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~~4,797,134~~

4,797,134 111989

4,804,389 2/1989

4,812,146 ~~2/1989~~

and Opportunities" by Joseph M. Colucci, Research Publication, General Motors Research Laboratories, GMR-6589, F&L-882, to be presented at DeWitt and Company-Petrochemical Review Seminar, Houston, TX, Mar. 30, 1989.

"The Refiner's Key to Future Gasoline Production" by William J. Piel, National Petroleum Refiners Association, AM-88-66, 1988 Annual NPRA Meeting, San Antonio, Texas, Mar. 20-22, 1988.

"Vehicle Evaporative and Exhaust Emissions as Influenced by Benzene Content of Gasoline" by Donald E. Seizinger, William F. Merrell

1991, pp.

8-10.

"Test Gasoline Matrix" a two-page document with handwritten date of Jul. 17, 1990.

"Effect of Gasoline Property on Exhaust Emissions and Driveability," Toyota Motor Corporation, dated Oct. 1990, 19 pages.

SAE 902094, "Effects of Gasoline Composition on Exhaust Emissions and Driveability," Hoshi et al., dated Oct. 22-25, 1990.

Analysis of Howell Midstates Unleaded Racing Fuel Jul. 1988.

CRC Report No. 445, "Influence of Leaded and Unleaded Fuels on Octane Requirement Increase in 1971 Model Cars," 20 Car Pilot Program at Southwest Research Institute, Mar. 1971, pp. 1 to 7, 17, 81-84, & 86.

CRC Report No. 451, "Influence of Leaded and Unleaded Fuels on Octane Requirement Increase in 1971 Model Cars, Phase 1:1970-1971 CRC Road Rating Program," May 1972, Revised Sep. 1972, pp. 6, 7, 19, 96 to 98, 102 & 103.

CRC Report No. 467, "Octane Number Requirement Survey 1973," May 1974, pp. 1-4, 6, 75, 76, 96, 97, & Table C-I.
CRC Report No. 476, "Octane Requirement Increase in 1973 Model Cars, Phase II: 1973 CRC Road Rating Program," Feb. 1975, pp. 1-4, 45, 46, 48, & 49.
CRC Report No. 479, "Octane Number Requirement Survey 1974," Aug. 1975, pp. 1-4, 6, 67, 68, 69a, 85, & 85a.
CRC Report No. 488, "1975 CRC Octane Number Requirement Survey," Aug. 1976.
CRC Report No. 493, "1976 CRC Octane Number Requirement Survey," Jul. 1977, pp. 1-4, 92, 93, 114, 115.

1975.

SAE Paper No. 750937, "Octane Number Increase of Military Vehicles Operating on Unleaded Gasoline," by J. D. Tosh et al., 1975.

SAE Paper No. 7708 11, "Road Octane Number Trends of Japanese Passenger Cars," by K. Date et al, 1977.

SAE Paper No. 780612, "The Influence of Fuel Characteristics on Vaporization in the S.I. Engine Cylinder During Cranking at Low Temperature," by Y. Nakajima et al., 1978.

SAE Paper No. 780653, "The Hot-Fuel Handling Performance of European and Japanese Cars," by B. D.

ability Program, Jan. 1990, p. 22 (Table III), and B-7.

SAE Paper No. 710136, "The Effect of Gasoline Volatility on Emissions and Driveability," by P. J. Clarke, 1971.

SAE Paper No. 710364, "Effects of Fuel Factors on Emissions," by S. S. Sorem,

File History of U.S. Patent 4,429,173, Hutson, Jr. et al., Production of High-Octane Unleaded Motor Fuel by Alkylation of Isobutane with Isoamylenes Obtained by Dehydrogenation of Isopentane, Jan. 31, 1984, File History includes copies of 15 patents cited during prosecution.

File History of U. S. Patent 4,525,174, Croudace, Method and Fuel Composition for Control of Octane Requirement Increase, Jun. 25, 1985.

