74-34 AW

An Evaluation of the Hydrocatalyst Corporation's Pre-combustion Catalyst Emission Control Device

June 1974

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.

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 Branch 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 a retrofit device 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

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.

to be a worthwhile candidate for such further testing from the standpoint of the liklihood of ultimately validating claims made. However, a definitive, quantitative evaluation of its effectiveness on a broad range of vehicle types would equally require further testing in accordance with footnote 1/.

The Hydrocatalyst Corporation produces a device called the Pre-combustion Catalyst which is purportedly designed to reduce emissions from internal combustion engines. The Pre-combustion Catalyst consists of two plated screens (see device description below) suspended in the intake flow. It is claimed that the two screens have a catalytic effect on the air/fuel mixture which influences combustion in such a manner as to lower hydrocarbon, carbon monoxide and oxides of nitrogen emissions. In addition, it is claimed that the octane requirement of the engine is lowered.

The device was previously tested by the EPA and reported on in July 1973 (report #74-4). At that time, no baseline tests were run on the test vehicle (with the Hydrocatalyst device not installed), so it was not possible to compare the vehicle emissions before and after the installation of the device. The conclusions of that report were that no significant control of hydrocarbons or oxides of nitrogen was demonstrated (compared to typical certification results) and that the low levels of carbon monoxide achieved during the test program were probably a function of choke setting. In addition, minimal choke action led to poor cold start driveability.

Because of a lack of baseline testing during the initial test program, a re-evaluation of the device was scheduled to further investigate the effect on emissions attributable to the Hydrocatalyst device.

Device and Test Vehicle Description

The Hydrocatalyst device consists of a bowl-shaped, dual-screened element which is fixed in the intake manifold. The screen element is made of a pair of screens of a planar configuration spaced about 1/16" apart. One screen is plated with cadmium and the other with nickel. The element is made as an integral part of the intake manifold/carburetor gasket and is suspended in the flow stream of the intake manifold/carburetor interface.

In the literature supplied with the device, it was claimed that a catalytic effect on the air/fuel mixture causes and/or initiates precursors that influence combustion. It was claimed that this precursory effect lowered vehicle octane requirement and allowed for more tolerance to lean carburetion, thus achieving a reduction in emissions.

The test vehicle was a 1970 Valiant with a 225 CID engine. The car was equipped with an automatic transmission. At the start of the evaluation program the test vehicle was given a complete tune-up to manufacturer's specifications. Vehicle mileage at the tune-up was 14,300 miles. Since

the test vehicle had been run on a variety of fuels in past test programs, it was run-in after the tune-up for 500 miles on the Durability Driving Schedule described in the Federal Register (Vol. 37, No. 221, November 15, 1972), with leaded fuel (used throughout this program) to stabilize combustion chamber deposits.

Test Program

All tests were run as directed in the 1975 Federal Test Procedure (FTP) Federal Register, November 15, 1972, Vol. 37, No. 221, Part II. The following sequence of tests was performed:

1. After the tune-up to manufacturer's specifications and the 500-mile running-in, baseline emissions tests were run with the car adjusted to manufacturer's specifications.

2. After completion of the baseline emissions tests, the parameter adjustments recommended in the Hydrocatalyst installation instructions were made to the car. These adjustments consisted of advancing the timing 6 degrees beyond manufacturer's specifications and leaning the idle mixture to a setting just richer than misfire. Several emissions tests were run on the vehicle with these parameter adjustments.

3. After testing the vehicle with parameter adjustments, the Hydrocatalyst device was installed. After the device was installed, the mixture was again leaned to the point just richer than misfire. Several emissions tests were run on the vehicle after device installation.

4. Since the installation instructions indicated that the effectiveness of the device improves with time after installation, 1500 miles were accumulated on the vehicle using the same durability driving schedule that was used for the baseline running-in. Several tests were run on the vehicle after completion of the mileage accumulation.

5. The idle mixture was then readjusted to the point just before misfire and two more emissions tests were run. This condition represented the best adjustment for emissions with the device installed on the vehicle.

6. The device was then removed from the vehicle and two more emissions tests were run. No changes in engine parameters were made from step 5.

7. Finally, the vehicle was reset to manufacturer's specifications and a second series of baseline emissions tests were run. The purpose of the final baseline tests was to determine if there had been any change in exhaust emissions attributable to cleaning of combustion chamber deposits during the time the device was on the vehicle.

Hydrocatalyst personnel were invited to observe the entire test program. They elected to view the device installation and vehicle adjustments made in steps 5, 6 and 7, as well as the accompanying testing (except in step 7 where only the adjustments were observed).

Test Results

Exhaust emissions data in grams per mile and fuel economy calculated by the carbon balance method are presented in Table I.

