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Emissions and Fuel Economy of the Kat's Engine Block Heater Device

by

Jesse McCall

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Test and Evaluation Branch
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16. ABSTRACT

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Testing of three 1979 passenger cars was conducted at EPA's Motor Vehicle Emission Laboratory from December 1981 through March 1982. The test sequence used was the Federal Test Procedure (FTP). The test results varied between test vehicles although some definite improvements in HC and CO were noted at the lower temperatures. Minor improvements in fuel economy were found during the warm-up period. As the test temperatures were increased, the amount of change caused by the device was reduced. Vehicle start-up and driveability were essentially unchanged throughout the program.

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Abstract

This report describes the results of testing the Kat's Engine Block Heater with respect to exhaust emissions and fuel economy at ambient temperatures of 20°, 40°, and 60° Fahrenheit. This device contains an electric heating element within an open metal cylinder which is spliced into the lower radiator hose of the engine's cooling system. The primary purpose of this device is to minimize hard starting in cold weather. A secondary purpose is to improve fuel economy.

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Description of the Device

The Kat's Engine Block Heater is marketed by Five Star Manufacturing Co. It contains an electric heating element within an open metal cylinder which is spliced into the lower radiator hose. When the device is in operation, the engine coolant is heated by the heating element and is circulated by convection currents through the radiator to the engine block and back to the device. The primary purpose of this device is to minimize hard starting in cold weather. A secondary purpose is to improve fuel economy.

Various models of the Kat's heater are available to fit radiator hoses of different diameters. Each is rated at 750 watts for 120 volts and is thermostatically controlled. Instructions for installing and operating the device are shown in Appendix A.

Program Design

Three late model vehicles were used: a Ford Pinto with a 4-cylinder engine, a Ford Granada with an 8-cylinder engine, and an Oldsmobile Cutlass with a 6-cylinder engine. All vehicles were equipped with automatic transmissions. A detailed description of each vehicle is provided in Appendix B.

Exhaust emission tests were conducted according to the 1977 Federal Test Procedure (FTP) described in the Federal Register of June 28, 1977 although the vehicles were not tested for evaporative emissions. Indolene HO (unleaded) fuel was used for all testing.

The following procedure was used for each vehicle:

1. All vehicles were adjusted to manufacturer's specifications. Thermocouples were installed to monitor the temperatures of the coolant and the oil.

2. An appropriate model of the Kat's Engine Block Heater was installed.

3. Replicate baseline FTP tests were performed at temperatures of 20°F, 40°F, 60°F and 75°F without the device being in operation. The test at 75°F was performed strictly for baseline purposes.

4. Replicate FTP tests were performed at temperatures of 20°F, 40°F, and 60°F after the device had been in operation for a minimum of 2.5 hours.

5. Oil and water temperatures were recorded immediately before each test.

6. Start-up and driveability characteristics were recorded by the driver.

Conduct of the Program

All vehicles were checked with a Sun engine analyzer and adjusted to manufacturer's specifications when required. Installation of the Kat's Engine Block Heater was performed in accordance with the instructions provided with the device. The vehicles were tested between December 1981 and March 1982. All tests were performed by EPA at the Motor Vehicle Emission Laboratory in Ann Arbor, Michigan. The test sequence was conducted as proposed.

Test Results

The devices were installed without difficulty. Each was found to be effective in maintaining the coolant at a temperature substantially above the ambient. A summary of these results is contained in Table 1. The subjective evaluations of startability and driveability indicated that each vehicle started well and operated smoothly under virtually all conditions. Since our test facility could not achieve the temperatures where such heaters are usually employed, these results were not unexpected.

The results of the individual emission tests on each vehicle are presented in Appendices C, D, and E. These values were used in developing Table 2 which summarizes the results of the test program. The test results show that with the device operating, emissions decreased significantly and minor fuel economy improvements were realized as the temperatures were decreased. Using the student's "T" test, a statistical analysis was made of the exhaust emissions and fuel economy data. At a 95% confidence level, this analysis indicated that there were some significant changes. Those changes determined to be statistically significant are shown in parentheses in Table 2.