- Croudace, M. C. and Jessup, P. J., "Studies of Octane Properties of Mixtures of Isomeric Hexanes," SAE Technical Paper Series, 88 1604, International Fuels and Lubricants Meeting and Exposition, Portland, Oregon, Oct. 10-13, 1988.
- Pendleton, P. O., "Automotive Gasoline Usage in Reciprocating Aircraft Engines," SAE Technical Paper Series, 871012, General Aviation Aircraft Meeting and Exposition, Wichita, Kansas, Apr. 28-30, 1987.
- "Carbon Monoxide Linked to Heart Failure in Elderly," The Orange County Register, Oct. 10, 1995, one page.
- "Southland Smog: Causes and Effects," The South Coast Air Quality Management District, two pages.
- "CARB Says Phase 2 RFG Reduces Cancer Risk by 30%-40%," *Octane Week*, Sep. 18, 1995, p. 8.
- Testimony, Dr. Robert Zweig, Meeting of California Air Resources Board, Nov. 21, 1991, Transcript pp. i, ii, 129-134 and 353.
- Morton Lippmann, "Health Effects of Ozone: A Critical Review," *The Journal of the Air & Waste Management Association*, vol. 39, No. 5, May 1989, pp. 672-695.
- "Health Effects of Ozone: Critical Review Discussion Papers," *The Journal of the Air & Waste Management Association*, vol. 39, No. 9, Sep. 1989, pp. 1185-1194.
- F. L. Potter, "Clean Air Act History Marked by Battle, Compromise," *Fuel Reformulation*, vol. 1, No. 1, 1991, pp. 22-25.
- J. E. Peeples, "A Brave New World for Fuel Reformulation," *Fuel Reformulation*, vol. 1, No. 1, Sep./Oct. 1991, pp. 27-31.
- "EPA Administrator Points to Reformulated Fuels for Clean Air," *Octane Week*, vol. V, No. 6, Jun. 18, 1990, pp. 1 and 8.
- "Clean Air Act Now Law; Refiners Busy Responding," *Octane Week*, vol. V, No. 27, Nov. 19, 1990, pp. 1, 4, and 6.
- "API: Industry 'Committed,' But Emissions Data Lacking," *Octane Week*, vol. V, No. 25, Nov. 5, 1990, pp. 1, 7, and 8.
- "Air Quality Designations and Classifications; Final Rule," Environmental Protection Agency, *Federal Register*

(National Institute for Petroleum and Energy Research) computer data regarding properties of summer gasolines from 1976-86

“Development of Ozone Reactivity Scales for Volatile Organic Compounds,” William P. L. Carter, Statewide Air Pollution Research Center, EPA Contract CR-814396-01-0, Apr., 1990, University of California, Riverside, CA 92521. CRC Project No. CM-79-71, “Analysis of 1971 Road Rating Data: Unleaded Gasolines in 1971 Cars, Phase II:1970–1971 CRC Road Rating Program,” Coordinating Research Council, Inc., Jun., 1973.

CRC Report No. 454, “Effect of Altitude Changes on Octane Number Requirement of Late Model Cars,” Oct., 1973.

CRC Report No. 455, “Evaluation of a High Temperature Driveability Test Procedure,” Jun. 1973, pp. 1-3, 8-10, 39, & 40.

CRC Report No. 477, “1973 CRC Fuel Rating Program Part I: Road Octane Performance in 1973 Model Cars”, Feb. 1975.

CRC Report No. 494, “1975 CRC Fuel Rating Program: Road Octane Performance in 1975 Model Cars”, Oct. 1977.

CRC Report No. 510, “1978 Fuel Rating Program: Road Octane Performance in 1978 Model Cars”, Aug. 1979, pp. 1-3, 17, & 18.

CRC Report No. 578, “Effect of Volatility and Oxygenates on Driveability at Intermediate Ambient Temperatures,” Mar. 1992.

“Initial Findings of the 1989 CRC Cold-Start and Warm-Up Driveability Program,” Yakima, Washington, CRC Project No. CM-118-89, Jun. 1990, with cover letter dated Jun. 13, 1990, by Beth Evans, Technical Project Coordinator to the Members of the CRC-Automotive Committee and the CRC-Volatility Group, Jun. 13, 1990.

SAE Paper No. 710138, “Passenger Car Driveability in Cool Weather,” by J. D. Benson et al., 1971.

SAE Paper No. 720700, “Mathematical Expressions Relating Evaporative Emissions from Motor Vehicles Without Evaporative Loss-Control Devices to Gasoline Volatility,” by W. F. Biller et al., 1972.

SAE Paper No. 720932, “The Effect of Gasoline Volatility on Exhaust Emissions,” by P. J. Clarke, 1972.

SAE Paper No. 720933, “Driveability Testing on a Chassis Dynamometer,” by R. J. Wahrenbrock et al., 1972.

SAE Paper No. 730474, “An Evaluation of the Performance and Emissions of a CRF Engine Equipped with a Precham-
Precham-European Passenger Cars,” by R. F. Becker et al., 1978.

SAE Paper No. 780949, “The Effects of Refinery Gasoline Components on Road Octane Quality,” by R. E. Burtner et al., International Fuels

& Lubricants Meeting, Royal York, Toronto, Nov. 13-16, 1978.

