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INTERIM REPORT ON TESTING OF A MERCEDES BENZ DIESEL SEDAN

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Background

The Test and Evaluation Branch has the responsibility for testing the prototype vehicles being delivered under the Federal Clean Car Incentive Program. Since one of the cars in the program will be powered by a diesel engine, it became necessary for the T&E Branch to develop testing techniques for accurately determining emissions from this kind of engine. The Mercedes Benz 220 diesel sedan is the most readily available diesel car in the United States, so the Branch asked to borrow one from the U.S. distributor, Mercedes Benz of North America. Our test vehicle was furnished through the courtesy of Mr. Hans Prykop of Mercedes Benz of North America. A Branch representative received the car at the distributor's headquarters in New Jersey and drove the car back to the Motor Vehicle Emission Laboratory in early December.

Vehicle Description

The car is a 1972 Mercedes Benz 220 Diesel four-door sedan, equipped with automatic transmission. On its arrival in Ann Arbor the car had about 2000 miles on the odometer. Curb weight of the vehicle is approximately 3200 pounds, and the vehicle was tested using a simulated inertia weight of 3500 pounds.

The car is powered by a water cooled in-line four cylinder diesel engine of 134 cubic inches displacement, having a maximum output of 65 SAE horsepower.

Test Program

Testing to date has been by the 1975 Federal Emission (3-bag) Test Procedure, with the inertia set at 3500 pounds. There have also been some emissions tests under cruise conditions for sampling investigations.

Instrumentation was as specified in the Federal Register, with additions necessitated by testing this car. Normal CVS bag samples were analyzed for unburned hydrocarbons (HC) with a FID, for CO and CO_2 with NDIR, and for nitrogen oxides (NOx) with chemiluminescence (CL). Three different CO analyzers were used, though not all on the same tests: a standard length NDIR with a range of about 0-2500 ppm, a similar analyzer with EPA modifications having a range of 0-250 ppm, and a long path NDIR having a range of 0-200 ppm.

The widely recognized problem of having hydrocarbon condensation on CVS ducting, sample lines, and sample bags was approached with the following technique. A small sample of the diluted exhaust mixture was pulled from the CVS system through the heated sample line and analyzed continuously with the heated FID.

Integrating the output signal gave average HC concentrations over the appropriate test interval.

For expediency the sample was taken at the same point as the CVS bag on the first series of three tests. There are two reasons why this was not the best sample point to use. First, the pressure depression at that point, just upstream of the CVS Roots blower, is large enough to reduce sample flow to the FID, thereby reducing response. Secondly, there are several feet of ducting and heat exchanger upstream of this point where the unburned heavy hydrocarbons could condense and not be analyzed.

The last three tests employed a modified CVS in which the exhaust/dilution air mixing chamber was only about four feet downstream of the vehicle exhaust pipe. Thus, the diesel exhaust was diluted much sooner than in the previous, more conventional, CVS system. A pitot-type sample probe was placed in the mixing chamber outlet duct and the sample transported to the FID through the heated sample line.

This setup had the effect of reducing response time of the FID to a change in engine operation from twenty seconds to four seconds. Traversing the duct with the probe revealed no appreciable stratification of the mixture.

Results

Emissions data are presented in Table 1. The CO data are those that were determined by the more sensitive analyzer used in each test. Two sets of HC data are shown: from the standard CVS bag procedure and from continuous hot FID analysis. Oxides of nitrogen are presented as NO_2, corrected to 75 grains humidity. Ambient temperatures ranged between 74 and 79 degrees Fahrenheit from test to test. Emissions of CO were obviously well within the required level for 1975.

Mass emissions of HC from the continuous hot FID method were about twice as high as from the bag samples, but still quite low, being very close to the 1975 levels.

Emissions of NOx were about four times the level required for 1976.

Conclusions

Comparison of our emissions data with data from Mercedes diesels from other sources shows good agreement in CO and NOx, when it is considered that different cars were tested in different laboratories. For instance, five tests on a Mercedes diesel sedan at Southwest Research Institute gave these average results: .22 grams per mile HC (CVS bag), .87 gpm HC (hot continuous), 1.62 gpm CO, and 1.27 gpm NOx (by a Saltzman method). This indicates that the present CVS bag procedure is valid and reliable for determining CO and NOx emissions.

The sampling method for HC needs to be refined, chiefly for two reasons: we do not know how much HC is lost through condensation in the mixing chambers and we do not know the best sample points of the various CVS units in use at the Ann Arbor facility.

Investigations underway at this time are aimed at answering those questions.

Table 1

Mercedes Benz 220 Diesel
Mass Emissions, Grams Per Mile

1975 Federal Test Procedure

Test No.	HC Cold Bag	HC Hot Continuous	CO	NOx	CO_2
1	.22	.31	1.11	1.61	508.73
2	.20	.37	1.47	1.49	495.30
3	.24	.42	1.56	1.50	498.21
4	.17	.39	1.44	1.47	404.26
5	.14	.31	1.34	1.62	398.78
6	.16	.30	1.37	1.62	420.16