The individual FTP bag results were evaluated to determine the effect of the device during both warm-up and stabilized operating conditions. It should be noted that Bag 1 represents unstabilized (warm-up) condition while Bag 2 represents a more stabilized engine. Bag 3 represents the most stabilized condition. Bag 1 represents approximately 3.5 miles of driving. Appendix F summarizes the percentage of improvements attributable to the device during each of those operating conditions. As shown in Appendix F, the largest percentage changes for each vehicle occur during Bag 1.

Table 1

Summary of Temperatures at Start of Test (°F)

Nominal Temp	Test Condition	Actual Ambient	Oil	Water
20	Baseline	18	21	21
20	Device	18	31	123
40	Baseline	39	41	41
40	Device	39	54	132
60	Baseline	59	61	61
60	Device	58	68	132

Cost Effectiveness

The Kat's Engine Block Heater retails for about $30 and requires about one-half hour to install. At a rating of 750 watts and typical usage of at least several hours, there is also some expense in using the device. Based on the results of this study, it is unlikely the fuel saved will offset the cost of the electricity. On the other hand, the device does have merit in reducing HC and CO emissions during warm-up. When employed at temperatures more typical for the use of this type of device, we expect startability to improve as well. Ultimately, the cost effectiveness of this device lies in minimizing the consequences of a vehicle which will not start on a cold day and not in saving energy.

Conclusions

The Kat's Engine Block Heater was found to have some significant benefits with respect to HC and CO emissions, especially at the lower temperatures. For the temperatures used in this program, only minor fuel economy improvements were shown. It appears that the cost of the electricity to operate the device cannot be offset by any savings in fuel. Startability and driveability were essentially unchanged at these test temperatures.

Table 2

Summary of Emissions and Fuel Economy Test Results

20° Fahrenheit		FTP			
Vehicle	Configuration	HC	CO	NOx	F.E.
Oldsmobile	Baseline Av.	5.98	52.9	1.42	16.25
Cutlass	Device Av.	2.26	23.7	1.58	17.62
	Av. Change	(-62%)	(-55%)	11%	(8%)
Ford	baseline Av.	1.85	16.2	3.61	20.00
Pinto	Device Av.	1.56	12.6	3.29	20.10
	Av. Change	(-16%)	-22%	-9%	-1%
Ford	Baseline Av.	1.73	24.4	1.88	13.13
Granada	Device Av.	1.21	18.9	1.68	13.45
	Av. Change	-30%	-23%	(-11%)	2%

40° Fahrenheit		FTP			
Vehicle	Configuration	HC	CO	NOx	F.E.
Oldsmobile	Baseline Av.	3.79	25.8	1.60	18.17
Cutlass	Device Av.	1.66	16.9	1.59	18.93
	Av. Change	(-56%)	-34%	-1%	4%
Ford	Baseline Av.	1.63	14.2	2.72	20.66
Pinto	Device Av.	1.58	9.1	2.82	21.15
	Av. Change	-3%	-36%	4%	2%
Ford	Baseline Av.	1.18	19.7	1.41	14.40
Granada	Device Av.	1.04	15.0	1.54	14.17
	Av. Change	-12%	(-24%)	9%	-2%

