76-12 RBM

Mini Turbo-Charger Air Bleed:
Evaluation on a Light Duty Gasoline Powered Vehicle

January 1976

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

Background

The Environmental Protection Agency (EPA) first became interested in the Mini Turbo-Charger air bleed device (also marketed under the name of "Air-Jet") in 1972. At that time the manufacturer of the device, Albano Enterprises, requested that the EPA conduct an evaluation of the device to determine its effects on pollutant emissions when installed in an automobile. The EPA conducted a test program in the summer of 1972, testing a vehicle for emissions on the 1972 Federal Test Procedure ('72 FTP), both with and without the device installed.* It was found to be marginally effective for CO reduction but had little effect on HC or NOx.

Recently the Federal Trade Commission contacted EPA concerning claims made for the device which is now being marketed as a fuel economy improver. They provided data which to some extent supported the advertised claims but also some data which showed little effect. Since the original EPA test did not specifically look at fuel economy and because the advertised claims were different from those made in 1972, a retest was made on two of the devices using the 1975 Federal Test Procedure and measuring both urban and highway fuel economy. The test program was begun in late December 1975 and completed in January 1976.

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.

* Report #73-2, "Evaluation of the Air-Jet Device-Air Bleed," August 1972, EPA, TAEB.

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.

The conclusions from the EPA confirmatory tests can be considered to be quantitatively valid only for the specific type of vehicles 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/.

Device Description

The Mini Turbo-Charger is an engine vacuum actuated valve which allows air to bleed into the intake manifold via the PCV system. The valve is said to be designed so that under conditions of high manifold vacuum the actuator valve is closed and no additional air is allowed to the manifold. The valve opens when the vacuum is reduced, to allow additional air to the engine. According to literature provided by the manufacturer of the device, the valve is closed at conditions of idle and up to 35-40 mph; over 40 mph the valve is open. It should be noted, however, that manifold vacuum varies with accelerations and decelerations as well as different cruising speeds. An acceleration from idle could provide a very low vacuum, lower than highway cruising speeds, and therefore the valve would be open during this mode.

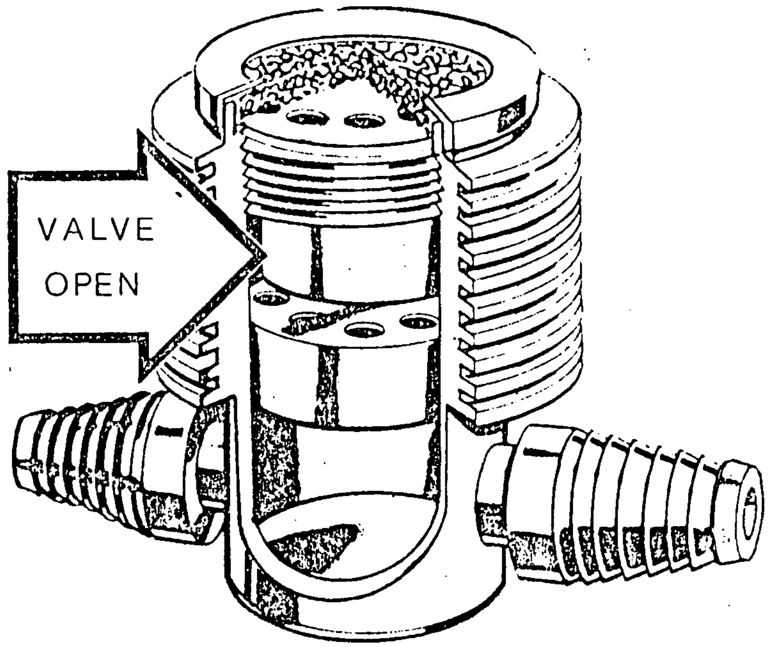
The device is installed in the PCV line between the PCV valve and the carburetor and installation takes only a few minutes.