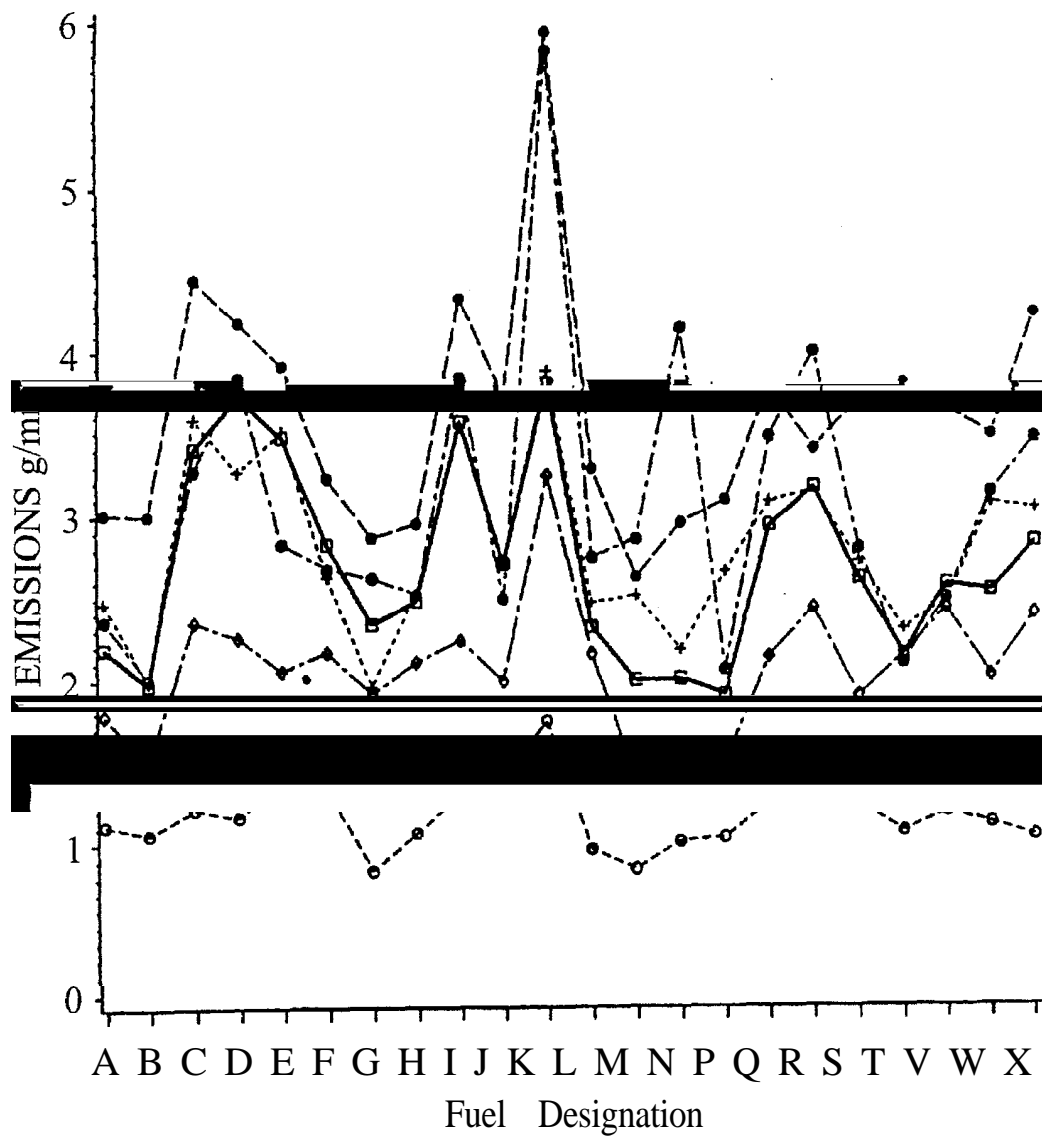
SAE Paper No. 801352, “Evaluation of MTBE Gasoline by Japanese Passenger Cars,” by Shintaro Miyawaki et al., 1980.

