

Exhaust Emissions from Three
Diesel-Powered Passenger Cars

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Background

The Emission Control Technology Division is currently conducting a technical feasibility study and evaluation of the light duty Diesel engine to determine it's potential for low exhaust emissions in light duty passenger vehicle applications. As part of the experimental phase of this study we have tested three passenger cars powered by Diesel engines that are in current production. These are the Mercedes 220D, the Opel Rekord 2100 D, and the Peugeot 504 Diesel. The Mercedes was supplied by Mercedes-Benz of North America, the Opel by General Motors Corp., and the Peugeot by Peugeot, Inc. Of the three vehicles the Mercedes 220 Diesel is the only one available for purchase in the United States.

Vehicle Descriptions

The Mercedes is a four-door sedan with a capacity of five persons. It is powered by a four-cylinder, four-stroke, 2.2 litre (134 CID) Diesel engine which develops 65 hp (SAE). The car is equipped with a four-speed automatic transmission. Inertia weight is set at 3500 pounds.

The Opel is a four-door sedan with a capacity of five persons. The engine is a four-cylinder, four-stroke, 2.1 litre (126 CID) Diesel engine which develops 68 hp (SAE). Inertia weight is set at 3000 pounds. The transmission is a three-speed automatic.

The Peugeot is also a four-door sedan with a capacity of five persons. The engine is a four-cylinder, four-stroke, 2.1 litre (129 CID) Diesel which develops 65 hp (DIN). The transmission is a four-speed manual. Inertia weight is set at 3000 pounds.

Test Procedure

Tests were run on all cars as specified in the 1975 Federal Test Procedure for light duty Diesel passenger vehicles. In addition, several tests were run on the Mercedes after a modified injection system was installed. The modified system consisted of new fuel lines which incorporated dampers for the purpose of damping out stray pressure pulses in the delivery lines to the nozzles.

Standard instrumentation specified in the Federal Register for measurement of CO, CO₂, HC and NO_x was used. For the Mercedes with the standard injection system, an IPM RS-5 flame ionization detector (FID) was used to continuously analyze the dilute exhaust for hydrocarbons. A Beckman 402 FID was used for the remainder of the tests. FID oven and sample line temperature was 375°F.

Results

Emissions from the Mercedes were consistently within the 1975 limits (see Table I). The modifications to the injection system caused no change in NO_x, but resulted in approximately 25% reductions in CO and HC (see Table II). NO_x levels were about four times the permissible level for 1976.

The Opel ran at or below the 1975 levels. CO and NO_x are about half the specified limits (Table III). HC ran very close to the 1975 standard, with some tests above it and some tests below. NO_x is about three times the level required for 1976.

Emissions from the Peugeot exceeded the 1975 standards for CO and HC (see Table IV). HC levels were about seven times the allowable level and CO was slightly above the allowable level.

NOx levels are about one-third the 1975 level.

Conclusions

Both the Mercedes and the Opel are capable of meeting the 1975 standards. The Opel has adequate power for city and country driving. It can keep pace with traffic without using full throttle. The Mercedes is considerably slower than the Opel and it is necessary to use full throttle most of the time in order to keep up with traffic. The Peugeot in its present form does not meet the 1975 standards. This may be due to what Peugeot calls its "deferred injection" system, which alters the injection rate at idling speed to reduce the amount of engine noise. The driveability of the Peugeot is comparable to the Opel.

Fuel economy was calculated from emissions data, by the 1975 FTP and the 1972 FTP. All three cars exhibit superior fuel economy for their weight classes. Using the data from Tables I-IV, we find the 3500 lb. Mercedes achieved an average of 23.6 mpg in stock form and 24.6 mpg with the modified injection system, both calculated from 1975 FTP emissions data. The 3000 lb. Opel averaged 23.8 mpg and the 3000 lb. Peugeot averaged 25.2 mpg, again from 1975 FTP emissions data.

An EPA report released in November 1972 and titled "Fuel Economy and Emission Control" gives the following data for gasoline-powered cars (1972 FTP):

1973 Model Year Inertia Weight	Average MPG	Range
3000	16.2	12.6 to 19.7
3500	14.0	9.8 to 17.8

The Diesel-powered cars show about 70% greater fuel economy, by the same test procedure (1972 FTP), than comparable gasoline cars.