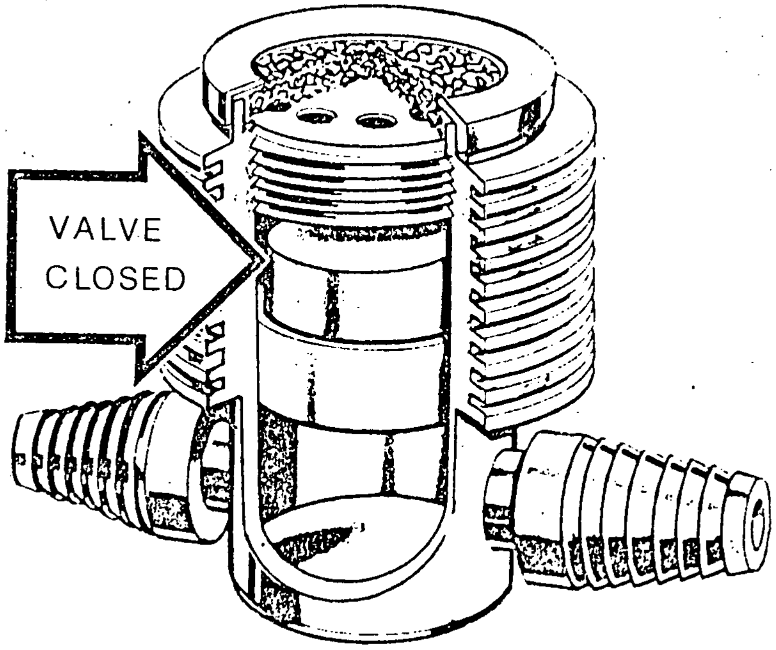
Test Procedure

Exhaust emissions tests were conducted according to the 1975 Federal Test Procedure described in the Federal Register of November 15, 1972. Additional tests included the EPA Highway cycle, steady state conditions of idle, 15, 30, 40, 50 and 60 mph, and vehicle acceleration tests on the dynamometer of 10-60, 20-60 and 30-60 mph. Zero to 60 mph accelerations could not be run because the acceleration rate was too high for the dynamometer's capability. These tests were conducted both with and without the device installed.

MINI TURBO-CHARGER

Air Bleed Device, ~2.5 X Actual Size





The vehicle used in the test program was a 1971 Ford Galaxie with a 351 CID (5753 cc) engine and automatic transmission (a complete vehicle description is given on the following page). All tests were conducted using an inertia weight setting of 4500 pounds (2041 kg) with a road load setting of 12.7 horsepower (9.47 kW) at 50 miles per hour (80.5 km/hr). The test vehicle was first tuned to the manufacturer's specifications and then no adjustments were made after the program began; installation of the device requires no re-tuning of the engine.

Test Results

Exhaust emissions and fuel economy data are summarized in Tables 1, 2, and 3 below. Acceleration results are summarized in Table 4.

On the 1975 FTP and on the EPA Highway Cycle, with the device installed, hydrocarbon mass emissions (HC) increased, carbon monoxide (CO) and oxides of nitrogen (NOx) decreased, and fuel economy decreased slightly.

Mixed results were obtained on the steady state tests. HC increased at idle, 15, 30, and 40 mph but decreased at 50 and 60 mph; CO decreased at idle and 60 mph, but increased in all the other speeds; NOx was reduced at all conditions; idle fuel consumption decreased with the device installed, but fuel economy decreased at all other steady state conditions.

No significant differences were noted on the dynamometer acceleration tests with the device installed. Driveability, however, was worsened with the device. The engine idled roughly and the test driver noticed that it was more difficult to make smooth speed changes, such as when driving the car on a '75 FTP, with the device installed.

Although the device is not supposed to allow extra air to enter the engine (valve closed) at conditions of high vacuum such as idle, the valve was open at idle, and appears to have been open at all conditions; the changes noted at all steady state conditions seem to confirm this.