SAE Paper No. 841386. “Hot and Cold Fuel Volatility

5,593,567

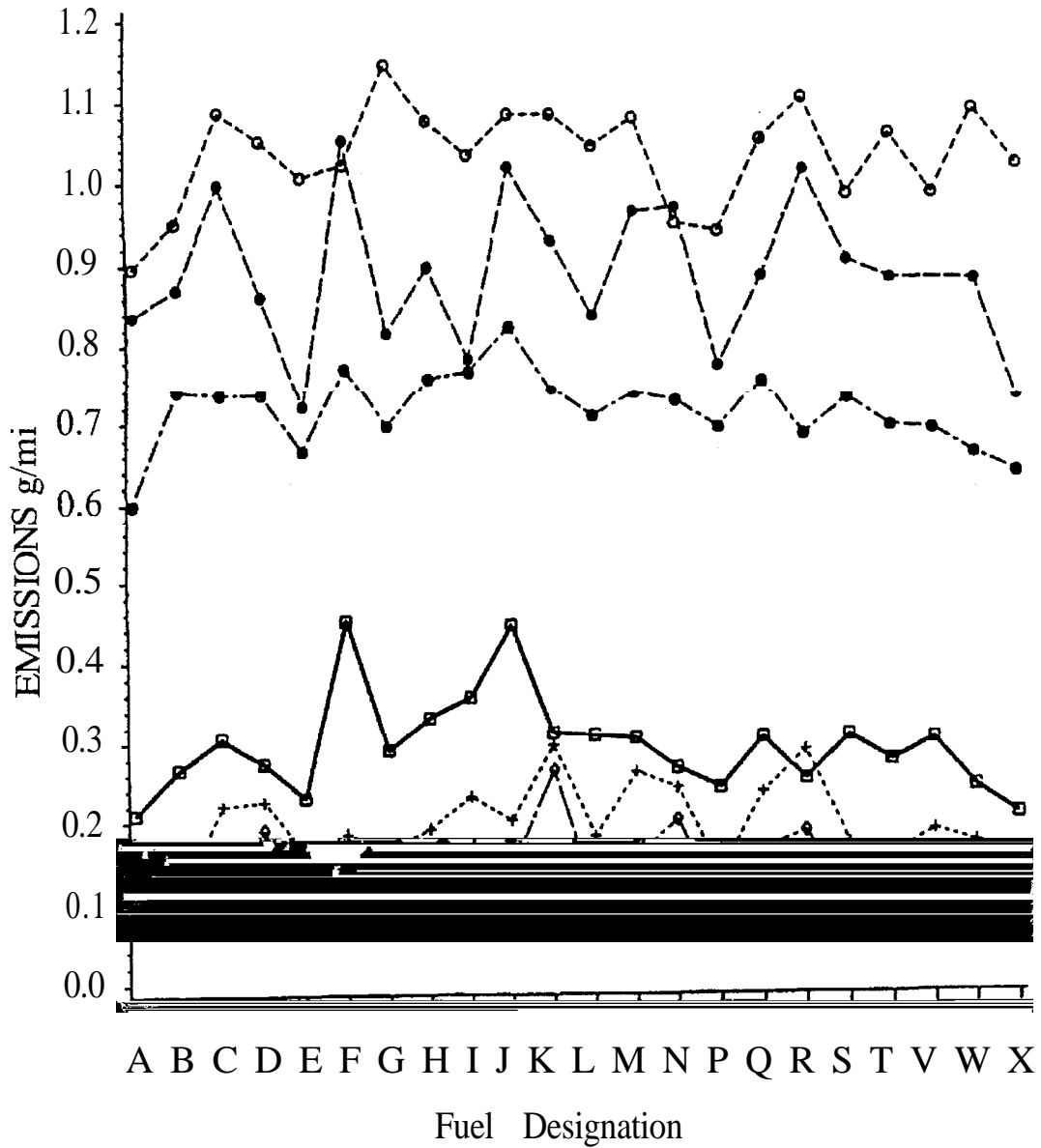
Page 8

Figure 1



+ + + 1989 Calais q q • I 1988 Olds 98
 • • •
 ⊕ ⊕ ⊕ 1990 Sha 1990 ◇ ◇ ◇ 1989/1990 Taurus

