (g/hr)	1.31	4.02	+207
	CO (g/hr)	0.0	0.0	0.0
	NOx (g/hr)	2.39	3.36	+ 41
	F.E. (gal/hr)	.74	.86	- 16
Idle Drive	HC (g/hr)	.54	1.08	+100
	CO (g/hr)	0.0	0.1	+infinite
	NOx (g/hr)	2.94	3.06	+ 4.1
	F.E. (gal/hr)	.79	.85	- 7.6
Federal Short Cycle	HC (g/mi)	.21	.29	+ 38
	CO (g/mi)	0.2	0.0	-100
	NOx (g/mi)	.91	1.26	+ 38
	F.E. (mpg)	14.9	14.9	0.0

Table 3
Baseline Tests

Test #	Test	HC (gram/mi)	CO (gram/mi)	NOx (gram/mi)	Fuel Economy (mi/gal)
78-5955	Bag 1	1.63	23.8	2.53	12.0
	Bag 2	.27	0.0	1.23	12.2
	Bag 3	.56	0.7	2.46	14.3
	FTP	.63	5.1	1.84	12.7
78-5960	Bag 1	1.66	20.6	2.64	12.1
	Bag 2	.31	0.1	1.28	12.2
	Bag 3	.38	0.7	2.45	14.1
	FTP	.61	4.5	1.88	12.6
78-5956	HFET	.13	0.0	2.82	17.0
78-5961	HFET	.13	0.0	2.56	17.6
78-5957	Fed. Short	.22	0.2	0.74	14.9
78-5962	Cycles	.20	0.1	1.07	14.9
	Steady States				
78-5958	20 mph	.19	0.0	.34	20.8
78-5963	20	.10	0.0	.25	19.6
78-5958	30	.09	0.0	.45	19.4
78-5963	30	.08	0.0	.39	20.1
78-5959	40	.11	0.0	.82	19.7
78-5964	40	.05	0.0	.93	19.6
78-5959	50	.11	0.0	1.78	18.9
78-5964	50	.10	0.0	1.70	18.5
		(gram/hr)	(gram/hr)	(gram/hr)	(gal/hr)
78-5958	Idle	1.66	0.0	2.14	0.59
78-5963	Neutral	.96	0.0	2.64	0.89
78-5959	Idle	1.08	0.0	3.00	0.81
78-5964	Drive	0.00	0.0	2.88	0.76

Table 4
Tests With NRG #1 Added

Test #	Test	HC (gram/mi)	CO (gram/mi)	NOx (gram/mi)	Fuel Economy (mi/gal)
78-6329	Bag 1	1.70	23.8	2.71	12.1
	Bag 2	.27	0.1	1.25	12.2
	Bag 3	.28	0.4	2.60	14.1
	FTP	.57	5.0	1.92	12.6
78-6367	Bag 1	1.58	19.9	2.75	12.3
	Bag 2	.29	0.0	1.25	12.3
	Bag 3	.35	0.8	2.38	14.5
	FTP	.57	4.3	1.87	12.8
78-6328	HFET	.13	0.0	3.17	16.9
78-6394	HFET	.13	0.1	2.96	17.0
78-6331	Fed. Short	.19	0.0	1.16	16.1
78-6331	Cycles	.20	0.0	1.18	15.8
	Steady States				
78-6327	20 mph	.17	0.0	.29	19.5
78-6333	20	.21	0.0	.25	21.3
78-6327	30	.08	0.0	.45	19.4
78-6332	30	.08	0.0	.43	19.8
78-6326	40	.13	0.0	.85	19.5
78-6395	40	.07	0.0	.91	20.5
78-6326	50	.18	0.0	1.64	17.6
78-6332	50	.13	0.0	1.89	18.2
		(gram/hr)	(gram/hr)	(gram/hr)	(gal/hr)
78-6327	Idle	2.28	0.0	4.80	.86
78-6333	Neutral	2.88	5.6	2.88	.75
78-6333	Idle	1.56	22.9	3.36	.72
78-6395	Drive	1.29	0.0	3.19	.75

Table 5
Tests After 500 Miles With NRG #1

Test #	Test	HC (gram/mi)	CO (gram/mi)	NOx (gram/mi)	Fuel Economy (mi/gal)
78-6379	Bag 1	2.19	27.5	2.89	12.0
	Bag 2	.33	0.1	1.30	12.1
	Bag 3	.32	0.3	2.61	14.3
	FTP	.71	5.8	1.98	12.6
78-6374	Bag 1	2.82	28.2	2.82	11.9
	Bag 2	.42	0.1	1.34	11.8
	Bag 3	.38	0.4	2.73	13.9
	FTP	.90	6.0	2.03	12.3
78-6378	HFET	.13	0.0	2.94	17.7
78-6373	HFET	.14	0.0	2.94	17.6
78-6375	Fed. Short	.25	0.0	1.25	14.8
78-6370	Cycles	.32	0.0	1.26	14.9
	Steady States				
78-6372	20 mph	.32	0.0	.39	12.2
78-6377	20	.15	0.0	.25	20.1
78-6371	30	.12	0.0	.48	19.2
78-6376	30	.10	0.0	.45	19.4
78-6371	40	.07	0.0	.99	19.7
78-6376	40	.07	0.0	.94	19.9
78-6371	50	.09	0.0	2.12	19.0
78-6376	50	.09	0.0	2.04	19.1
		(gram/hr)	(gram/hr)	(gram/hr)	(gal/hr)
78-6372	Idle	4.56	0.0	3.12	.86
78-6377	Neutral	3.48	0.0	3.60	.86
78-6372	Idle	1.20	0.0	3.00	.85
78-6377	Drive	.96	0.1	3.12	.85

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