Effects of FID Oven and Sample Line Temperature on the Measurement of Hydrocarbon Emissions from Gasoline Engines

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Background

The Test and Evaluation Branch of the Emission Control Technology Division has completed an in-house program to determine the effects of oven and sample line temperature of a Flame Ionization Detector (FID) on the measurement of hydrocarbon (HC) emissions from light duty Diesel vehicles (Report #73-26). Since significantly different results were found when measuring hydrocarbon emissions from Diesel engines using a heated FID as compared to the CVS (Constant Volume Sampler) 3-bag method, it was felt that a similar study should be made for light duty gasoline engines.

Vehicle Description

Two cars were used for the gasoline program, a 1970 Plymouth Valiant and a 1971 Chevrolet Vega. Both cars are part of the EPA fleet of test cars.

The Valiant was powered by a 225 CID, 6-cylinder engine equipped with an automatic transmission. It was tested at an inertia weight of 3000 lbs. Vehicle mileage at the start of testing was 13,000 miles.

The Vega was powered by a 140 CID, 4-cylinder engine. The car was equipped with a 3-speed manual transmission. It was tested at an inertia weight of 2750 lbs. Vehicle mileage at the start of testing was 7100 miles.

Test Program

A series of 1975 Federal emissions tests were run on the two cars using Indolene clear gasoline. Standard instrumentation specified in the Federal Register was used to measure HC, carbon monoxide (CO), and nitrogen oxides (NOx). In addition, a Beckman 402 FID was used to continuously sample the dilute exhaust for hydrocarbon emissions. The output of the FID was recorded on a strip chart recorder and integrated to determine the average concentration of hydrocarbons in the exhaust. The sample for the FID was drawn from the CVS duct immediately downstream of the dilution box, and transported to the FID through a heated stainless steel sample line. Tests were run at FID oven and sample line temperatures of 180°F, 200°F, 250°F, 300°F, and 375°F.

The hydrocarbon concentrations obtained from the integrated hot FID traces were compared to the concentrations obtained from the cold FID analysis of CVS sample bags to get the ratio Hot HC/Cold HC. Hot HC refers to the hot FID results, Cold HC refers to the CVS bag results. The data was examined for any relationship between this ratio and the oven and sample line temperature.

In addition to the 1975 emissions tests, steady states were run at each oven and sample line temperature. The cars were run at 40 mph until fully warmed-up and the sample line was heated to 425°F. When the system stabilized, the sample line heaters were shut off and the sample line was allowed to cool to 180°F. Variations in hydrocarbon concentrations with sample line temperature were recorded.

Results

For the 1975 emissions tests, the ratio Hot HC/Cold HC varied from 0.99 to 1.07 (see Table I). The average of the integrated hot FID results agreed with the cold FID bag results within 3%. There was no relationship between the temperature of the oven and sample line and the ratio Hot HC/Cold HC. The steady state tests showed no significant variation in hydrocarbon concentration with sample line temperature.

Conclusions

It appears that it is not necessary to use a hot FID with a heated sample line to measure the hydrocarbon emissions from gasoline-powered vehicles. The effect of the heated line is negligible when compared to the CVS 3-bag results.

TABLE I

Mass Emissions
grams per mile

Car	Hot HC	Cold HC	CO	CO_2	NOx	Hot HC/ Cold HC	°F Temp.
Vega	2.07	2.01	35.51	303.18	2.39	1.03	180
Vega	1.98	1.91	36.80	289.00	2.50	1.04	180
Valiant	2.39	2.32	31.56	366.82	5.97	1.03	200
Valiant	2.29	2.31	33.06	383.29	6.15	0.99	200
Valiant	2.31	2.25	31.84	408.45	6.07	1.03	250
Valiant	2.22	2.22	29.01	410.85	6.38	1.0	250
Vega	2.06	2.05	34.89	307.80	2.54	1.0	300
Vega	1.92	1.90	37.34	308.08	2.54	1.01	300
Valiant	2.42	2.30	31.93	410.33	6.13	1.03	350
Valiant	2.45	2.37	34.56	423.74	6.39	1.03	350
Vega	1.74	1.63	31.87	258.53	2.21	1.07	375
Vega	1.85	1.76	35.00	270.07	2.51	1.05	375

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