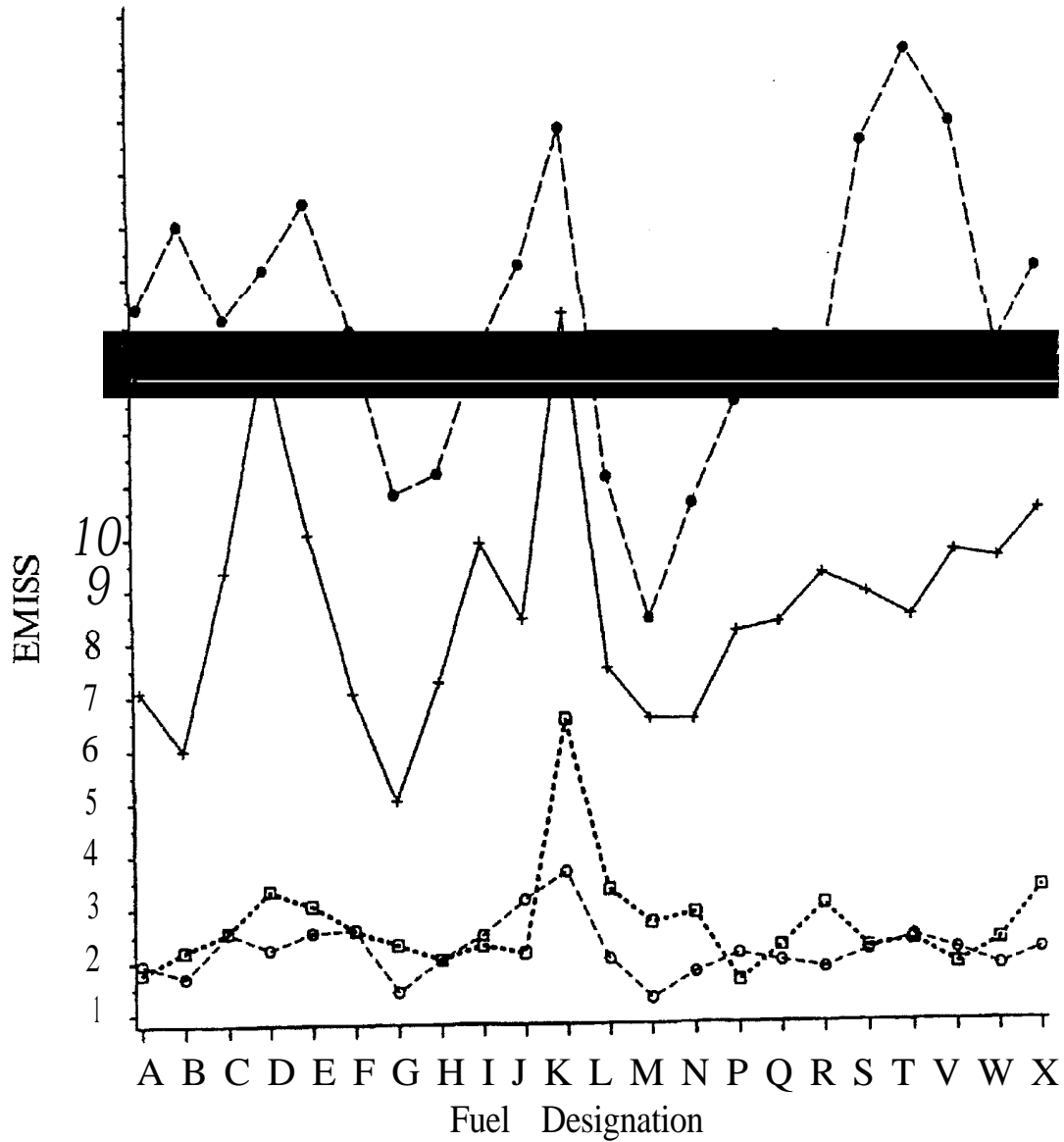
Figure 2



+ + + 1989 Calais □ □ □ 1
• • • 1990 Lincoln 1
⊕ ⊕ ⊕ 1990 Shadow 1

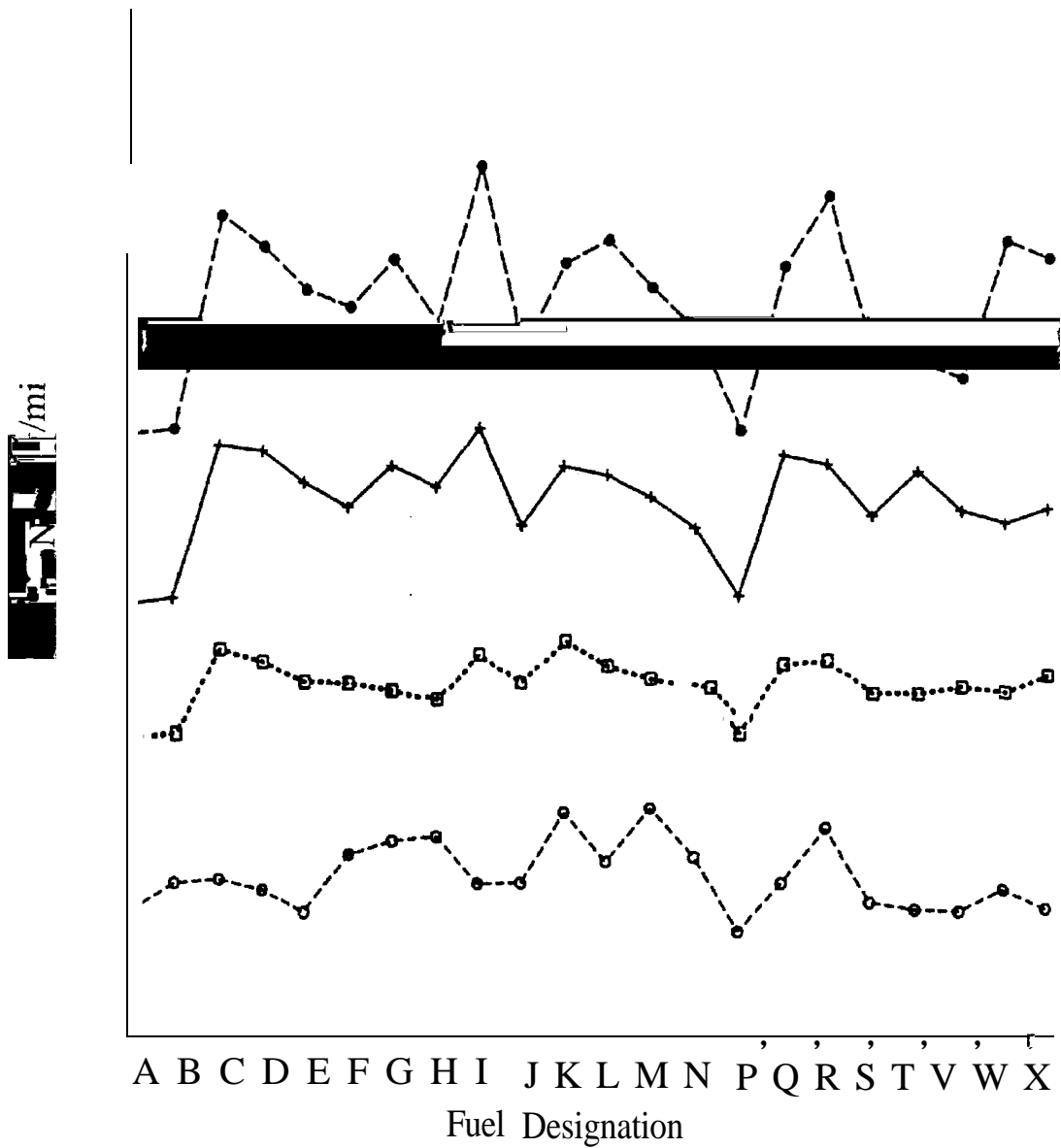


Figure 4



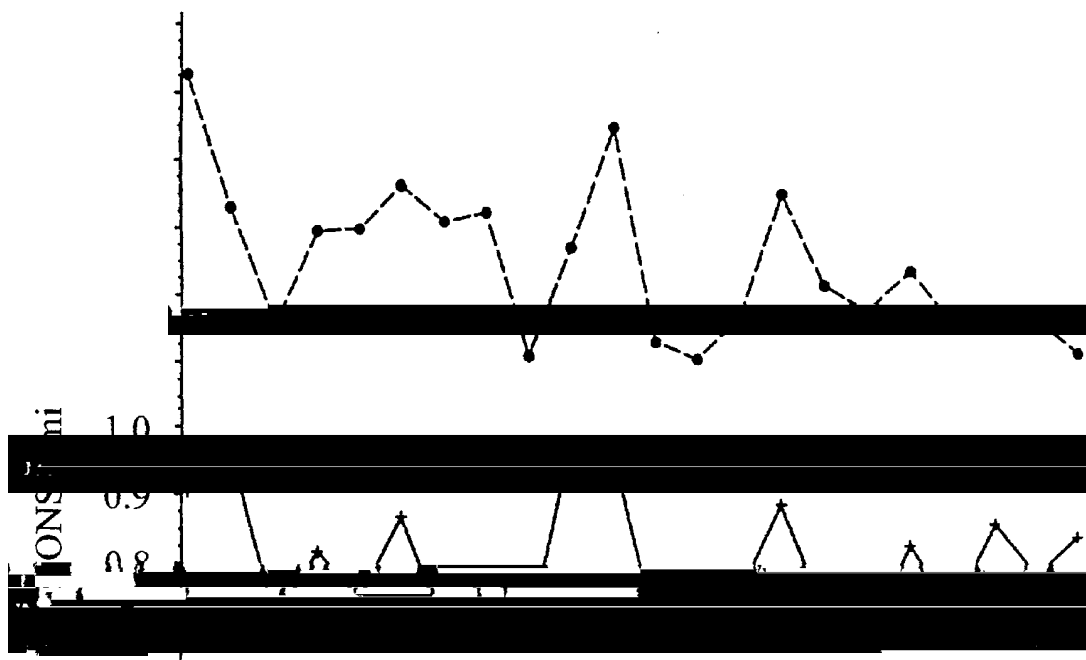
+ + + 1985 Tempo □ □ □ 1984 Caprice
o o o 1988 Accord . . . 1985 Suburban

Figure 5



+ + + 1985 Tempo □ □ □ 1984 Caprice
 • • • 1988 o o o

Figure 6



A B C D E F G H I J R L M N P Q R S T V W X
 Fuel Designation

+ + + 1985 Tempo □ q q 1984 Caprice
 • • • 1988 Accord . . . 1985 Suburban

Figure 7

Car	Fuel Variable									
	Arom	Olef	Para	MTBE	RON	MON	T10			RVP
1989 Calais								+++		
1988 Oldsmobile 98								+		
1985 Tempo								++		
1990 Lincoln								+		
1984 Caprice	-							+		
1988 Accord								+		
1989 Taurus								+		
1990 Shadow								+	+	
1985 Suburban			+					++	0	
1990 Camry								++		



Figure 8

Car	Level Variable										RVP	
	MON	T10	T50	T90								
1985 Tempo		(+)									+++ +	0.992
1990 Lincoln		+									+++ +++ +++ +	0.995
1984 Caprice		+	+								+++ +	0.994
1988 Accord		+	(-)								+++ +++ +++ +	
1989 Taurus		+	(+)								+++ ++	
1990 Shadow		+	(+)									

indicated minor effects

GASOLINE FUEL

This application is a continuation of application Ser. No. 081077,243, filed Jun. 14, 1993 now abandoned which is a division of application Ser. No. 07628,488, filed Dec. 13, 1990 now U.S. Pat. No. 5,288,393.