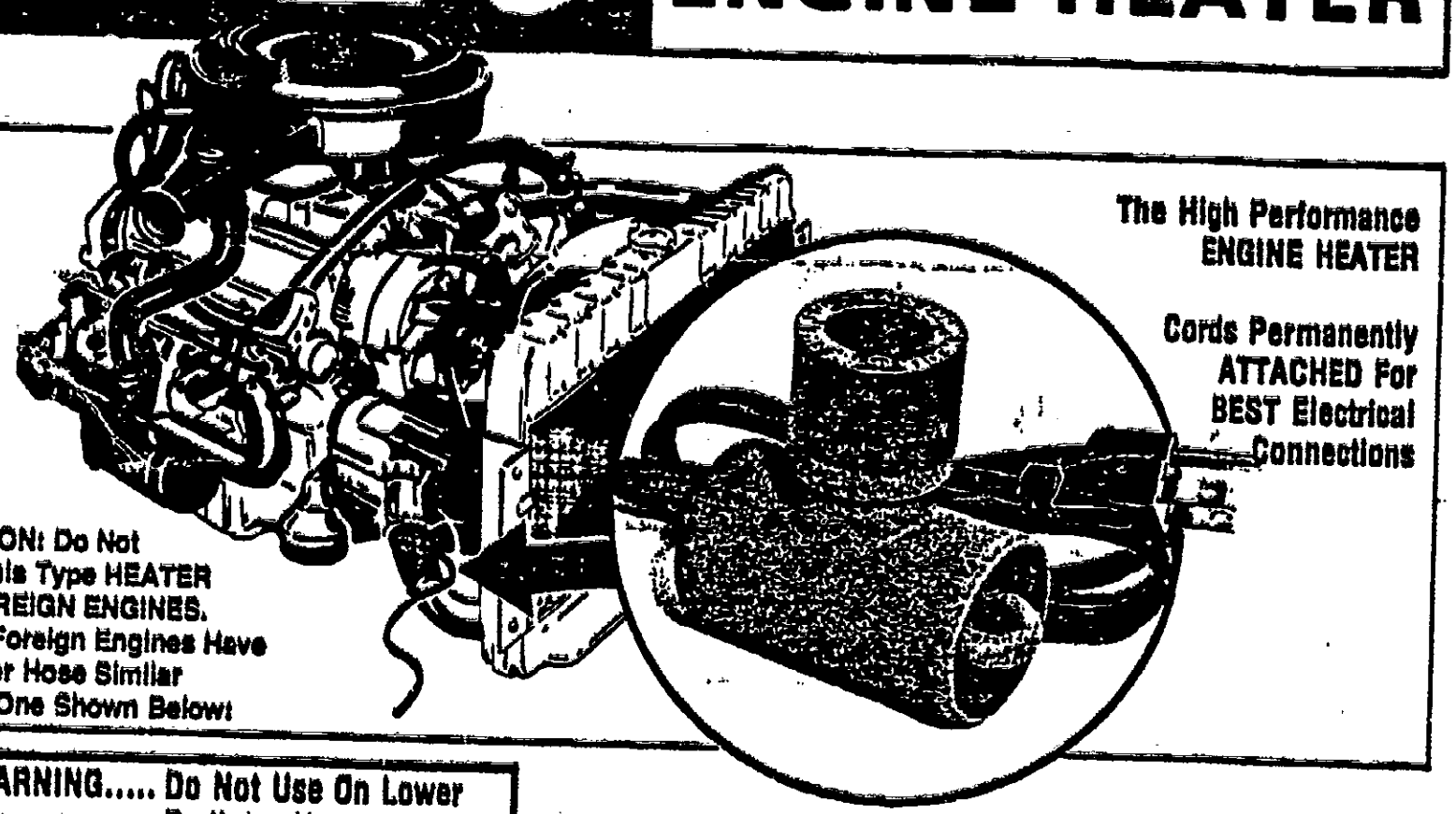
60° Fahrenheit		FTP			
Vehicle	Configuration	HC	CO	NOx	F.E.
Oldsmobile	Baseline Av.	1.69	17.5	1.18	19.58
Cutlass	Device Av.	0.99	9.3	1.69	19.42
	Av. Change	(-41%)	(-47%)	43%	-1%
Ford	Baseline Av.	1.65	10.6	1.72	21.76
Pinto	Device Av.	1.70	8.8	1.79	22.15
	Av. Change	3%	(-17%)	4%	2%
Ford	Baseline Av.	1.00	9.1	1.84	13.85
Granada	Device Av.	0.97	4.9	1.41	13.86
	Av. Change	-3%	-46%	(-23%)	0%

NOTE: Emission results are in grams per mile. Fuel economy (F.E.) values are miles per gallon. Values in parentheses were found to be statistically significant.

