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Exhaust Emissions From A Passenger Car Equipped With A Universal Oil Products Catalytic Converter

December 1970

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Division of Motor Vehicle Research and Development
Air Pollution Control Office
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Vehicle Tested

In order to evaluate the Universal Oil Products catalytic reactor UOP supplied APCO with a converted vehicle. For this test, a 1970 Volkswagen Squareback with electronic fuel injection was used. This vehicle is equipped with a 98 cubic inch opposed four cylinder engine and automatic transmission. The stock fuel injection system was modified to prevent cutoff of fuel during deceleration and the catalyst unit was installed in place of the standard muffler. The vehicle was first delivered to APCO for test in August 1970. However, exhaust leaks made the results of that test questionable and the vehicle was returned to UOP for repairs. The vehicle was returned to APCO in December 1970 for the further testing described in this report. All tests were run on Indolene clear fuel.

Tests Conducted

The following tests were performed on the vehicle:

1. Standard 1970 Federal test procedure for exhaust emissions (Table 1).

2. Closed, constant volume sampling technique using 9 repeats of the seven mode 1970 Federal emissions test cycle (Table 2).

3. Standard 1972 Federal test procedure using the LA4-S3 driving cycle with constant volume sampling (Table 3).

For the 1970 Federal test procedure oxides of nitrogen were analyzed using a continuous non-dispersive infrared technique in addition to the specified instrumentation. For the constant volume sampling tests oxides of nitrogen were measured using both the wet chemical modified Saltzman technique and the electrochemical "NOx Box". Carbon monoxide was measured using non-dispersive infrared and hydrocarbons were determined using a flame ionization detector.

Emission Results

In Table 1 comparisons are made between two identical tests using the 1970 Federal test procedure. In order to emphasize the effectiveness of the exhaust catalyst, the results from the first (cold) cycle is separated from the seventh (hot) cycle. The very significant effect of the combination warm up of the engine and the catalyst show an order of magnitude

reduction from the cold condition to the hot condition. The effect of this device on all three pollutants is quite evident. For reference the emission standards for 1970 are hydrocarbons 2.2 gpm and carbon monoxide 23 gpm.

In Table 2 constant volume tests run simultaneously with the 1970 Federal test are shown. During these tests, the exhaust pipe temperature was high enough to ruin the rubber coupling. In order to prevent contamination of the exhaust with burned rubber products, an asbestos sleeve with aluminum cover was used between the test pipe and rubber coupling.

The 1972 Federal test procedure results are reported in Table 3. Test #1 was run on the first day of testing and test #2 was run on the last day. The UOP representative reported that the differences in these tests was possibly due to the effect of conditioning. After long periods of high speed steady load operation, emissions tend to be higher but tend to drop after a period of operation at lower speeds and varying load. The proposed emission standards for 1975 are hydrocarbons 0.5 gpm, carbon monoxide 11 gpm and oxides of nitrogen 0.9 gpm. This vehicle came quite close to meeting these standards. It would appear that the standards could be met on this vehicle if the emissions during the first 40 seconds of start up and warm up could be reduced.

An attempt was made to measure particulates, but the high exhaust temperature caused significant amounts of the rubber coupling to be burned off and collected as particulate.

Driveability of the vehicle was acceptable although the use of an engine of this size caused a considerable amount of full throttle operation during the emission tests.

Conclusions

1. The vehicle supplied by UOP for evaluation showed quite low exhaust emissions.

2. There appears to be an adverse effect on the early results caused by the conditioning of the vehicle prior to testing.

3. The vehicle failed to meet the 1975 exhaust emission standards.

4. The driveability of the vehicle as converted was acceptable.

TABLE 1

1970 Federal Test Procedure Replicate Tests

	Hydrocarbons	Carbon Monoxide	Oxides of Nitrogen
First Cycle	279 ppm	3.0 %	784 ppm
	279 ppm	3.1 %	643 ppm
Seventh Cycle	32 ppm	0.62 %	28 ppm
	18 ppm	0.32 %	0 ppm
Composite	0.4 gpm	10 gpm	0.5 gpm
	0.4 gpm	8 gpm	0.4 gpm

PPM indicates concentration in parts per million.

GPM indicates calculated mass in grams per mile.

TABLE 2

Constant Volume Sampling Using 1970 Driving Cycle

	Test 1	Test 2
Hydrocarbons	1.1 gpm	1.2 gpm
Carbon Monoxide	14 gpm	14 gpm
Carbon Dioxide	403 gpm	386 gpm
Oxides of Nitrogen*	1.2 gpm	1.2 gpm
Oxides of Nitrogen**	0.8 gpm	0.9 gpm

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* NOx Box results reported as NO_2.
** Saltzman results reported as NO_2.
GPM indicates grams per mile.

TABLE 3

1972 Federal Test Procedure

	Test 1	Test 2
Hydrocarbons	2.3 gpm	1.4 gpm
Carbon Monoxide	32 gpm	10 gpm
Carbon Dioxide	444 gpm	431 gpm
Oxides of Nitrogen*	1.3 gpm	1.1 gpm
Oxides of Nitrogen**	0.6 gpm	0.8 gpm

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* NOx Box results reported as NO_2.
** Saltzman results reported as NO_2.
GPM indicates grams per mile.