The present invention relates to fuels, particularly gasoline fuels, and combustion methods therefor, and methods for preparing gasoline fuels which, upon combustion, minimize the release of CO,

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the olefin content to below 5.0 vol. % (preferably to essentially zero), by decreasing the 10% D-86 Distillation Point to below 120° F. (49° C.), and/or by maintaining the Reid Vapor pressure below 7.0 psi (0.48 atm).

The presently preferred specifications proposed for commercial use for a gasoline produced in accordance with the invention are: (1) Olefin Content of 0%; (2) Reid Vapor Pressure of 7.5 psi (0.51 atm) maximum; and (3) 50% D-86 distillation point greater than 180° F. (82° C.) but no greater than 205° F. (96° C.). However, other fuels falling within the scope of the invention are also possible, for example, fuels meeting the following criteria:

- (1) a 50% D-86 distillation point no greater than 215°

5

At present, most gasolines suitable for combustion in automotive spark-ignition engines conform to the requirements of ASTM D4814-89 specifications, which specifications are herein incorporated by reference in their entirety.

Tr 0.026 Tc 5.56 r fp r56 -0.1621 Tc 0 Tw (therefor) Tj 0

6

-continued

in °F)
+0.0159 × (RVP in psi)

Equation 6

Tr 33.7504 0 TD 0.0485 Tc 4.4394 Tw (set forth in t

emissios

-K₃ × (Vol% Paraffins)

some decrease in the

NOx

content,

x (D-86 Dist. 50% Point in °F.)

7

if all other properties are held essentially constant, that reducing the Reid Vapor Pressure and the 50% D-86 distillation point will decrease the emissions of CO, NOx, and hydrocarbons. Likewise, decreases in these three pollutants can be attained by decreasing the 50% D-86 Distillation Point and decreasing the olefin content.

The above equations also lead to the following conclusions (again as to the 1988 Oldsmobile Regency and similar automobiles):

All other properties of a gasoline fuel being substantially the same,

1. As the 50% D-86 Distillation Point is progressively decreased, progressively greater reductions in CO and hydrocarbons emissions will result;

2. As the olefin content is progressively decreased, progressively greater reductions in NOx and hydrocarbons emissions will result;

3. As the paraffin content is progressively increased, progressively greater reductions in CO and NOx emissions will result;

4. As the Reid Vapor pressure is progressively decreased, progressively greater reductions in NOx emissions will result;

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to follow, the most important of the foregoing factors are Reid Vapor Pressure (for reducing NOx) and the 50% D-86 Distillation Point (for reducing CO and hydrocarbon emissions). Of secondary importance in reducing NOx are the olefin content and the 10% D-86 Distillation Point, with the former being of greater influence than the latter. The following Examples serve to further illustrate the inventive concept and are not intended to be construed as limitations on the invention, which is defined by the claims.

EXAMPLE 1

A total of 22 different unleaded gasoline fuels was tested in a 1988 Oldsmobile Regency 98 automobile equipped with a 3800 cc V-6 engine. This automobile was selected because it represented a high sales volume product with close to the current state-of-the-art emission technology. The emission system was closed loop control on the air to fuel ratio with a three way catalyst system and adaptive learning capability. The automobile had been previously driven for 38,000 miles to stabilize the Octane Requirement Increase.

The properties of each of the 22 fuels are shown in the

Pressure

were run, in random order, and all more than once. However, every fifth run was conducted with fuel G3297-PJ as a control to evaluate systematic error. Each fuel was tested in accordance

will be noted that the 1.5 test fuels were purposely blended to provide widely different values for the ten properties shown in Table 2. The emissions data derived from combusting the 15 different test fuels were then analyzed by computer program using the SAS system commercially available from SAS Institute Inc. In this program, the results of the runs with the 15 different fuels were regressed against each of the 10 variables shown in Table 2, as well as against all possible combinations thereof, searching for an equation for each of the three pollutants of interest (NO_x, CO, and HC).

of pollutants (in grams per mile) emitted as a function of the properties of the fuel combusted in the 1988 Regency vehicle.

After developing the foregoing equation, the other fuels shown in Table 2 were tested, most in multiple runs, and again with the G3297-PJ fuel being used in every fifth run. These fuels were tested for the purpose of checking the accuracy of the foregoing equations in forecasting emissions for new fuel, i.e., they were used as "check fuels."