NEW THERMOSTATICALLY CONTROLLED MODELS*KH5, KH6, KH7, KH8

KAT'S

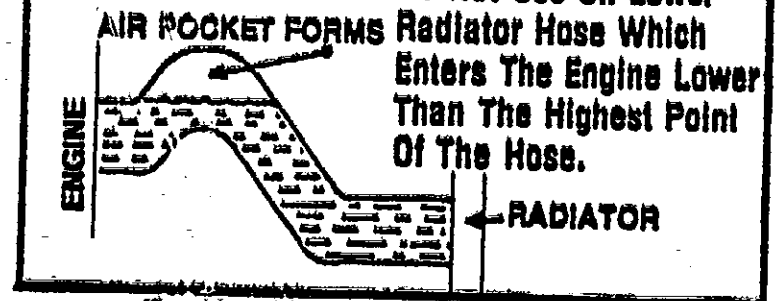
LOWER RADIATOR HOSE ENGINE HEATER



The High Performance ENGINE HEATER

Cords Permanently ATTACHED For BEST Electrical Connections

CAUTION: Do Not Use This Type HEATER on FOREIGN ENGINES. Many Foreign Engines Have a Lower Hose Similar to the One Shown Below:



Do Not Use On FLEXIBLE WIRE REINFORCED RADIATOR HOSE

When Installing a Hose Heater, Check the Condition of the Lower Hose. If Cracked or Worn, Replace with New Hose Before Installing Electric Hose Heater.

* * * * * * *

KH SERIES

KH5* or KH1 FITS 1¼" diameter hose
KH6* or KH2 FITS 1½" diameter hose
KH7* or KH3 FITS 1¾" diameter hose
KH8* or KH4 FITS 2" diameter hose

(Includes 2 Gear Type Clamps)

*THERMOSTATICALLY CONTROLLED

All KAT'S Lower Radiator Hose Heaters Rated 750 Watts–120 Volts

INSTRUCTIONS: FOR INSTALLING AND OPERATING

1. Drain and clean the cooling system. (Recommend that this be done annually for more efficient heater operation.)
2. Cut and remove a 1" section from the lower (molded) radiator hose at a point close to the water pump that will accept the heater without changing the form of the original radiator hose. Cut and remove three inches of the wire coil that reinforces the hose where the heater will be placed. Make certain that the engine heater has a rise toward the water pump.
3. Place gear type hose clamps on the cut hose before installing heater. Position the hose heater and electrical cord so that it will clear all belts, fans and pulleys and tighten hose clamps securely.
4. Place the electric cord from heater through radiator grille or other convenient opening and tape or fasten in position, making sure it is clear of all moving parts (fan blades) and heated parts (manifold).
5. Refill cooling system, start engine and check for leaks before connecting to power source. CAUTION: This heater will burn out unless the element is fully immersed in coolant.
6. Connect extension cord to proper voltage outlet to determine if heater is operating properly. This heater is rated at 750 Watts, 120 Volts. It can be operated all night or for several hours prior to starting the engine.
7. Use extension cord of adequate size for engine heater wattage and distance from source. Check with your local electrician for proper sizes.

FIVE STAR MANUFACTURING CO., CLARKSDALE, MISS. 38614

Appendix B

Test Vehicle Descriptions

Make/Model	Oldsmobile Cutlass	Ford Granada	Ford Pinto
Model Year	1979	1979	1979
Type	2 door	4 door	2 door
Vehicle I.D.	3R47A9M52380	9W82F123952	9T11Y186165
Initial Odometer	36112.0	26634.0	26047.7
Engine Type	Spark Ignition	Spark Ignition	Spark Ignition
Configuration	V6	V8	In-Line 4
Displacement	231	302	140
Fuel Metering	2V Carburetor	2V Carburetor	1V Carburetor
Fuel Requirement	Unleaded	Unleaded	Unleaded
Transmission	Automatic	Automatic	Automatic
Tires	P195/75R14	ER78X14	BR78X13
Inertia Weight	4000	3500	3000
Actual HP @50 mph	12.0	11.2	10.3
Major Emission Control Systems	EGR Air Pump Catalyst	EGR Air Pump Catalyst	EGR Pulsating Air Catalyst