After the test program was completed, the device was checked on three other vehicles and was observed to be sucking in air at idle on all the vehicles. A vacuum gage check showed that even at 20" Hg vacuum the valve was open (this was checked simply by holding one's hand at the top of the device and feeling the suction). A duplicate device which was supplied by the FTC gave the same results, and to make sure there was no malfunction, such as a stuck valve, it was taken apart and inspected. It was found to be in satisfactory condition, the valve closing with pressure applied to the top of the piston. Idle CO was checked with the device installed on the test vehicle as a further check. The device caused a reduction from the baseline condition of 0.5% to about 0.2% CO.

TEST VEHICLE DESCRIPTION

Chassis model year/make - 1971 Ford Galaxie

Engine

type	4 stroke Otto cycle, OHV, V-8
bore x stroke	4.00 x 3.50 in/102 x 89 mm
displacement	351 cu in./5753 cc
compression ratio	9.0/1
maximum power @ rpm	240 hp/179 kW @ 4600 rpm
fuel metering	2 barrel carburetor
fuel requirement	91 RON

Drive Train

transmission type	automatic (3 forward gears)
final drive ratio	2.75:1

Chassis

type	body/frame, front engine, rear wheel drive
tire size	H 78 x 15
curb weight	4130 lbs/1873 kg
inertia weight	4500 lbs/2041 kg
passenger capacity	6

Emission Control System

basic type	engine modifications, PCV

Engine Specifications (at idle in Drive)

speed	600 rpm
dwell angle	27^{o}
CO concentration	0.5%
spark timing	6^{o} BTDC
manifold vacuum	15.5" Hg (measured value)

Table 1
'75 FTP Composite Mass Emissions
grams per mile
(grams per kilometre)

	HC	CO	NOx	Fuel Economy (Fuel Consumption)
Baseline - mean of 2 tests	2.74	20.4	3.60	13.88 miles/gal (16.95 litres/100 km)
Device - mean of 2 tests	3.21	8.24	2.80	13.38 miles/gal (17.58 litres/100 km)
% Change	+17%	-60%	-22%	-4% in miles/gal (+4% in litres/100 km)

Table 2
EPA Highway Cycle Mass Emissions
grams per mile
(grams per kilometre)

	HC	CO	NOx	Fuel Economy (Fuel Consumption)
Baseline - mean of 2 tests	1.00	3.55	4.16	20.8 miles/gal (11.31 litres/100 km)
Device - mean of 2 tests	1.24	3.04	3.16	20.1 miles/gal (11.70 litres/100 km)
% Change	+24%	-14%	-24%	-3% in miles/gal +3% in litres/100 km)

Ta›le 3
Steady State Mass Emissions
grams per mile

Speed (mph)		HC	CO	NOx	Fuel Consumption /Economy
Idle*	Baseline	.68	3.34	.23	.737 gal/hr
	Device	1.33	0.66	.05	.666 gal/hr
	% Change	+96%	-80%	-78%	-10% (consumption)
15	Baseline	2.19	2.97	.58	19.6 miles/gal
	Device	10.03	4.94	.21	16.8 miles/gal
	% Change	+358%	+66%	-64%	-14%
30	Baseline	.94	1.97	.77	26.5 miles/gal
	Device	1.80	2.99	.28	22.5 miles/gal
	% Change	+91%	+52%	-64%	-15%
40	Baseline	.76	2.17	1.42	24.6 miles/gal
	Device	.90	2.67	.60	23.1 miles/gal
	% Change	+18%	+23%	-58%	-6%
50	Baseline	.62	2.20	3.09	23.1 miles/gal
	Device	.58	2.64	1.76	22.3 miles/gal
	% Change	-6%	+20%	-43%	-3%
60	Baseline	.66	3.06	5.35	20.9 miles/gal
	Device	.45	2.55	3.55	20.8 miles/gal
	% Change	-32%	-17%	-34%	0%

