Exhaust Emissions From a Reactor Equipped, Full-Sized Automobile Using LPG Fuel

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Vehicle Tested

A specially equipped 1971 Oldsmobile Delta 88 was supplied by General Motors for evaluation by APCO. This vehicle was to have very low exhaust emissions, approaching the 1975 levels. A Century LPG Conversion Kit was used with modifications made to provide low emissions. In addition, a reactor, exhaust gas recycle and a pulse air injection system were supplied. All vehicle tests were made using the fuel supplied by GM and no attempt was made to analyze the fuel composition.

Tests Conducted

The following tests were performed on the vehicle:

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

2. Closed, constant volume sampling technique using nine repeats of the Federal emissions test cycle (9x7).

3. Closed, constant volume sampling technique using the LA4-S4 driving schedule as developed for 1972 and later new vehicle certification (LA4).

Bag samples taken during closed cycle tests were analyzed using non-dispersive infrared analysis (IR) for carbon monoxide and carbon dioxide, flame ionization detection (FID) was used for hydrocarbon analysis. In order to compare oxides of nitrogen measurements with data taken on other vehicles, a variety of techniques were used. A modified Saltzman (Saltz) technique was used for wet chemical analysis, a chemiluminescent technique (CI), and an electrochemical (ENVTS) technique were also used. All results are reported as NO_2 and have been corrected for humidity using the following:

$$NO_2 \text{ corr} = \frac{NO_2 \text{ measured}}{1-0.0047\ (H-75)}$$

where H is the humidity in grains of water.

When open cycle tests were run, non-dispersive infrared oxides of nitrogen data were taken.

Emission Results

All of the data taken during the test period can be found in Tables 1 and 2. After the first test shown in Table 1, the carburetor was adjusted to improve driveability. The hydrocarbon values were consistantly higher than the proposed 1975 standards of 0.46 gpm while carbon monoxide was lower than the standard of 4.7 gpm except on the last test. No standard for oxides of nitrogen has been adopted, however, the values shown on these tests are very low. The hydrocarbon values would probably be reduced if a density for hydrocarbon in the exhaust had been determined and used in place of the standard density for gasoline. The results fell in the low ranges of the instruments used and the exact numbers may be questionable, although repeatability was good. Background hydrocarbon levels were quite high on some tests and may have influenced levels also.

Conclusions

The vehicle showed low emission levels. There were no attempts to measure driveability except for acceleration runs.

Table 1

Date	HC (FID)	CO (NDIR)	CO_2 (NDIR)	NO_x (Saltz)	NO_x (CI)	NO_x (ENVTS)
			LA4-S4 Test Results (gpm) *			
2/09	1.0	1.3	984	0.3	0.4	0.6
2/11	1.0	2.9	952	0.4	0.4	0.8
2/16	0.6	5.0	981	0.4	0.1	---
			9x7 Test Results			
2/12	0.6	1.4	905	0.6	0.2	0.6

* Results obtained using HC density of 16.33 and no correction for reactivity or fuel composition. The effect of density correction would be less than 10%.

TABLE 2

1970 Federal Test Procedure (FTP)*

Cycle	HC ppm	CO ppm	NO ppm
1	280	0.08	92
2	61	0.02	100
3	44	0.02	106
4	36	0.02	100
6	45	0.02	100
7	40	0.01	102
Composite	.93 gpm	.61 gpm	.45 gpm

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* Results obtained using standard method with no correction for fuel type, reactivity or instrument response.