Appendix C

Test Results - Oldsmobile Cutlass

20° Fahrenheit — FTP

Test Date	Test #	Configuration	HC	CO	NOx	F.E.
1-18-82	81-1970	Baseline	5.45	50.2	1.29	16.51
1-19-82	81-1972	Baseline	6.35	54.6	1.37	16.03
3-15-82	81-2535	Baseline	6.14	53.8	1.60	16.20
1-19-82	81-1971	Device	2.06	23.3	1.61	17.70
1-20-82	81-1973	Device	2.45	24.2	1.54	17.53

40° Fahrenheit — FTP

Test Date	Test #	Configuration	HC	CO	NOx	F.E.
1-20-82	81-1974	Baseline	3.47	17.0	1.46	18.64
1-21-82	81-1976	Baseline	3.66	15.5	1.50	18.82
2-18-82	81-2301	Baseline	4.60	39.4	1.72	17.30
3-11-82	81-2473	Baseline	3.43	31.1	1.72	17.90
1-21-82	81-2475	Device	1.41	14.1	1.58	18.80
1-27-82	81-2161	Device	1.98	19.4	1.61	19.10
1-28-82	81-2165	Device	1.60	17.3	1.57	18.90

60° Fahrenheit — FTP

Test Date	Test #	Configuration	HC	CO	NOx	F.E.
1-12-82	81-1964	Baseline	1.73	17.9	1.04	19.90
1-12-82	81-1965	Baseline	1.78	18.0	1.10	19.84
2-17-82	81-2297	Baseline	1.56	16.5	1.41	19.00
2-3-82	81-1004	Device	1.02	9.4	1.65	19.53
2-2-82	81-1006	Device	0.91	9.6	1.60	19.53
2-4-82	81-2214	Device	1.05	9.0	1.81	19.21

75° Fahrenheit — FTP

Test Date	Test #	Configuration	HC	CO	NOx	F.E.
1-11-82	81-1963	Baseline	1.45	15.9	1.03	19.3
2-3-82	81-2215	Baseline	1.13	8.9	1.43	20.0
2-11-82	81-2251	Baseline	1.30	12.1	1.31	19.4
2-16-82	81-2280	Baseline	1.10	11.0	1.30	19.5

NOTE: Emission results are in grams per mile. Fuel Economy values are in miles per gallon.

Appendix D

Test Results - Ford Pinto

20° Fahrenheit				FTP		
Test Date	Test #	Configuration	HC	CO	NOx	F.E.
2-24-82	81-2323	Baseline	1.82	14.6	3.65	20.40
2-25-82	81-2356	Baseline	1.82	16.4	3.91	19.70
3-17-82	81-2583	Baseline	1.90	17.6	3.26	19.90
3-17-82	81-2568	Device	1.51	12.5	3.13	20.20
2-25-82	81-2343	Device	1.66	13.8	3.41	20.10
3-9-82	81-2460	Device	1.50	11.4	3.33	20.00

40° Fahrenheit				FTP		
Test Date	Test #	Configuration	HC	CO	NOx	F.E.
2-22-82	81-2319	Baseline	1.62	12.7	2.73	20.61
3-4-82	81-2434	Baseline	1.64	15.6	2.70	20.70
2-23-82	81-2320	Device	1.60	9.2	2.72	21.00
2-24-82	81-2322	Device	1.53	8.9	2.92	21.30

60° Fahrenheit				FTP		
Test Date	Test #	Configuration	HC	CO	NOx	F.E.
2-9-82	81-2160	Baseline	1.63	10.3	1.63	21.82
2-10-82	81-2168	Baseline	1.67	10.8	1.80	21.70
2-10-82	81-2167	Device	1.74	8.9	1.78	22.10
2-11-82	81-2170	Device	1.66	8.6	1.79	22.20

75° Fahrenheit				FTP		
Test Date	Test #	Configuration	HC	CO	NOx	F.E.
2-8-82	81-2171	Baseline	1.58	8.5	1.61	22.4
3-1-82	81-2405	Baseline	1.43	5.7	1.26	23.7
3-3-82	81-2423	Baseline	1.34	4.2	1.65	22.5

NOTE: Emission results are in grams per mile. Fuel Economy values are in miles per gallon.

