74-10 DWP

Evaluation of Dana Retronox EGR and UOP Oxidizing Catalyst Retrofits On Two Medium Duty Vehicles

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Emission Control Technology Division
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Background

Medium duty vehicles (6000 to 10,000 pounds GVW) have been shown to have many similarities to light duty vehicles. Characterization of technically feasible emission reduction is an important input when considering development of medium duty exhaust emission standards. In addition, state authorities have expressed interest in retrofit control for this vehicle class. To provide technical input to these areas test work was conducted on two medium duty vehicles retrofitted with oxidizing catalysts and exhaust gas recirculation (EGR) systems.

Device Description

Dana Retronox EGR system and UOP oxidizing catalysts were retrofitted to both a 1972 Chevrolet 3/4-ton pick-up truck with a 350 CID engine and automatic transmission, and a 1972 Dodge stake truck with a 318 CID engine and standard transmission.

The Dana Retronox EGR system employs an engine speed and ported carburetor vacuum controlled EGR system, and an engine speed controlled vacuum advance cut-off system. Both EGR and relative spark timing retard have been shown to be effective in reduction of total oxides of nitrogen. The Retronox system is installed typically as per the attached figure 1. The EGR valve is controlled by ported vacuum assuming the engine speed is above the set point of the ignition operated speed-sensing valve. The recirculated exhaust gas is introduced into the intake system via the existing PCV plumbing. The distributor vacuum advance is connected downstream of the speed-sensing valve. Thus, as with the EGR, vacuum advance can only be activated above the speed-sensing valve set point.

In both truck installations the engine speed-sensing valve opened at 1200 to 1300 rpm and the vacuum operated EGR valve closed at approximately 3 in. Hg vacuum. Both trucks were retrofitted with UOP pellet-type, noble metal oxidizing catalysts. Air pumps were required. The Chevrolet installation incorporated two heavily loaded sixty cubic inch converters (1.7 gm noble metal/catalyst). One was fitted to each exhaust manifold of the 350 CID V8 engine. The Dodge installation incorporated one moderately loaded 180 cubic inch low profile converter (1.52 gm noble metal in catalyst).

Test Program

Tests were performed on the Chevrolet and Dodge trucks in both the stock and retrofitted configurations. Tests were conducted according to the 1975 FTP as described in the November 15, 1972, Federal Register. The vehicles were tested at various inertia loads and rear wheel horsepower absorption levels. Inertia vs. power absorption is presented in Table II. Steady state testing was also conducted. No mileage accumulation was attempted during this program.

Results

A summary of results from this testing is given in Table I. At low mileage a minimum of 80% reduction in hydrocarbon and carbon monoxide emissions was achieved with a minimum 40% reduction in oxides of nitrogen. Complete tabulation of test results is given in Tables III and IV.

Conclusion

At low mileage the Dana Retronox EGR system/UOP oxidizing catalyst retrofit of two medium duty vehicles demonstrated consistent reductions in hydrocarbon and carbon monoxide emissions in excess of 80% and a reduction of 40% or more in oxides of nitrogen.