Initial testing after installation of the Hydrocatalyst device (step 3) showed a 26% increase in HC, a 73% increase in CO, no change in NOx, and a 4% decrease in fuel economy compared to the baseline results.

After the 1500-mile accumulation (step 4), there was a 15% increase in HC, a 93% increase in CO, a 2% increase in NOx, and an 11% decrease in fuel economy compared to baseline. Further enleanment of the mixture (step 5) resulted in a 24% HC increase, a 58% CO increase, an 8% NOx increase and an 8% decrease in fuel economy compared to baseline.

Final baseline emissions (step 7) were about the same as the original baseline emissions.

Driveability of the test vehicle was unaffected by installation of the Hydrocatalyst device.

Conclusions

Use of the Hydrocatalyst device on this test vehicle proved to be detrimental to both emissions and fuel economy. The large increases over baseline of carbon monoxide and hydrocarbons suggest that the engine was running at a richer air/fuel ratio with the catalyst installed. A possible explanation for this apparent richening of the mixture is that the screens, for which catalytic action is claimed, choked the carburetor throat to the extent that the secondary power circuit was coming into use (the power valve senses manifold vacuum).

The data from steps 3, 4 and 5 show that the Hydrocatalyst device had no significant effect on NOx emissions. The large NOx increases seen in steps 2 and 6 were caused by the parameter adjustments, i.e., ignition timing advance and idle mixture enleanment.

Final baseline emissions showed no evidence of combustion chamber cleaning due to use of the Hydrocatalyst device. Had there been a cleaning of combustion chamber deposits during the test program, then HC emissions in step 7 would be significantly lower than in step 1. Since HC emissions in step 7 were not significantly lower than in step 1, it is concluded that the cleaning did not occur.

The change in baseline NOx emissions (a 15% increase in step 7 compared to step 1) is not considered significant, when factors such as the accumulation of 1500 miles and test-to-test variability are taken into account.

Table I
Evaluation of Hydrocatalyst Device
on a 1970 Valiant with a 225 CID, 6-Cylinder Engine
Mass Emissions in grams per mile and Fuel Economy in miles per gallon
1975 Federal Test Procedure

Test Step:	HC	CO	CO_2	NO_x	MPG
1. Baseline	2.20	30.9	421	---	18.2
	1.87	23.8	410	5.08	19.2
	1.98	24.4	408	4.35	19.3
AVERAGE	2.02	26.4	413	4.72	18.9
2. Engine Parameter Changes					
	2.05	20.7	406	5.44	19.4
	2.05	20.6	408	6.32	19.4
	1.97	22.2	403	6.01	19.4
AVERAGE	2.02	21.2	406	5.92	19.4
% Change from Baseline	0	-20%	-2%	+25%	+3%
3. Hydrocatalyst device installed, before mileage accumulation					
	2.37	43.6	393	4.65	18.2
	2.71	47.7	389	4.83	17.9
AVERAGE	2.54	45.7	391	4.74	18.1
% Change from Baseline	+26%	+73%	-5%	0	-4%
4. Hydrocatalyst device installed, after mileage accumulation					
	2.25	52.1	420	4.77	16.8
	2.38	49.7	428	4.86	16.7
AVERAGE	2.32	50.9	429	4.82	16.8
% Change from Baseline	+15%	+93%	+3%	+2%	-11%
5. Hydrocatalyst device installed, after mileage accumulation enleanment					
	2.37	41.1	421	4.90	17.4
	2.63	42.1	425	5.31	17.3
AVERAGE	2.50	41.6	423	5.11	17.4
% Change from Baseline	+24%	+58%	+2%	+8%	-8%
6. Hydrocatalyst device removed, no parameter changes					
	1.74	16.7	427	6.48	19.1
	1.69	17.4	421	6.31	19.3
AVERAGE	1.72	17.1	424	6.40	19.2
% Change from Baseline	-15%	-35%	+3%	+36%	+2%
7. Final Baseline					
	2.01	27.9	410	5.17	18.8
	2.14	26.6	426	5.65	18.4
AVERAGE	2.08	27.3	418	5.41	18.6
% Change from Baseline	+3%	+3%	+1%	+15%	-2%

ADDENDUM TO HYDRO-CATALYST REPORT

Subsequent to the publication of the EPA test report on the Hydro-Catalyst device, EPA was notified by Hydro-Catalyst that the unit intended for use on Chrysler Corporation 225 CID engines has been redesigned. The mounting flange on that unit has been changed to allow venting of the carburetor and avoidance of carburetor enrichment.

Data reported by Hydro-Catalyst support their claim that the redesign avoids the carburetor enrichment problem, but do not show significant reduction in exhaust emissions. EPA has not tested the redesigned unit.

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