Appendix E

Test Results - Ford Granada

20° Fahrenheit — FTP

Test Date	Test #	Configuration	HC	CO	NOx	F.E.
12-29-81	80-4601	Baseline	1.45	20.8	1.94	13.20
12-30-81	80-4602	Baseline	1.20	18.4	1.82	13.40
1-4-82	80-4603	Baseline	1.96	31.1	1.86	13.10
1-5-82	80-4604	Baseline	2.31	27.2	1.91	12.80
12-28-82	80-4600	Device	1.14	17.0	1.72	13.50
1-6-82	81-1942	Device	1.12	19.4	1.59	13.64
1-5-82	81-1954	Device	1.37	20.3	1.72	13.20

40° Fahrenheit — FTP

Test Date	Test #	Configuration	HC	CO	NOx	F.E.
12-16-82	80-4597	Baseline	1.18	19.7	1.41	14.40
12-22-82	80-4598	Device	1.07	16.2	1.39	14.50
1-7-82	81-1943	Device	1.01	13.7	1.69	13.84

60° Fahrenheit — FTP

Test Date	Test #	Configuration	HC	CO	NOx	F.E.
12-14-81	80-4593	Baseline	1.01	10.5	1.78	13.70
12-15-82	80-4594	Baseline	0.99	7.6	1.90	14.00
12-16-82	80-4595	Device	0.96	5.1	1.46	13.70
12-17-82	80-4596	Device	0.97	4.6	1.36	14.02

75° Fahrenheit — FTP

Test Date	Test #	Configuration	HC	CO	NOx	F.E.
12-9-81	80-4591	Baseline	0.89	5.7	1.15	14.5
12-10-81	80-2548	Baseline	0.96	9.1	0.92	14.6
3-16-82	81-4592	Baseline	0.96	6.0	1.14	14.1

NOTE: Emission results are in grams per mile. Fuel Economy values are in miles per gallon.

Appendix F

Summary of Changes Between Baseline and Device by Bag Numbers (change given in percent)

	HC	CO	NOx	F.E.
Cutlass				
20° Fahrenheit				
Bag 1	-79%	-70%	62%	32%
Bag 2	-35%	-30%	-4%	1%
Bag 3	-1%	-10%	-3%	1%
40° Fahrenheit				
Bag 1	-73%	-60%	-5%	13%
Bag 2	-22%	-10%	7%	2%
Bag 3	-21%	-10%	-5%	1%
60° Fahrenheit				
Bag 1	-40%	-40%	41%	2%
Bag 2	-53%	-60%	42%	0%
Bag 3	-24%	-30%	44%	-4%
Pinto				
20° Fahrenheit				
Bag 1	-44%	-30%	4%	9%
Bag 2	3%	-20%	-30%	-1%
Bag 3	-1%	0%	-1%	-1%
40° Fahrenheit				
Bag 1	-17%	-47%	6%	7%
Bag 2	0%	-10%	2%	1%
Bag 3	8%	-20%	2%	1%
60° Fahrenheit				
Bag 1	13%	-30%	2%	5%
Bag 2	-1%	-10%	7%	1%
Bag 3	0%	-10%	4%	1%
Granada				
20° Fahrenheit				
Bag 1	-40%	-20%	-17%	7%
Bag 2	3%	-46%	-10%	1%
Bag 3	0%	-10%	-1%	1%
40° Fahrenheit				
Bag 1	-16%	-30%	1%	3%
Bag 2	-3%	-20%	-12%	-3%
Bag 3	-8%	-2%	18%	-4%
60° Fahrenheit				
Bag 1	-11%	-70%	-56%	3%
Bag 2	0%	20%	4%	0%
Bag 3	14%	9%	4%	-1%