76-28 AW

An Evaluation of the EI-5 Fuel Additive

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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 devices for which emission reduction or fuel economy improvement claims are made. In some cases, both claims are made for a single device. In most cases, these devices are being recommended or promoted for retrofit to existing vehicles although some represent advanced systems for meeting future standards.

The EPA is interested in evaluating the validity of the claims for all such devices, because of the obvious benefits to the Nation of identifying devices that live up to their claims. For that reason the EPA invites proponents of such devices to provide to the EPA complete technical data on the device's principle of operation, together with test data on the device made by independent laboratories. In those cases in which review by EPA technical staff suggests that the data submitted holds promise of confirming the claims made for the device, confirmatory tests of the device are scheduled at the EPA Emissions Laboratory at Ann Arbor, Michigan. The results of all such confirmatory test projects are set forth in a series of Technology Assessment and Evaluation Reports, of which this report is one.

The conclusions drawn from the EPA confirmatory tests are necessarily of limited applicability. A complete evaluation of the effectiveness of an emission control system in achieving its claimed 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 confirmatory test projects conducted by EPA. 1/ For promising devices it is necessary that more extensive test programs be carried out.

The conclusions from the EPA confirmatory tests can be considered to be quantitatively valid only for the specific type of vehicle used in the EPA confirmatory test program. Although it is reasonable to extrapolate the results from the EPA confirmatory test to other types of vehicles in a directional or qualitative manner, i.e., to suggest that similar results are likely to be achieved on other types of vehicles, tests of the device on such other vehicles would be required to reliably quantify results on other types of vehicles.

In summary, a device that lives up to its claims in the EPA confirmatory test must be further tested according to protocols described in footnote 1/, to quantify its beneficial effects on a broad range of vehicles. A device which when tested by EPA does not meet the claimed results would not appear to be a worthwhile candidate for such further testing from the standpoint of the likelihood of ultimately validating the claims made. However, a definitive quantitative evaluation of its effectiveness on a broad range of vehicle types would equally require further tests in accordance with footnote 1/.

1/ See Federal Register 38 FR 11334, 3/27/74, for a description of the test protocols proposed for definitive evaluations of the effectiveness of retrofit devices.

EPA had begun receiving inquiries from private citizens and governmental agencies across the country about a motor fuel additive called EI-5 when a request for EPA testing was made by a Federal Trade Commission Regional Office, on behalf of the State of Minnesota, which was undertaking investigation of advertising claims for the product. Claims made for the additive were that its use yields improvements in fuel economy of 18 to 25 percent. Because of the apparent national promotion of the product, and the considerable public interest as to its effectiveness in improving fuel economy, an evaluation test program was conducted.

Test Vehicle and Fuel Additive Description

EI-5 is a liquid additive that is supplied with instructions directing that the product be used in both the fuel tank and engine crankcase. The exact composition of EI-5 is considered to be a trade secret by the manufacturer. The manufacturer does indicate (in information furnished to EPA by the Minnesota Attorney General) that the main ingredients of EI-5 are "refined pure oil, xylene and antioxidants." EI-5 is claimed to interact with and modify gasoline molecules, resulting in "more complete combustion."

The directions for the initial application of the product call for the addition of one ounce of EI-5 for each five gallons of fuel in a full fuel tank, and the addition of three ounces of EI-5 to the oil in the crankcase. Also, one ounce of EI-5 per cylinder is poured into the carburetor throat with the engine warm and running at fast idle.

For subsequent refuelings, EI-5 is added to the fuel in the proportion of one ounce or less for each seven gallons of fuel. It is suggested in the directions accompaning the product that better fuel economy may be achieved by lowering the proportion of EI-5 to fuel, i.e., one ounce of EI-5 for each eight to ten gallons of fuel. For oil changes, one ounce of EI-5 per five quarts of oil is recommended.

Two vehicles were used for the test program, a 1970 Chevrolet for evaluation of the additive and a 1970 Plymouth Valiant for a control vehicle. Both vehicles had accumulated approximately 22,000 miles. The Chevrolet is equipped with a 350 cu in. engine and an automatic transmission. The Valiant is equipped with a 225 cu in. engine and an automatic transmission.

A tabulation of pertinent vehicle statistics is given on the vehicle information sheets at the end of this report.

Test Program

Exhaust emission and fuel economy tests were conducted in accordance with the 1975 Federal Test Procedure ('75 FTP) for light-duty vehicles (Federal Register, June 30, 1975, Vol. 40 No. 126, Part III), and the EPA Highway Fuel Economy Test (HFET). Evaporative emissions were not measured.