DANA RETRONOX EGR SYSTEM INSTALLATION

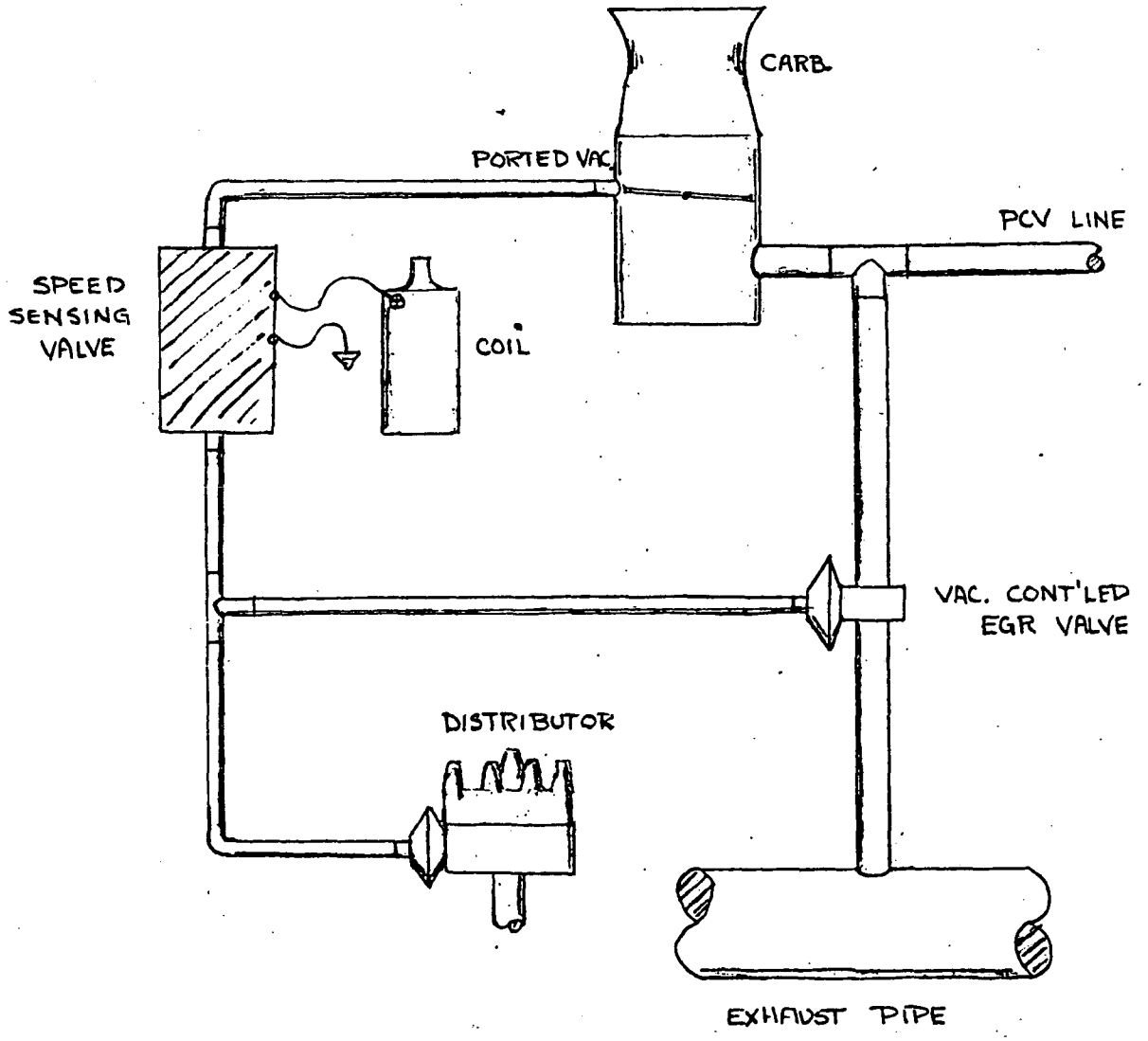

FIGURE 1

TABLE I

1975 FTP - Summary of Average
Results with and without Dana/UOP Retrofit

Chevrolet 3/4-ton Pick-up Truck

6500 lb. inertia

	HC (gm/mi)	CO (gm/mi)	NOx (gm/mi)
Baseline	2.92	39.61	6.58
Retrofit	0.51	7.27	4.02
% reduction	83	82	39

5500 lb. inertia

Baseline	3.23	44.28	6.43
Retrofit	0.35	3.14	2.74
% reduction	89	93	57

Dodge Stake Truck

7000 lb. inertia

Baseline	7.99	81.93	7.49
Retrofit	1.15	11.66	4.07
% reduction	86	86	46

6500 lb. inertia

Retrofit	1.11	11.66	4.36

6000 lb. inertia

Retrofit	1.09	11.12	4.07

5500 lb. inertia

Retrofit	0.97	7.75	3.52

TABLE II

Medium Duty Rear Wheel HP at 50 MPH

Inertia lbs.	Rear Wheel Power HP
5500	22.7
6000	27.5
6500	32.3
7000	37.1

TABLE III

Test Results on 1972 3/4-ton Chevrolet C-20
Pick-up with 350 CID engine

1975 FTP Results

No Emission Control (5500 lb. inertia)

	HC	CO	NOx
	2.97	37.11	7.29
	3.85	56.11	6.11
	2.86	38.95	5.90
	3.23	44.06	6.43
Average	3.23	44.28	6.43

Steady State No Emission Control (22.7 HP @ 50 MPH)

Idle gm/5 min.	15 mph gm/mi	30 mph gm/mi	45 mph gm/mi	60 mph gm/mi	
1.97	1.29	1.51	1.86	3.05	HC
40.62	12.15	3.41	16.64	96.62	CO
.04	.93	5.00	8.96	8.42	NOx

1975 FTP Results
With Dana/UOP Retrofit (5500 lb. inertia)

	HC gm/mi	CO gm/mi	NOx gm/mi
	0.32*	3.08*	2.34*
	0.37	3.43	2.43
	0.33	2.69	2.88
	0.35	3.29	2.91
Average	0.35	3.14	2.74

Steady State with Dana/UOP Retrofit (22.7 HP @ 50 MPH)

Idle gm/5 min	15 mph gm/mi	30 mph gm/mi	45 mph gm/mi	60 mph gm/mi	
0.14	0.07	0.05	0.03	0.05	HC
0.73	0.07	0.02	0.03	0.18	CO
0.07	0.48	0.58	1.32	3.09	NOx

* Test conducted at 17.4 hp at 50 mph instead of 22.7 hp.