Table I

Mercedes-Benz 220 Diesel
Gaseous Emissions
1975 Federal Test Procedure
(grams per mile)

Test No.	Cold Bag HC	Hot FID HC	CO	CO ₂	NOx
1	0.16	0.27	1.21	423.39	1.62
2	0.19	---	1.58	434.97	1.55
3	0.18	0.30	1.51	416.80	1.17
4	0.16	0.40	1.34	409.82	1.45
5	0.16	0.37	1.46	411.76	1.38
AVERAGE	0.17	0.34	1.42	419.35	1.43
1975 Standards		0.41	3.4 ^{pp}	---	3.1
1976 Standards		0.41	3.4	---	0.4

Fuel Economy (miles per gallon)

<u>Test No.</u>	<u>MPG</u> ('75 FTP)	<u>MPG</u> ('72 FTP)
1	23.7	23.3
2	22.6	22.3
3	23.8	23.3
4	24.0	23.9
5	24.0	23.5
AVERAGE	23.6	23.3

Table II

Mercedes-Benz 220 Diesel
Modified Injection System
Gaseous Emissions
1975 Federal Test Procedure
(grams per mile)

Test No.	Cold Bag HC	Hot FID HC	CO	CO ₂	NOx
1	0.13	0.26	1.15	418.66	1.46
2	0.13	0.26	1.01	412.35	1.50
3	0.12	0.24	1.06	400.12	1.42
4	0.12	0.27	1.05	402.38	1.46
5	0.14	0.35	1.13	410.03	1.55
AVERAGE	0.13	0.28	1.08	408.71	1.48
1975 Standards		0.41	3.4	---	3.1
1976 Standards		0.41	3.4	---	0.4

Fuel Economy (miles per gallon)

<u>Test No.</u>	<u>MPG ('75 FTP)</u>	<u>MPG ('72 FTP)</u>
1	23.8	22.8
2	24.4	23.8
3	25.3	24.0
4	24.9	24.0
5	24.5	23.6
AVERAGE	24.6	23.6

Table III
Opel Rekord 2100 Diesel
Gaseous Emissions
1975 Federal Test Procedure
(grams per mile)

Test No.	Cold Bag HC	Hot FID HC	CO	CO ₂	NOx
1	0.13	0.28	1.12	414.39	1.37
2	0.16	0.32	1.12	409.23	1.29
3	0.17	0.50	1.24	427.13	1.38
4	0.17	0.48	1.17	419.98	1.32
AVERAGE	0.16	0.40	1.16	417.68	1.34
1975 Standards		0.41	3.4	---	3.1
1976 Standards		0.41	3.4	---	0.4

Fuel Economy (miles per gallon)

<u>Test No.</u>	<u>MPG ('75 FTP)</u>	<u>MPG ('72 FTP)</u>
1	23.9	23.3
2	24.3	23.5
3	23.2	22.7
4	23.7	23.1
AVERAGE	23.8	23.2

Table IV

Peugeot 504 Diesel
Gaseous Emissions
1975 Federal Test Procedure
(grams per mile)

Test No.	Cold Bag HC	Hot FID HC	CO	CO ₂	NOx
1	0.96	---	3.37	399.33	1.05
2	0.83	2.76	3.04	394.06	1.08
3	1.05	3.41	3.54	407.28	1.09
4	1.03	2.72	3.30	397.22	1.07
5	1.30	3.53	3.84	379.47	1.04
AVERAGE	1.03	3.11	3.42	395.47	1.07
1975 Standards		0.41	3.4	---	3.1
1976 Standards		0.41	3.4	---	0.4

Fuel Economy (miles per gallon)

<u>Test No.</u>	<u>MPG ('75 FTP)</u>	<u>MPG ('72 FTP)</u>
1	25.4	24.3
2	25.2	24.3
3	24.1	23.3
4	25.2	24.2
5	26.2	25.1
AVERAGE	25.2	24.2