EXHAUST EMISSIONS FROM A VEHICLE RETROFITTED WITH THE MONOCAR HC CONTROL SYSTEM

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Background

The Monocar HC device was first seen by a Government representative in the summer of 1969 when Mr. Ken Mills of HEW observed a prototype device under test at the Automotive Research Associates (ARA) laboratory in San Antonio, Texas. Our first written contact with Monocar occured in June of 1970 when EPA's predecessor (NAPCA) was offered a device for testing. NAPCA accepted this offer in October and Monocar acknowledged receipt of our agreement to test. We were telephoned by Monocar in December of 1970 at which time we again stated that we were willing to test their system. In May of 1971 we were again contacted by Monocar at which time they told us they were modifying their system to include NOx control and that they would like to arrange testing after their own preliminary tests were complete. In June of 1971 we again told Monocar we would test their system if data on the new system indicated a potential for emissions reductions.

In October of 1971 Mr. John Brogan (EPA) received a letter from Mr. William A. Hayne of the Council on Environmental Quality. Mr. Hayne asked us to test the Monocar device that had been given to him by Dr. Echeverria, the brother of Mexico's President. In November we contacted Monocar, informed them we were going to test the device supplied by Mr. Hayne and asked them for installation instructions. Rather than send instructions, three Monocar representatives visited our laboratory in December and brought with them the equipment necessary to convert our 1971 Ford Galaxie to the configuration in which the vehicle is sold in Mexico. This involved changing the carburetor, intake manifold and distributor. We agreed to test the Monocar system on the vehicle as it is manufactured in Mexico and report the results with and without the Monocar system installed.

System Tested

The Monocar system is an air bleed device combined with distributor modifications which partially eliminate vacuum advance. The air bleed part of the system consists of an adjustable valve which is mounted anywhere in the engine compartment. The valve is connected to the intake manifold at the base of the carburetor. On the vehicle tested, a spacer plate fitted between the carburetor and the intake manifold was drilled to accept two

small, knurled tubes. Rubber tubing connects these tubes to the air bleed valve. An open-celled foam air cleaner is used on the air bleed valve to reduce the amount of dust inducted. On vehicles without spacer plates between the carburetor and intake manifold it is necessary to drill into the intake manifold at the base of the carburetor. In either case carburetor removal is necessary to clean metal chips from the intake manifold.

The distributor modification consists of changing the vacuum advance spring (Ford vehicles only). The modified spring reduces vacuum advance. Table II illustrates the difference between the modified and standard distributors.

Vehicle Tested

The vehicle used to evaluate the Monocar system was a 1971 Ford Galaxie powered by a 351 CID engine with a two barrel carburetor and an automatic transmission. This vehicle is one of the EPA-owned fleet used to evaluate devices and systems. At the request of the Monocar people this vehicle was converted to the configuration manufactured and sold in Mexico. This involved replacing the intake manifold and carburetor with a four barrel induction system (Holley carburetor #4550), changing the distributor and changing the spark plugs. In this configuration the vehicle had no emission control system.

At the conclusion of the series of baseline and device tests the vehicle was returned to the stock (U.S.A. production) configuration with the two barrel intake system. Another series of baseline tests was run to compare the control effectiveness of the Monocar system on an uncontrolled engine to the control effectiveness of the Ford Motor Company low emission engine calibration.

Test Program

The 1975-76 Federal Test Procedure was used to determine exhaust emission levels. This test involves starting a vehicle after it has been parked in a 68-86°F ambient for at least 12 hours and operating it on a chassis dynamometer simulating an 11.1 mile urban drive which contains a 10 minute stop after the first 7.5 miles. Vehicle exhaust is diluted to constant volume and a portion of the diluted exhaust is collected continuously in sample bags during the 31 minutes of driving.

A flame ionization detector (FID) is used to determine unburned hydrocarbon (HC) concentration. Non-dispersive infrared (NDIR) analyzers are used to determine carbon monoxide (CO) and carbon dioxide (CO_2) concentrations. A chemiluminescent (CL) analyzer is used to determine both nitric oxide (NO) and nitrogen dioxide (NO_2). The sum of NO and NO_2 is reported as NOx. Pollutant concentrations are used to determine the average mass of emissions per mile of operation.