TABLE III con't.

1975 FTP Results

With UOP Cat.- No EGR (5500 lb. inertia)

	HC gm/mi	CO gm/mi	NOx gm/mi
	0.33	2.95	5.94
	0.32	2.71	5.36
Average	0.33	2.83	5.65

1975 FTP Results

No Emission Control (6500 lb. inertia)

	3.23	44.42	6.61
	2.64	35.81	6.31
	2.88	38.59	6.82
Average	2.92	39.61	6.58

Steady State No Emission Control (32.3 HP @ 50 MPH)

Idle gm/5 mi	15 mph gm/mi	30 mph gm/mi	45 mph gm/mi	60 mph gm/mi	
1.99	0.52	0.84	0.83	1.64	HC
37.30	6.28	1.64	5.63	15.25	CO
0.00	0.48	3.46	6.56	11.83	NOx

1975 FTP Results

With Dana/UOP Retrofit (6500 lb. inertia)

	HC gm/mi	CO gm/mi	NOx gm/mi
	0.43	5.07	3.43
	0.56	7.98	5.04
	0.47	6.56	4.09
	0.56	9.48	3.53
Average	0.51	7.27	4.02

Steady State with Dana/UOP Retrofit (32.3 HP @ 50 MPH)

Idle gm/5 mi	15 mph gm/mi	30 mph gm/mi	45 mph gm/mi	60 mph gm/mi	
0.29	0.07	0.10	0.06	0.11	HC
0.68	0.00	0.14	0.09	1.35	CO
0.07	0.77	1.26	4.12	6.13	NOx

TABLE IV

Test Results on 1972 Dodge Stake Truck
With 318 CID Engine

1975 FTP Results

No Emission Control (7000 lb. inertia)

	HC gm/mi	CO gm/mi	NOx gm/mi
	8.62	85.44	7.69
	7.90	80.86	9.11
	8.40	78.99	5.99
	7.46	84.38	8.27
	7.56	79.96	6.39
Average	7.99	81.93	7.49

Steady State No Emission Control (37.1 HP @ 50 MPH)

Idle gm/5 mi	15 mph gm/mi	30 mph gm/mi	45 mph gm/mi	60 mph gm/mi	
4.95	4.15	2.43	2.09	1.44	HC
148.69	42.82	3.57	6.88	18.75	CO
0.14	1.10	5.43	9.17	11.33	NOx

1975 FTP Results

With Dana/UOP Retrofit (7000 lb. inertia)

	HC gm/mi	CO gm/mi	NOx gm/mi
	1.27	13.51	4.22
	1.19	9.84	4.31
	1.14	9.64	3.96
	1.10	13.37	4.31
	1.04	11.95	3.55
Average	1.15	11.66	4.07

Steady State with Dana/UOP Retrofit (37.1 HP @ 50 MPH)

Idle gm/5 mi	15 mph gm/mi	30 mph gm/mi	45 mph gm/mi	60 mph gm/mi	
0.08	0.29	0.25	0.18	0.03	HC
1.25	0.92	0.34	0.41	0.93	CO
0.00	0.14	1.25	3.38	4.90	NOx

TABLE IV con't.

1975 FTP Results

With UOP/Dana Retrofit (6500 lb. inertia)

	HC gm/mi	CO gm/mi	NOx gm/mi
	1.04	9.47	4.35
	1.18	13.85	4.37
Average	1.11	11.66	4.36

1975 FTP Results

With UOP/Dana Retrofit (6000 lb. inertia)

	1.11	11.01	4.06
	1.17	9.63	5.70
	1.13	12.46	3.93
	1.16	13.38	3.72
	0.88	9.11	2.94
Average	1.09	11.12	4.07

Steady State with Dana/UOP Retrofit (27.5 HP @ 50 MPH)

Idle gm/5 mi	15 mph gm/mi	30 mph gm/mi	45 mph gm/mi	60 mph gm/mi	
0.05	0.34	0.26	0.18	0.10	HC
0.96	1.06	0.00	0.37	0.96	CO
0.15	0.66	1.63	4.99	8.91	NOx

1975 FTP Results

With UOP/Dana Retrofit (5500 lb. inertia)

	HC gm/mi	CO gm/mi	NOx gm/mi
	0.95	8.01	3.29
	0.99	7.49	3.76
Average	0.97	7.75	3.52