An Evaluation of the Echlin Retro-fit Emission Control System

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Background

In March of 1972 the Echlin Manufacturing Company contacted EPA's Mobile Source Pollution Control Program and requested an EPA review of an emission control system which they had developed. A meeting was held between Echlin representatives and T&EB personnel on May 30, 1972, to discuss the system and the possibility of EPA testing. The system used what Echlin representatives termed "...an important scientific advance in the field of sonic energy". In further describing the properties of their "ultrasonic generator" the Echlin representatives reported:

> "The new combustion environment created permits setting the spark timing at nominal top-dead-center and management of the fuel mass and ignition timing is such as to maintain essentially stoichiometric combustion throughout all the driving modes. This is accomplished without the temperature anamolies and performance deterioration usually accompanying these engine parameter adjustments, in the absence of the Echlin system."

At the meeting Echlin presented emission data which had been generated by Scott Research Laboratories. Emission levels with and without the "ultrasonic generator" had been determined. The data showed no emission reduction due to the "ultrasonic generator." Echlin representatives admitted that the data did not show a clear emissions benefit but that there was a fuel economy benefit with the Echlin system as opposed to the fuel economy loss normally associated with vacuum spark advance disconnect (VSAD). Echlin also reported that the engine ran significantly cooler with the Echlin system but the Scott data did not consistently support this claim.

At the conclusions of the meeting T&EB personnel agreed to run a series of tests on one of our vehicles used for device evaluation.

System Tested

The complete Echlin system consists of:

1. An "ultrasonic generator"
2. A carburetor spacer plate
3. Tubing, which connects the generator to the carburetor spacer plate
4. Gaskets necessary for carburetor removal and replacement

In addition to the installation of this hardware, Echlin recommended that the spark timing be retarded to 2° BTDC, the

When the "ultrasonic generator" was disconnected the hose which bled air to the spacer plate was clamped partially shut until the idle CO level was the same (2%) as when the "generator" was hooked up. The air bleed flow characteristics were undoubtedly different through the partially clamped hose than they were through the generator device but the effects were similar. In this configuration hydrocarbons were slightly reduced from the baseline (5.1%), carbon monoxide was significantly increased (57.3%) and oxides of nitrogen were significantly decreased (49.3%). There was no fuel economy penalty measured. The plots of water temperature vs. time with and without the "ultrasonic generator" were identical. When the Echlin system was removed from the vehicle another series of tests were run with 2% idle CO, 2° BTDC timing and vacuum spark advance disconnect. In this configuration hydrocarbons were reduced from the baseline by 22.7%. Carbon monoxide increased by 23.5% and oxides of nitrogen were reduced by 60.4%. A 5.4% fuel economy improvement was measured.

No adverse driveability was noticed in any of the four configurations during the testing.

<u>Conclusions</u>

1. The Echlin system significantly reduced oxides of nitrogen emissions and significantly increased CO emissions on the vehicle tested.

2. The emission reductions of a vehicle using the Echlin system are due to vacuum spark advance disconnect (VSAD). The Echlin hardware itself has no significant effect on exhaust emissions. Our series of tests indicated that calibrating a vehicle to 2% idle CO, setting timing to 2° BTDC and eliminating vacuum spark advance results in lower emission levels and improved fuel economy than retrofitting the same vehicle with the Echlin system.

3. The "ultrasonic generator" of the Echlin system did not improve fuel economy or reduce water temperature.

4. The Echlin system may cause durability and emission problems on some vehicles because there is no provision for restoring spark advance when engine temperatures are high.

5. The addition of the carburetor spacer plate may cause problems on some vehicles. On our test car the intake air preheater had to be modified because it was no longer sealed when the Echlin spacer plate was installed. Carburetor linkages may need modification or adjustment on some vehicles.

TABLE I

Summary of Echlin Device Testing
1975 Federal Test Procedure
(all data in grams per mile)

	Test Number	HC	CO	NOx	Calculated MPG.
Baseline, 1963 Ford	18-0428	6.73	59.93	5.48	13.3
	18-0432	6.40	56.97	5.94	12.72
	18-0436	6.14	55.09	5.38	12.96
	Average	6.42	57.3	5.6	13.0
Echlin System	12-2300	5.20	78.67	3.19	11.87
	12-2302	5.41	80.76	3.38	11.94
	12-2303	5.00	79.78	3.10	12.12
	Average	5.20	79.74	3.22	11.9
Change from Baseline		-19%	+39.2%	-42.5%	-8.5%
Vacuum spark advance disconnected, air bleed	12-2386	6.35	93.11	2.88	12.64
	12-2389	5.84	87.15	2.80	13.62
	Average	6.09	90.13	2.84	13.10
Change from Baseline		-5.1%	+57.3%	-49.3%	+.8%
Vacuum spark advance disconnected, 2% idle CO, no Echlin components	16-0001	4.88	67.59	1.90	13.67
	12-2412	5.03	73.91	2.54	13.70
	Average	4.96	70.75	2.22	13.70
Change from Baseline		-22.7%	+23.5%	-60.4%	+5.4%