Two series of tests were run on the Monocar HC system. During the first series of tests the vehicle exhibited high hydrocarbons and an erratic idle. After the first test series it was discovered that two spark plugs were damaged and the carburetor was calibrated overly rich. This first test series was voided and a complete second test series was run.

Test Results

The results of the testing appears in Table I. This table compares emission levels achieved with the Monocar system (partial and complete) with the Mexican version (uncontrolled) of the 1971 Ford and the U.S. version (calibrated for low emissions) of the 1971 Ford. Also appearing in Table I is the fuel consumption for each configuration. Fuel consumption figures reported were calculated from the emissions data by a carbon balance technique. The actual weight of fuel used was determined on several tests and the results agreed with the calculated values.

As can be seen from Table I, the Monocar HC system reduced exhaust emissions from the "uncontrolled" configuration (baseline A) significantly. This was accomplished with an 11% increase in fuel consumption. Comparing the Mexican version to the U.S. production version (baseline B), the U.S. production vehicle produced yower emission levels than the Mexican vehicle with the Monocar system. The U.S. production version (baseline B) also had 13% lower fuel consumption than the Monocar modified Mexican production version.

A series of tests using only the air bleed portion of the Monocar HC system demonstrated results typical of enleanment devices; hydrocarbons were reduced slightly, carbon monoxide was reduced significantly and oxides of nitrogen were increased slightly. Incorporating the modification to partially eliminate vacuum advance reduced oxides of nitrogen and hydrocarbons significantly.

Conclusions

1. The Monocar HC system is an effective control method for lowering exhaust emissions from uncontrolled vehicles with minor fuel consumption penalty.

2. The Monocar HC system is not as effective as the recalibrated carburetors and ignition system which have been developed by the auto manufacturers.

3. Driveability of the vehicle with the Monocar HC system installed was not as good as either "baseline" vehicle (Mexican or U.S. production versions). Increased tendency to stall after start up was noticed.

4. The proper installation of the Monocar HC system requires an extremely competent mechanic. This statement is made because system installation requires removal of the carburetor and drilling into the intake manifold.

5. The durability of the Monocar HC system should be proven before the system can be considered for retrofit applications.

Table I

Monocar HC Test Program - 1975 Federal Test Procedure

	Test Number	HC gpm	CO gpm	NOx gpm	Calculated mpg
Baseline A (Holley carb., Mexican distributor)	18-0204	4.02	50.56	5.23	12.95
	12-2163	3.58	53.47	5.67	12.65
	12-2168	3.58	56.56	5.19	12.77
	Average	3.72	53.70	5.36	12.80
Baseline B (stock '71 Ford)	18-0261	2.04	12.80	3.69	12.92
	18-0263	2.10	12.14	3.65	12.98
	Average	2.07	12.45	3.67	12.95
Monocar HC air bleed	18-0202	2.65	15.40	6.21	14.00
	18-0192	4.24	17.90	6.26	13.26
	12-2174	2.72	18.10	6.12	12.74
	Average	3.20	17.14	6.20	13.30
Monocar HC air bleed and distributor modification	12-2211	2.29	24.16	3.98	11.10
	12-2214	1.79	12.77	3.67	11.40
	Average	2.04	18.46	3.83	11.25
Change from Baseline A		-45%	-66%	-28%	-11%
Change from Baseline B		-1%	+48%	+4%	-13%

Table 2

Monocar HC Distributor Modification

Manifold Vacuum (inches Hg)	Degrees of Distributor	
	Standard Spring	Monocar Spring
0	0	0
1	0	0
2	0	0
3	0	0
4	0	0
5	0	0
6	0	0
7	1	0
8	3	0
9	4.8	0
10	6	0
11	6.5	0
12	7.5	.3
13	8.5	.3
14	9.5	1
15	10	2.3
16	10.8	3.3
17	11.5	4
18	11.5	4.8
19	11.5	5.8
20	11.5	6.3
21	11.5	7