EXHAUST EMISSIONS FROM THE AUTO-MATE RESEARCH CHEVROLET

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Background

The Test and Evaluation Branch of EPA's Motor Vehicle Emission Laboratory received several requests from Auto-Mate Research Corporation of Fairmont, Minnesota, to conduct an evaluation of their modified 1969 Chevrolet Kingswood. The vehicle had received a brief 7-mode test previously at EPA's old Willow Run facility. Results of that test did not indicate significant reductions in emissions from levels that are typical of standard 1969 Chevrolets. Auto-Mate personnel claimed to have improved the system and accumulated test data from an EPA approved laboratory which indicated substantial reductions in emission levels. A series of baseline tests and tests with the Auto-Mate devices used was scheduled and performed in our Ann Arbor laboratory.

Vehicle & Devices Tested

The vehicle tested was a 1969 Chevrolet Kingswood station wagon equipped with a 350 CID, four barrel V-8 and an automatic transmission.

Several devices were evaluated. The first device was an air bleed valve which caused an enleanment of the mixture during light load conditions.

A "fuel valve" was installed between the fuel pump and the carburetor. The Auto-Mate people apparently believed that at light engine loads (low fuel consumption) the fuel pump pressure forced the bowl inlet valve open and overfueled the engine. The "fuel valve" continuously by-passed a portion of fuel pump discharge to the inlet side of the fuel pump.

An electronic device attached to the fender of the vehicle was claimed to eliminate oxides of nitrogen emissions. A voltage was supplied to the device and air was drawn through it by intake manifold vacuum.

Two Auto-Mate Research fuel additives received a brief evaluation. Both additives were claimed to eliminate oxides of nitrogen emissions.

Test Program

Both the 1972 and the 1975 Federal Test Procedures were used. These tests involve starting a vehicle that has been parked in a 68-86°F ambient for at least 12 hours and operating it on a chassis dynamometer simulating an urban drive. Vehicle exhaust is diluted to a constant volume and a portion of the dilute exhaust is collected continuously in sample bags. The concentrations of pollutants in the sample bags are then measured. A flame ionization detector (FID) is used to determine unburned hydrocarbon (HC) concentration. Non-dispersive infrared (NDIR) analyzers are used for carbon monoxide (CO) and carbon dioxide (CO_2). A chemiluminescent 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 calculate the mass of emission per mile of operation, grams per mile (gpm).

The two procedures differ in that the 1975 procedure is longer than the 1972 procedure and it involves shutting off the vehicle for 10 minutes and then restarting it and completing the test. Weighting factors are applied to the hot and cold starts in the 1975 procedure. Fuel consumptions were determined using both weight and carbon balance techniques.

The most extensive evaluation was made on the combination of the air bleed and fuel valve device. Three baseline tests of the vehicle without the devices operational and four tests of the vehicle with both devices in use were run using the 1972 and 1975 procedures.

One afternoon was devoted to running steady state tests to check the effectiveness of the two fuel additives and the electronic NOx device. These tests were considered adequate since the effectiveness of the additives and devices was advertised to be immediate and significant.

Test Results

The test results are summarized in Tables 1, 2 and 3. Table 1 compares baseline test results to results obtained with the fuel valve and air bleed operational using the 1975 procedure. The vehicle with devices demonstrated a 33% reduction in unburned hydrocarbons, a 54% decrease in carbon monoxide and a 7% increase in oxides of nitrogen. Fuel consumption was determined by weight of fuel consumed during the test and remained unchanged.

Table 2 is the same as Table 1 except that the 1972 test procedure was used. The vehicle demonstrated a 31% reduction in unburned hydrocarbons, a 41% reduction in carbon monoxide and an 8% increase in oxides of nitrogen with the air bleed and fuel valve operational.

Table 3 illustrates the results of the steady state testing. Configuration 1 establishes a "baseline" for the additive and NOx device tests. Results from configuration 2 demonstrated no significant change in emission levels with the NOx device on. Results from configurations 3 and 4 indicate increases in hydrocarbons and carbon monoxide when the fuel additives were used. There was no significant change in NOx levels. Configuration 5 resulted in significant increases in carbon monoxide and significant reductions in oxides of nitrogen when the fuel valve was closed.

Summary and Conclusions

The reductions in hydrocarbons and carbon monoxide and the increases in oxides of nitrogen observed during the test of the air bleed and fuel valve are typical of devices that cause an enleanment of the mixture. Steady state results comparing configurations 4 and 5 indicate that the fuel valve also had an enleanment effect on the mixture. The bubbles in the return line coming from the fuel valve suggest that leaks in the system were causing air to be entrained in the fuel.

Similar effects to those observed in the air bleed and fuel valve tests can be obtained without add-on devices by altering the idle mixture, jetting and power valving in the carburetor. Many late model vehicles already have carburetors recalibrated for lean operation at light loads. The use of enleanment devices on these vehicles could cause stumble, surging and missing. Hydrocarbom emission levels could rise drastically.

The steady state tests indicated that the fuel additives and the electronic NOx device had no beneficial effects on emissions. It appeared that the NOx device was an ozone (O_3) generator. Ozone could react with nitric oxide to form nitrogen dioxide. The NOx detector used, however, was designed to measure both NO and NO_2 as they are both hazardous pollutants. Any ozone in the exhaust of the vehicle would also be undesireable.

Table 1

Auto-Mate Research Vehicle
1975-76 Federal Test Procedure

	HC	CO	NOx	MPG
Baseline (no devices installed) Avg. of 3 tests	5.34	65.06	3.59	11.68
With air bleed and fuel valve Avg. of 4 tests	3.56	30.25	3.85	11.66
1975 Federal Standards	.41	3.40	3.0	---
1976 Federal Standards	.41	3.40	.40	---

Table 2

Auto-Mate Research Vehicle
1972-74 Federal Test Procedure

	HC	CO	NOx
Baseline Avg. of 3 tests	6.12	86.54	3.51
With air bleed and fuel valve Avg. of 4 tests	4.19	50.88	3.80
1972 Federal Standards	3.4	39.0	---
1973-74 Federal Standards	3.4	39.0	3.0

Table 3

Auto-Mate Research Vehicle
50 mph Steady State

Configuration	HC	CO	CO_2	NOx
1. Indolene 30 fuel, no air bleed, fuel valve open, NOx device off	1.27 gpm	3.84 gpm	496 gpm	3.88 gpm
2. Same as 1 with NOx device on	1.16	4.05	466	3.75
3. Same as 2 plus #1 additive in fuel	1.51	5.51	459	3.75
4. Same as 2 plus #2 additive in fuel	1.33	5.58	464	3.58
5. Same as 4 with fuel valve closed	1.36	8.34	441	3.10