TAED 75-26

Investigation into Hydrogen Sulfide Odor Problem on a Privately-Owned, Catalytic Converter-Equipped 1975 Automobile

June 1975

Technology Assessment and Evaluation Branch
Emission Control Technology Division
Office of Mobile Source Air Pollution Control
Environmental Protection Agency

Background

The Michigan-Ohio District Office of the Environmental Protection Agency was contacted in April 1975 by a person living in the Cleveland, Ohio area about the unpleasant odor emanating from his brand-new 1975 catalytic converter-equipped Plymouth Gran Fury. The "very pungent and acrid odor" had been noticeable from the time the owner took delivery of the car, and was at its worst when the car was idling or moving in dense traffic, according to the owner. Along with the unpleasant odor, irritations of the throat and nose were experienced by the owner and his family. Taking the car to the dealer did not result in any alleviation of the odor, although a driveability problem (hesitation on tip-in) was solved.

District Office personnel contacted the Emission Control Technology Division for technical advice on the problem. Descriptions of the odor and the driving modes when it occurred led EPA to speculate that hydrogen sulfide (H_2S) was being formed over the oxidation catalyst due to the carburetor being set too rich. On advice of EPA the owner changed brands of gasoline, seeking one with lower sulfur content, but no reduction in the odor occurred.

The situation was seen by EPA personnel as an opportunity to look into the cause of recently reported odor problems on in-use catalytic converter-equipped vehicles, and to respond in a helpful manner to a concerned citizen, so the owner was invited to bring his car to the Motor Vehicle Emission Laboratory (MVEL) for a thorough investigation. This report covers that investigation, which took place in early June 1975.

Vehicle Description

The car was a 1975 Plymouth Gran Fury sedan, with a 360 cubic inch engine and oxidizing catalytic converter. Optional equipment included automatic transmission, power brakes, power steering and air conditioning. The car is described in detail in the table on the following page.

Test Procedure

Tests included the following: driveability, visual inspection, state of tune in as-received condition, and a hot start 72 FTP exhaust emissions test. After the car was tuned to manufacturer's specifications another hot start 72 FTP was run.

TEST VEHICLE DESCRIPTION

Chassis model year/make - 1975 Plymouth Gran Fury
Emission control system - Oxidation Catalyst

Engine

type	4 stroke Otto cycle, OHV, V-8
bore x stroke	4.00 x 3.58 in./101.6 x 90.9 mm
displacement	360 CID/5900 cc
compression ratio	8.40:1
maximum power @ rpm	170 hp/127 kW @ 4000 rpm
fuel metering	Holley 2 bbl carburetor
fuel requirement	91 RON unleaded

Drive Train

transmission type	3-speed automatic
final drive ratio	not known

Chassis

type	body/frame, front engine, rear wheel drive
tire size	GR 78 x 15
curb weight	not weighed
inertia weight	5000 lb.
passenger capacity	6

Emission Control System

basic type	oxidation catalyst, engine modifications, exhaust gas recirculation, positive crankcase ventilation, evaporative hydrocarbon emission control

Manufacturer's Tuning Specifications

basic timing	6^{o} BTDC
engine idle speed	750 rpm in Neutral
idle CO concentration	0.3% (measured at upstream end of converter)

As-Received Tuning Conditions

odometer reading	2460 miles
basic timing	10^{o} BTDC
engine idle speed	1200 rpm in Neutral
idle CO concentration	9.0%

Results

In the on-the-road driveability test the car was rated as good, with no hesitation, stumble, surge, or run-on. The visual inspection was performed with the vehicle at floor level and on a lift. No holes were seen in either body or trunk sheet metal. The exhaust system was in good condition, although the threaded plug in the catalytic converter (removable for idle CO analysis) was only finger-tight. The inside of the tailpipe was covered with soot, as was the inside of the converter plug. On the carburetor, the limiter caps were missing from the idle adjustment screws.

The car's as-received state of tune was checked by EPA personnel using a Sun Model C-65 Infra-Red Engine Performance Tester. It was found that idle speed was 1200 rpm and basic timing was 10^{o} BTDC, both of which were outside of the manufacturer's specifications. Idle CO concentration was 9% at the sample point in the upstream end of the converter and at the tailpipe.

When the car was driven from the tune-up area to the chassis dynamometer test cell the rotten-egg odor characteristic of H_2S was detected by the driver and other personnel.

A hot start 72 FTP was run on the car in the as-received condition. Results are listed below.

As Received
72 FTP Hot Start
Mass Emissions
grams per mile
(grams per kilometre)

Test No.	HC	CO	NOx	Fuel Economy (Fuel Consumption)
16-9340	1.92	93.63	2.54	11.78 miles/gallon
	(1.19)	(58.18)	(1.58)	(19.97 litres/100 kilometres)

The engine was then tuned to manufacturer's specifications (see Test Vehicle Description) and another hot start 72 FTP was run, with the following results.

Tuned to Manufacturer's Specifications
72 FTP Hot Start
Mass Emissions
grams per mile
(grams per kilometre)

Test No.	HC	CO	NOx	Fuel Economy (Fuel Consumption)
16-9341	.13 (.08)	6.24 (3.88)	3.38 (2.10)	11.77 miles/gallon (19.98 litres/100 kilometres)

After the car had been tuned to manufacturer's specifications, no H_2S odor was detected. However, driveability problems (hesitation and run-on) were noted.

Conclusions

The cause of the H_2S odor problem was the extremely rich carburetor setting. The idle CO concentration of 9% indicates that the air-fuel (A/F) ratio was about 11:1, whereas for this particular car it should have been about 15:1. From the tailpipe idle CO concentration of 9%, the soot in the tailpipe, and the hot start 72 FTP mass emissions of almost 94 grams per mile (gpm) CO, it is obvious that the catalyst could not promote oxidation, because insufficient oxygen was present in the engine exhaust. It was however causing H_2S to be formed, in line with reported experimental work.(1)

When the air-fuel mixture was leaned out to the proper setting the catalyst was able to light off and do the job for which it was intended, thus the low HC and CO emissions in the second test. Retarding the timing from 10^{o} to 6^{o} BTDC would ordinarily tend to reduce NOx formation. However in this case NOx formation was suppressed by the rich mixture, so that the effect of leaning out the A/F ratio was greater than retarding the timing and NOx increased from 2.54 to 3.38 gpm.

The effect of the retuning on the car's fuel economy was negligible. The absence of idle adjustment screw limiter caps suggests that they were removed in order to solve lean operation driveability problems.

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(1) Barnes and Summers, "Hydrogen Sulfide Formation Over Automotive Oxidation Catalysts," Society of Automotive Engineers Paper No. 750093, February 1975.

This investigation supports previous analyses and data (SAE 750093), and suggests that H_2S problems encountered with in-use cars are due to mixture enrichment (and/or air injection malfunction) rather than catalytic converter malfunction. The cause of H_2S formation is believed to be either poor quality control at the factory or maladjustment of air-fuel ratio arising from attempts to correct driveability problems. If this condition - the tradeoff between driveability and H_2S formatiom - is widespread among in-use cars then the solution will require proper training and equipping of mechanics.

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