* Emissions in grams per minute

Table 4
Dynamometer Acceleration Results
Time, seconds

	10-60 mph	20-60 mph	30-60 mph
Baseline - mean of 3 tests	8.9	7.7	6.0
Device - mean of 3 tests	8.9	7.7	6.1
% Change	0%	0%	+2%

Conclusions

The Mini Turbo-Charger air bleed device caused a small decrease in fuel economy when installed on the EPA test vehicle, on both the 1975 FTP and the EPA Highway Cycle. The increase in hydrocarbon emissions was probably due to a lean misfire condition, the decrease in CO to the enleanment effect, and the decrease in NOx to a combination of the misfiring and enleanment. Acceleration performance was unchanged and driveability worsened with the device.

Because most vehicles since 1971 are already operating at a relatively lean air-fuel ratio, a further enleanment of the mixture can have adverse effects on the fuel economy, pollutant emissions, and performance of the vehicle.

Appendix
Table 1-A

'75 FTP Composite Results
Mass Emissions, gpm
Fuel Economy, mpg

1. Baseline

Test Date	Test No.	HC	CO	CO_2	NOx	Fuel Economy
1-6-76	77-3	2.81	22.2	592	3.72	13.95
1-7-76	77-4	2.66	18.6	605	3.49	13.81
MEAN		2.74	20.4	598	3.60	13.88

2. Device

Test Date	Test No.	HC	CO	CO_2	NOx	Fuel Economy
1-8-76	77-49	3.18	8.50	640	2.75	13.37
1-9-76	77-51	3.24	7.99	640	2.85	13.39
MEAN		3.21	8.24	640	2.80	13.38

Table 2-A
'75 FTP Individual Bag Results
Mass emissions, grams per mile
Fuel economy, miles per gallon

Test Number	Bag 1 Cold Transient					Bag 2 Hot Stabilized					Bag 3 Hot Transient				
	HC	CO	CO_2	NOx	Fuel Economy	HC	CO	CO_2	NOx	Fuel Economy	HC	CO	CO_2	NOx	Fuel Economy
Baseline															
77-3	3.80	50.1	628	4.50	12.3	2.76	17.9	600	2.86	13.9	2.16	9.50	549	4.77	15.5
77-4	3.36	46.6	638	4.52	12.3	2.62	12.7	615	2.61	13.8	2.21	8.86	563	4.39	15.2
Device															
77-49	3.12	21.3	684	4.12	12.2	3.06	4.37	660	1.82	13.1	3.44	6.70	569	3.51	15.0
77-51	3.05	18.0	675	4.16	12.4	3.23	4.35	663	1.96	13.1	3.40	7.41	571	3.56	15.0

Table 3-A
EPA Highway Cycle
Mass Emissions, gpm
Fuel Economy, mpg

1. Baseline

Test Date	Test No.	HC	CO	CO_2	NOx	Fuel Economy
1-6-76	77-3	.99	3.63	415	4.24	20.9
1-7-76	77-4	1.02	3.47	420	4.08	20.7
MEAN		1.00	3.55	418	4.16	20.8

2. Device

Test Date	Test No.	HC	CO	CO_2	NOx	Fuel Economy
1-9-76	77-50	1.18	2.98	434	3.08	20.1
1-9-76	77-52	1.31	3.09	432	3.23	20.1
MEAN		1.24	3.04	433	3.16	20.1

Appendix
Table 4-A
Dynamometer Acceleration Results
Time, seconds

1. Baseline

Run	10-60 mph	20-60 mph	30-60 mph
1	8.9	7.7	6.0
2	8.9	7.6	6.0
3	9.0	7.7	6.0
MEAN	8.9	7.7	6.0

2. Device

Run	10-60 mph	20-60 mph	30-60 mph
1	8.9	7.7	6.1
2	8.9	7.7	6.1
3	8.8	7.6	6.1
MEAN	8.9	7.7	6.1

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