ËCHLIN SYSTEM

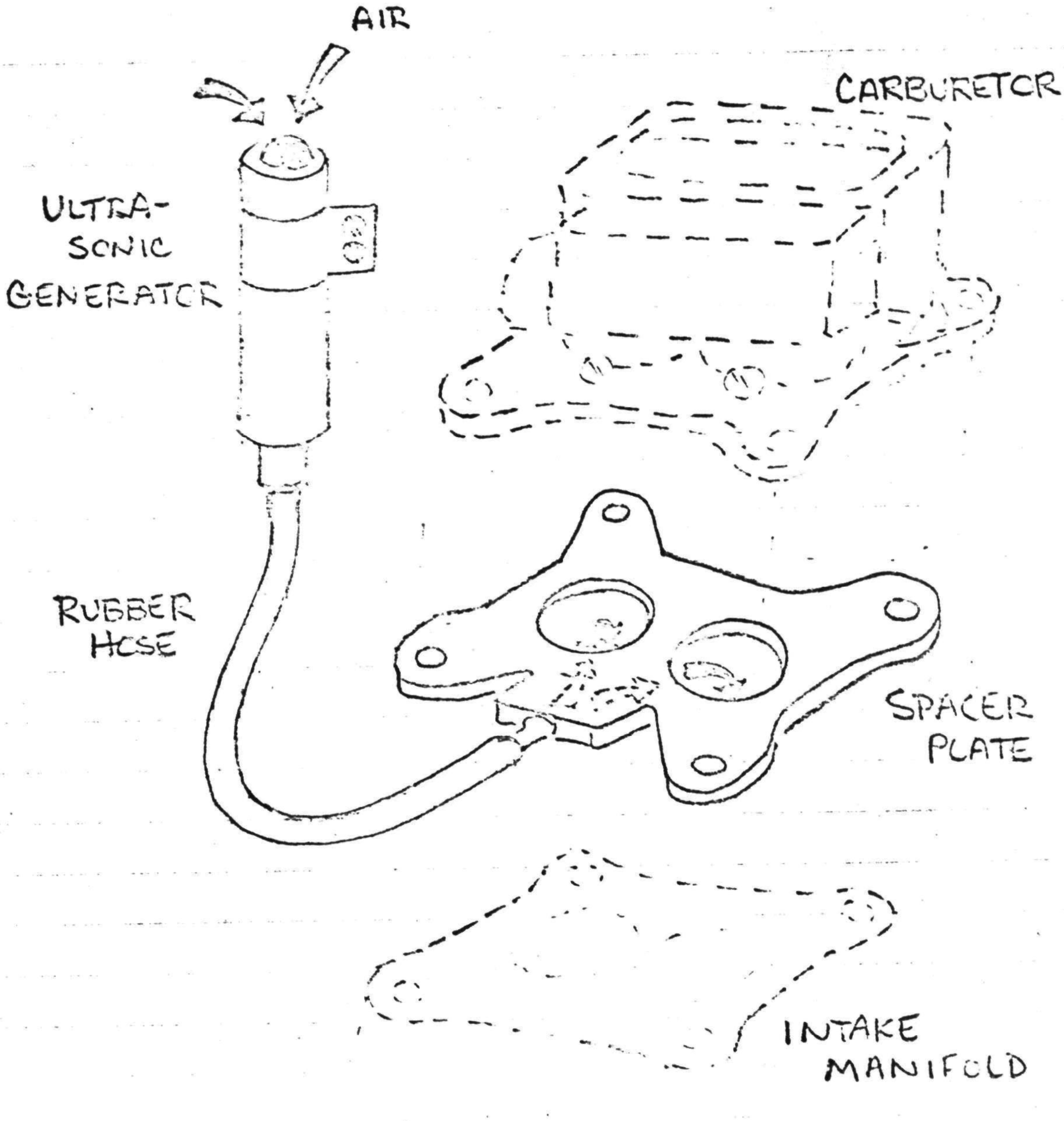

FIGURE 1.

FEDERAL EMISSION TESTING PROCEDURES FOR LIGHT DUTY VEHICLES

The Federal procedures for emission testing of light duty vehicles involves operating the vehicle on a chassis dynamometer to simulate a 7.5 mile (1972 procedure) or 11.1 mile (1975 procedure) drive through an urban area. The cycle is primarily made up of stop and go driving and includes some operation at speeds up to 57 mph. The average vehicle speed is approximately 20 mph. Both the 1972 and 1975 procedures capture the emissions generated during a "cold start" (12-hour soak @ 68°F to 86°F before start-up). The 1975 procedure also includes a "hot start" after a ten minute shut-down following the first 7.5 miles of driving.

Vehicle exhaust is drawn through a constant volume sampler (CVS) during the test. The CVS dilutes the vehicle's exhaust to a known constant volume with make up air. A continuous sample of the diluted exhaust is pumped into sample bags during the test.

Analysis of the diluted exhaust collected in the sample bags is used to determine the mass of vehicle emissions per mile of operation (grams per mile). A flame ionization detector (FID) is used to measure unburned hydrocarbon (HC) concentrations. Non-dispersive infrared (NDIR) analyzers are used to measure carbon monoxide (CO) and carbon dioxide (CO_2). A chemiluminescence (CL) analyzer is used to determine oxides of nitrogen (NOx) levels.

These procedures are used for all motor vehicles designed primarily for transportation of property and rated at 6,000 pounds GVW or less, or designed primarily for transportation of persons and having a capacity of twelve persons or less. Each new light duty vehicle sold in the United States in model years 1973 and 1974 must emit no more than 3.4 gpm HC, 39. gpm CO and 3.0 gpm NOx when using the 1972 procedure. In 1975 the standards will change to .41 gpm HC. 3.4 gpm CO and 3.1 gpm NOx using the 1975 procedure. In 1976 the standards will be .41 gpm HC, 3.4 gpm CO and .4 gpm NOx using the 1975 procedure.