An Evaluation of the Landrum Mini-Carbs Air-Bleed

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Technology Assessment and Evaluation Branch
Emission Control Technology Division
Office of Mobile Source Air Pollution Control
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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 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.

Data submitted to the EPA indicated that an air-bleed device known as the Landrum Mini-Carb could cause a reduction in exhaust emissions and improve fuel economy. Consequently, an EPA confirmatory test program was set up to investigate the effects of the Landrum Mini-Carbs on exhaust emissions and fuel economy.

Test Vehicle and Device Description

The vehicle used for the test program was a 1970 Chevrolet Bel-Air powered by a 350 cu in. V-8 and equipped with an automatic transmission. A listing of vehicle statistics is given on the Vehicle Description sheet at the end of this report.

The conventional approach (for carburetor equipped vehicles) to controlling idle air-fuel ratio is to regulate fuel delivery by means of a needle valve (usually referred to as the idle mixture adjustment screw). The Landrum Mini-Carb is an air-bleed device that replaces the idle mixture adjustment screw in the carburetor.

The Mini-Carb is a screw with an air passageway drilled longitudinally through the entire length of the screw. The diameter of the air passageway is sized to regulate the amount of air bled through the Mini-Carb. When the Mini-Carb is installed in the carburetor, the needle valve orifice is encompassed by one end of the Mini-Carb. Therefore, any flow through the needle valve orifice must pass through the Mini-Carb. Four small diameter holes are drilled through the wall of the Mini-Carb near the end that encompasses the needle valve orifice. Fuel that formerly passed through the idle mixture adjustment needle valve enters the Mini-Carb through the four drilled holes. The fuel, together with air entering the exposed end of the Mini-Carb, then passes through the needle valve orifice.

The test vehicle used for this program is equipped with a two-barrel carburetor. A Mini-Carb was installed in place of the idle mixture screw for each carburetor venturi. Supplied with the Mini-Carbs was a short length of flexible tubing that was connected between the protruding ends of the Mini-Carbs. An opening covered with a wire mesh for filtering the air passing into the Mini-Carbs is located in the middle of the tube.

Test Program

Exhaust emission tests were conducted in accordance with the 1975 Federal Test Procedure ('75 FTP). Exhaust emissions and fuel economy were also measured during the EPA Highway Fuel Economy Test (HFET) and at several steady state speeds.

Initially, the test vehicle was adjusted according to the manufacturer's tune-up specifications. Baseline tests were then conducted, and included duplicate tests according to the '75 FTP and HFET, and one set of steady states.

After completion of the baseline tests, the Mini-Carbs were installed as directed in the accompanying instructions. Testing again included the '75 FTP and HFET, and one set of steady states.

Test Results

The effects of the Mini-Carbs on exhaust emissions and fuel economy are illustrated in the following tables:

1975 Federal Test Procedure
mass emissions in
grams per mile
(grams per kilometer)

	HC	CO	NOx	Fuel Economy (Fuel Consumption)
Baseline - Avg. of 2 tests	2.14 (1.33)	37.5 (23.3)	3.99 (2.48)	12.4 miles/gal (19.0 liters/100 km)
Mini-Carbs avg. of 2 tests	1.98 (1.23)	25.4 (15.8)	4.07 (2.53)	12.7 miles/gal (18.6 liters/100 km)
% change from baseline	-7%	-32%	+2%	+2% (-2%)

Highway Fuel Economy Test
mass emissions in
grams per mile
(grams per kilometer)

	HC	CO	NOx	Fuel Economy (Fuel Consumption)
Baseline - avg. of 2 tests	1.32 (0.82)	22.3 (13.9)	4.99 (3.10)	18.7 miles/gal (12.7 liters/100 km)
Mini-Carbs - avg. of 2 tests	1.31 (0.81)	14.5 (9.0)	5.23 (3.25)	18.8 miles/gal (12.5 liters/100 km)
% change from baseline	-1%	-35%	+5%	+1% (-2%)

The effects of the Mini-Carbs on exhaust emissions are due to mixture enleanment caused by air bled into the idle circuit through the Mini-Carbs. This is evidenced by the decrease in HC and CO emissions, and the increase in NOx emissions.

The change in fuel economy accompanying installation of the Mini-Carbs is less than normal test variability and is not significant.

The wire mesh intended to filter air passing into the Mini-Carbs is too coarse to be effective. The size of the mesh openings is about the same as that of common window screen. Sand and dust can easily pass through the filter and into the idle circuit of the carburetor.

Details of all exhaust emissions and fuel economy tests are presented in Tables I-IV.

Conclusions

1. The Mini-Carbs appreciably reduced carbon monoxide emissions from the test vehicle. A small decrease in unburned hydrocarbon emissions and a small increase in oxide of nitrogen emissions also occurred.

2. The effect of the Mini-Carbs on fuel economy was not significant.

3. Ingestion of poorly filtered air through the Mini-Carbs may have an adverse effect on the engine and carburetor durability.