Of the two vehicles used during the test program, only the 1970 Chevrolet was treated with the EI-5. It was expected that the primary effects of the EI-5 would result from pouring the additive through the carburetor, and would probably be due to the solvent action of the EI-5 on carburetor and intake manifold deposits, as well as liquid droplets entering the combustion chamber and possibly knocking loose accumulated carbon deposits.

For comparison purposes, the 1970 Valiant was subjected to the same series of tests as the Chevrolet, but the Valiant was not treated with EI-5.

Prior to the start of emission testing, both vehicles were fueled with a commercial unleaded fuel and driven approximately 200 miles on public roads. This same base fuel was used for all mileage accumulation and emission tests. After completing the preliminary mileage accumulation each vehicle was tuned in accordance with the manufacturer's recommended procedures. Baseline emission and fuel economy tests, consisting of the 75 FTP and HFET, followed the tune-up.

After completion of the baseline tests, the EI-5 was added to the Chevrolet fuel tank and crankcase in the recommended proportions. Eight ounces (one ounce per cylinder) of EI-5 were poured into the carburetor throat. Similarly, six ounces of Diesel #2 (one ounce per cylinder) were poured into the carburetor throat of the Valiant, but nothing was added to its fuel tank or crankcase.

Both vehicles were again tested in accordance with the '75 FTP and HFET.

The next stage of the program was to accumulate another 200 miles on both vehicles. After completing the 200 miles, the Chevrolet fuel tank was refilled and EI-5 added, in the recommended dosage. The proportion of EI-5 used for the second dosage was one ounce per seven gallons of fuel. The Valiant was refilled with the commercial unleaded gasoline only. Both vehicles were tested for a final time in accordance with the '75 FTP and HFET.

Test Results

Exhaust emission and fuel economy data are summarized in the following tables.

1970 Chevrolet
'75 FTP mass emissions in grams per mile (grams per kilometer) (1)

	HC	CO	NOx	Fuel Economy (Fuel Consumption)
Baseline				
average of 2 tests	2.20 (1.37)	41.6 (25.9)	4.22 (2.62)	12.4 miles/gal. (19.0 liters/100km)
Initial application of EI-5				
average of 2 tests	2.11 (1.32)	29.6 (18.4)	4.46 (2.77)	12.4 miles/gal. (19.0 liters/100km)
% change from baseline	-4%	-29%	+6%	0
Second application of EI-5 (first refueling)				
average of 2 tests	2.14 (1.33)	33.3 (20.7)	4.50 (2.80)	12.5 miles/gal. (18.9 liters/100km)
% change from baseline	-3%	-20%	+7%	+1% (-1%)

(1) Values shown in parenthesis denote metric units

1970 Valiant
'75 FTP mass emissions in
grams per mile
(grams per kilometer) (1)

	HC	CO	NOx	Fuel Economy (Fuel Consumption)
Baseline				
average of 2 tests	2.76 (1.72)	36.5 (22.7)	6.10 (3.79)	18.3 miles/gal. (12.9 liters/100km)
After pouring Diesel fuel through the carburetor				
average of 2 tests	2.61 (1.62)	32.6 (20.3)	6.05 (3.76)	18.6 miles/gal. (12.7 liters/100km)
% change from baseline	-5%	-11%	-1%	+2% (-2%)
After accumulating 200 additional miles				
average of 2 tests	2.63 (1.64)	33.7 (21.0)	5.81 (3.61)	18.6 miles/gal. (12.7 liters/100km)
% change from baseline	-5%	-8%	-5%	+2% (-2%)

Details of individual tests ('75 FTP) and Highway cycles can be found in tables I - VI following the text of this report.

(1) Values shown in parenthesis denote metric units.

The measurable effects of EI-5 appear to be due to the solvent action of the additive when it is poured through the carburetor during the initial treatment. This is supported by the behavior of the Valiant following the addition of Diesel fuel to the carburetor throat. Both vehicles experienced decreases in emissions of CO, but no significant change in fuel economy. Changes in HC and NOx emissions were much smaller and probably not significant, judging from past experience with the test vehicles.

The test data also indicate that both vehicles' exhaust emissions were changing in the direction of a return to baseline emissions as mileage was accumulated following the initial treatments with EI-5 and Diesel fuel. This further supports the hypothesis that the effects of EI-5 are due to its solvent action when poured through the carburetor, thus cleaning gum and varnish from carburetor circuits. Diesel fuel was also an effective solvent in the carburetor of the Valiant. The effects of EI-5 attributable to its presence in the fuel tank and crankcase appear to be negligible.

Conclusions

1. The EI-5 fuel additive had no significant effect on fuel economy.

2. The effect of EI-5 on exhaust emissions (a reduction in CO) appears to be related to its solvent action in the carburetor.