Table I
1975 Federal Test Procedure
mass emissions in
grams per mile
(grams per kilometer)

Test #	HC	CO	CO_2	NOx	miles/gal. (liters/100 km)
Baseline					
77-2310	2.12 (1.32)	36.9 (22.9)	653. (406.)	4.12 (2.56)	12.4 (19.0)
77-2307	2.15 (1.34)	38.1 (23.7)	648. (403.)	3.86 (2.40)	12.4 (19.0)
Average	2.14 (1.33)	37.5 (23.3)	651. (405.)	3.99 (2.48)	12.4 (19.0)
Landrum Mini-Carbs installed					
77-2251	2.22 (1.38)	24.8 (15.4)	660. (410.)	4.13 (2.56)	12.6 (18.7)
77-2291	1.73 (1.08)	26.0 (16.2)	647. (402.)	4.00 (2.49)	12.8 (18.4)
Average	1.98 (1.23)	25.4 (15.8)	654. (406.)	4.07 (2.53)	12.7 (18.6)

Table II
'75 FTP individual bag emissions in
grams per mile

Test #	Bag 1: Cold Transient					Bag 2: Stabilized					Bag 3: Hot Transient				
	HC	CO	CO_2	NOx	mpg	HC	CO	CO_2	NOx	mpg	HC	CO	CO_2	NOx	mpg
Baseline															
77-2310	3.07	81.1	646.	4.76	11.3	1.88	25.6	687.	3.26	12.1	1.87	25.3	592.	5.28	13.9
77-2307	3.13	82.0	630.	4.38	11.5	1.93	26.7	685.	3.02	12.1	1.85	26.8	593.	5.08	13.8
Landrum Mini-Carbs installed															
77-2251	2.96	64.5	665.	4.82	11.4	1.94	13.6	691.	3.21	12.4	2.18	16.2	600.	5.37	14.0
77-2291	2.97	63.8	652.	4.53	11.6	0.99	16.5	673.	3.12	12.6	2.22	15.6	591.	5.29	14.2

Table III
Highway Fuel Economy Test
mass emissions in
grams per mile
(grams per kilometer)

Test #	HC	CO	CO_2	NOx	miles/gal. (liters/100 km)
Baseline 77-2311	1.28 (0.80)	20.1 (12.5)	439. (273.)	5.17 (3.21)	18.7 (12.6)
77-2308	1.35 (0.84)	24.5 (15.2)	435. (271.)	4.80 (2.98)	18.6 (12.7)
Average	1.32 (0.82)	22.3 (13.9)	437. (272.)	4.99 (3.10)	18.7 (12.7)
Landrum Mini-Carbs installed					
77-2252	1.34 (0.83)	15.7 (9.8)	447. (278.)	5.25 (3.26)	18.6 (12.6)
77-2292	1.27 (0.79)	13.2 (8.2)	441. (274.)	5.20 (3.23)	19.0 (12.3)
Average	1.31 (0.81)	14.5 (9.0)	444. (276.)	5.23 (3.25)	18.8 (12.5)

Table IV
Steady State
mass emissions in
grams per mile
(grams per kilometer)

Baseline	HC	CO	CO_2	NOx	miles/gal. (liters/100 km)
Idle (300 secs.)	1.35 gms	2.4 gms	564 gms	0.60 gms	
15 mph (24 kph)	0.99 (0.61)	13.9 (8.6)	649. (403.)	0.70 (0.44)	13.2 (17.9)
30 mph (48 kph)	1.03 (0.64)	8.8 (5.5)	372. (231.)	1.93 (1.20)	22.8 (10.3)
45 mph (72 kph)	1.08 (0.67)	21.8 (13.6)	385. (239.)	3.26 (2.03)	21.0 (11.2)
60 mph (97 kph)	0.96 (0.60)	19.0 (11.8)	447. (278.)	5.16 (3.21)	18.5 (12.7)

Landrum Mini-Carbs installed

	HC	CO	CO_2	NOx	miles/gal. (liters/100 km)
Idle (300 secs.)	1.30 gms	2.0 gms	553. gms	0.42 gms	
15 mph (24 kph)	0.71 (0.44)	3.5 (2.2)	663. (412.)	0.69 (0.43)	13.2 (17.8)
30 mph (48 kph)	0.93 (0.58)	2.2 (1.4)	372. (231.)	1.84 (1.14)	23.5 (10.0)
45 mph (72 kph)	1.02 (0.64)	18.5 (11.5)	387. (241.)	3.37 (2.10)	21.1 (11.1)
60 mph (97 kph)	0.85 (0.53)	12.3 (7.6)	462. (287.)	4.61 (2.87)	18.3 (12.8)

TEST VEHICLE DESCRIPTION

Chassis model year/make - 1970 Chevrolet Bel-Air
Emission control system - Engine Modifications

Engine

type	4 stroke, Otto cycle, V-8, ohv
bore x stroke	4.00 x 3.48 in./101.6 x 88.4 mm
displacement	350 cu in./5737 cc
compression ratio	9.0:1
maximum power at rpm	250 bhp/187 kW @ 4800 rpm
fuel metering	2 barrel carburetor
fuel requirement	regular leaded

Drive Train

transmission type	3 speed automatic
final drive ratio	2.75:1

Chassis

type	front engine, rear wheel drive
tire size	GR 70x15
curb weight	4210 lbs./1910 kg
inertia weight	4500 lb.
passenger capacity	6

Emission Control System

basic type	engine modifications
durability accumulated on system	22000 mi./35400 km

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