Table I
1970 Chevrolet
'75 FTP mass emissions in
grams per mile
(grams per kilometer) (1)

Test #	HC	CO	CO_2	NOx	miles/gal. (liters/ 100km)
Baseline					
77-3872	2.23 (1.39)	44.2 (27.5)	644. (400.)	4.24 (2.64)	12.3 (19.1)
77-3874	2.17 (1.35)	38.9 (24.2)	642. (399.)	4.19 (2.60)	12.5 (18.8)
Average	2.20 (13.7)	41.6 (25.9)	643. (400.)	4.22 (2.62)	12.4 (19.0)
Initial application of EI-5					
77-3945	2.14 (1.33)	30.5 (19.0)	658. (409.)	4.43 (2.75)	12.4 (18.9)
77-3947	2.08 (1.30)	28.6 (17.8)	666. (414.)	4.49 (2.79)	12.4 (19.0)
Average	2.11 (1.32)	29.6 (18.4)	662. (412.)	4.46 (2.77)	12.4 (19.0)
Second application of EI-5 (first refueling)					
77-3987	2.17 (1.35)	33.7 (20.9)	661. (411.)	4.71 (2.93)	12.3 (19.1)
77-4153	2.10 (1.31)	32.9 (20.5)	647. (402.)	4.29 (2.66)	12.6 (18.7)
Average	2.14 (1.33)	33.3 (20.7)	654. (407.)	4.50 (2.80)	12.5 (18.9)

(1) Values shown in parenthesis denote metric units.

Table II
HFET mass emissions in
grams per mile
(grams per kilometer) (1)

Test #	HC	CO	CO_2	NOx	miles/gal (liters/ 100km)
Baseline					
77-3873	1.36 (0.84)	23.8 (14.8)	436. (271.)	5.17 (3.22)	18.6 (12.7)
77-3875	1.38 (0.86)	24.0 (14.9)	434. (270.)	6.18 (3.22)	18.6 (12.6)
Average	1.37 (0.85)	23.9 (14.9)	435. (271.)	5.18 (3.22)	18.6 (12.7)
Initial application of EI-5					
77-3946	1.18 (0.73)	14.2 (8.8)	450. (279.)	5.73 (3.56)	18.6 (12.6)
77-3948	1.18 (0.73)	13.2 (8.2)	454. (282.)	5.99 (3.72)	18.5 (12.7)
Average	1.18 (0.73)	13.7 (8.5)	452. (281.)	5.86 (3.64)	18.6 (12.7)
Second application of EI-5 (first refueling)					
77-3988	1.17 (0.73)	14.8 (9.2)	446. (277.)	5.86 (3.64)	18.8 (12.5)
77-4117	1.15 (0.71)	13.5 (8.4)	444. (276.)	5.44 (3.38)	18.9 (12.4)
Average	1.16 (0.72)	14.2 (8.4)	445. (277.)	5.65 (3.51)	18.9 (12.5)

(1) Values shown in parenthesis denote metric units.

Table III

1970 Chevrolet '75 FTP
Individual Bag Emissions in
grams per mile

	Bag 1: Cold Transient					Bag 2: Stabilized					Bag 3: Hot Transient				
Test #	HC	NOx	CO_2	CO	MPG	HC	NOx	CO_2	CO	MPG	HC	NOx	CO_2	CO	MPG
Baseline															
77-3872	3.35	4.35	626.	96.1	11.3	1.99	3.52	682.	30.9	12.0	1.85	5.54	585.	30.5	13.9
77-3874	3.09	4.69	623.	79.0	11.7	1.90	3.37	679.	28.3	12.2	2.02	5.39	586.	29.0	13.9
Initial application of EI-5															
77-3945	3.00	4.99	659.	68.1	11.4	1.92	3.59	694.	21.8	12.1	1.91	5.62	589.	18.9	14.2
77-3947	2.92	5.11	669.	65.1	11.4	1.84	3.54	697.	19.5	12.1	1.91	5.83	604.	18.5	13.9
Second application of EI-5 (first refueling)															
77-3987	3.00	5.19	660.	73.3	11.3	1.97	3.75	688.	24.0	12.1	1.93	6.17	611.	22.3	13.6
77-4153	2.75	4.92	640.	63.9	11.9	1.95	3.39	679.	25.5	12.2	1.91	5.52	591.	23.8	14.0

Table IV
1970 Valiant
'75 FTP mass emissions in grams per mile (grams per kilometer) (1)

Test #	HC	CO	CO_2	NOx	miles/gal. (liters/ 100km)
Baseline					
77-3868	2.92 (1.82)	38.4 (23.9)	419. (261.)	6.12 (3.80)	18.2 (13.0)
77-3870	2.59 (1.61)	34.5 (21.5)	419. (260.)	6.08 (3.78)	18.4 (12.8)
Average	2.76 (1.72)	36.5 (22.7)	419. (261.)	6.10 (3.79)	18.3 (12.9)
Afterpouring Diesel fuel through the carburetor					
77-3938	2.46 (1.53)	29.5 (18.3)	420. (261.)	6.02 (3.74)	18.7 (12.6)
77-3949	2.75 (1.71)	35.7 (22.2)	417. (259.)	6.07 (3.77)	18.4 (12.8)
Average	2.61 (1.62)	32.6 (20.3)	419. (260.)	6.05 (3.76)	18.6 (12.7)
After accumulating 200 additional miles					
77-4007	2.53 (1.57)	32.0 (19.9)	427. (265.)	6.07 (3.77)	18.3 (12.9)
77-4009	2.73 (1.70)	35.4 (22.0)	407. (253.)	5.54 (3.44)	18.8 (12.5)
Average	2.63 (1.64)	33.7 (21.0)	417. (259.)	5.81 (3.61)	18.6 (12.7)

(1) Values shown in parenthesis denote metric units.

Table V
1970 Valiant
HFET mass emissions in
grams per mile
(grams per kilometer) (1)

Test #	HC	CO	CO_2	NOx	miles/gal. (liters/ 100km)
Baseline					
77-3969	1.31 (0.81)	11.5 (7.1)	343. (213.)	7.30 (4.53)	24.3 (9.7)
77-3871	1.30 (0.81)	11.4 (7.1)	333. (207.)	6.64 (4.13)	25.0 (9.4)
Average	1.31 (0.81)	11.5 (7.1)	338. (210.)	6.97 (4.33)	24.7 (9.6)
After pouring Diesel fuel through the carburetor					
77-3939	1.27 (0.79)	10.3 (6.4)	343. (213.)	6.74 (4.19)	24.4 (9.6)
77-3950	1.27 (0.79)	10.7 (6.6)	340. (211.)	6.80 (4.22)	24.6 (9.6)
Average	1.27 (0.79)	10.5 (6.5)	342. (212.)	6.77 (4.21)	24.5 (9.6)
After accumulating 200 additional miles					
77-4008	1.13 (0.70)	9.1 (5.7)	330. (205.)	6.33 (3.93)	25.5 (9.2)
77-4010	1.22 (0.76)	10.6 (6.6)	332. (206.)	6.21 (3.86)	25.2 (9.3)
Average	1.18 (0.73)	9.9 (6.2)	331. (206.)	6.27 (3.90)	25.4 (9.3)

(1) Values shown in parenthesis denote metric units.

Table VI

1970 Valiant '75 FTP
Individual Bag Emissions in
grams per mile

	Bag 1: Cold Transient					Bag 2: Stabilized					Bag 3: Hot Transient				
Test #	HC	NOx	CO_2	CO	MPG	HC	NOx	CO_2	CO	MPG	HC	NOx	CO_2	CO	MPG
Baseline															
77-3868	5.92	5.77	426.	100.7	14.7	2.21	5.79	427.	24.6	18.8	2.02	7.03	399.	17.9	20.5
77-3870	4.69	6.01	426.	84.7	15.5	2.14	5.70	428.	23.4	18.8	1.88	6.86	397.	18.0	20.6
After pouring Diesel fuel through the carburetor															
77-3939	3.75	6.18	435.	71.8	15.9	2.20	5.54	425.	20.1	19.1	1.97	6.80	401.	15.6	20.6
77-3949	5.10	6.04	426.	86.4	15.4	2.30	5.59	424.	24.8	18.9	1.84	7.02	398.	18.2	20.5
After accumulating 200 additional miles															
77-4007	4.69	6.23	437.	82.7	15.3	2.08	5.56	432.	20.5	18.8	1.73	6.94	409.	15.7	20.2
77-4009	5.46	5.55	420.	87.2	15.5	2.06	5.10	412.	24.0	19.4	1.95	6.38	386.	18.1	21.1

TEST VEHICLE DESCRIPTION

Chassis model year/make - 1970 Plymouth Valiant
Emission control system - Engine Modifications

Engine

type	4 stroke, Otto cycle, I-6, ohv
bore x stroke	3.40 x 4.12 in./86.4 x 104.7 mm
displacement	225 cu in./3688 cc
compression ratio	8.4:1
maximum power @ rpm	145 bhp/108 kW at 4000 rpm
fuel metering	one barrel carburetor
fuel requirement	regular leaded or unleaded

Drive Train

transmission type	3 speed automatic
final drive ratio	2.75 :1

Chassis

type	front engine, rear wheel drive
tire size	C78 x 14
curb weight	2960 lbs./1343 kg
inertia weight	3000 lbs.
passenger capacity	6

Emission Control System

basic type	engine modifications
durability accumulated on system	23000 mi./37000 km

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