2		0.196	0.100	1.593	0.203	0.131
3		0.186	0.094	1.638	0.201	0.127
4		0.264	0.145	2.226	0.271	0.179
5		0.252	0.193	2.458	0.235	0.194
6		N.D.	0.157	1.938	0.218	0.146
7		0.280	0.143	1.664	0.293	0.133
8	AR3951-8	2.335	0.232	2.238	0.233	0.147
9	AR3951-9	1.374	0.257	1.687	0.278	0.135
10	AR3951-10	2.068	0.286	2.182	0.281	0.177
11	AR3951-11	1.357	0.307	1.611	0.318	0.162
12	AR3951-12	3.752	0.273	3.089	0.269	0.264
13	AR3951-13	1.738	0.278	1.867	0.233	0.134
14	AR3951-14	2.275	0.311	1.678	0.295	0.133
15	AR3951-15	1.959	0.271	1.731	0.259	0.148
16	ULRG	1.654	0.190	1.628	0.183	0.133
17	AR3951-14	1.901	0.200	2.096	0.208	0.127
18	G3297-PJ	1.708	0.255	1.737	0.259	0.148
19	G3297-PJ	2.261	0.273	2.059	0.262	0.160
20	G3297-PJ	1.784	0.254	2.059	0.262	0.160
21	G3297-PJ	1.975	0.288	2.059	0.262	0.160
22	AR3951-1	2.265	0.263	2.059	0.262	0.160
23	AR3951-1	1.269	0.200	1.593	0.203	0.131
24	AR3951-1	1.535	0.200	1.593	0.203	0.131

	FTP CO Emissions	FTP NO _x Emissions	FTP HC Emissions	Calculated CO Emissions	Calculated NO _x Emissions	Calculated HC Emissions	
24	AR3951-2	1.253	0.163	0.133	1.638	0.201	0.127
25	AR3951-3	1.692	0.244	0.148	2.226	0.271	0.179
26	AR3951-4	2.835	0.274	0.235	2.458	0.235	0.194
27	AR3951-5	1.764	0.250	0.159	1.938	0.218	0.146
28	AR3951-6	1.338	0.268	0.115	1.664	0.293	0.133
29	AR3951-7	2.059	0.223	0.146	2.238	0.233	0.147
30	AR3951-8	1.633	0.271	0.140	1.687	0.278	0.135
31	AR3951-9	1.952	0.281	0.157	2.182	0.281	0.177
32	AR3951-11	3.443	0.237			0.269	0.264
			0.266			0.233	0.134
			0.320			0.295	0.133
			0.284			0.259	0.148
			0.263				
			0.240				
			0.278				
			0.286				
			0.252				

53 ULRG	2222	1.963	0.246	0.157	2.417	0.345	0.189
		1.769	0.211	0.139	2.096	0.208	0.127

The multiple test emissions data for each of the check fuels and the control fuel were then averaged, set against the calculated values, the deviation from the calculated value then determined, and compared against the standard deviation, which in turn was calculated from only the data pertaining to the control fuel G3297-PJ. These data are set forth in the following Table 4:

TABLE 4

Emis.	Fuel	Actual g/mi	Calculated g/mi	Deviation	Standard Deviation
CO	ULRG	1.835	2.096	0.261	0.205
CO	G3297-PJ	2.127	2.059	0.067	0.205
CO	Arco	1.584	1.810	0.226	0.205
CO	EC1				
CO	A/O	1.593	1.579	0.014	0.205
CO	1111				
CO	A/O	1.981	2.417	0.436	0.205
CO	2222				
CO	SU2000E	1.738	2.104	0.366	0.205
CO	A/O	2.319	1.798	0.521	0.205
CO	AVE				
NOx	ULRG	0.209	0.207	0.002	0.0162
NOx	G3297-PJ	0.266	0.261	0.005	0.0162
NOx	Arco	0.263	0.256	0.007	0.0162
NOx	EC1				
NOx	A/O	0.295	0.222	0.073	0.0162
NOx	1111				
NOx	A/O	0.366			
NOx	2222				
NOx	SU2000E			0.053	
NOx	A/O				

A
B
C
D
E
F
G
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K

TABLE 5-continued

Blend Designation	GASOLINE PROPERTIES									
	Aromatics Vol. % by FIA	Olefins Vol. % by FIA	Paraffins Vol. % by FIA	MTBE Vol. % by IR	Octane Number	Octane Number	D86 Dist. 10% point (°F.)	D86 Dist. 50% point (°F.)	D86 Dist. 90% point	Reid Vapor Pressure
<hr/>										
<hr/>										

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15

When the data of Examples 2 and 3 are analyzed as shown

the invention are best taken advantage of when a large number of automobiles operating with spark induced internal combustion engines requiring a gasoline fuel are powered with the fuel of the invention. In fact, the benefits of the invention increase directly with the number of automobiles which employ the fuel. Therefore, in one embodiment of the invention, on a given day, and preferably on a daily basis over a period of at least one month, at least 1,000 and more preferably at least 10,000 automobiles are provided with a fuel composition of the invention-and even more preferably it is desired that the 1000+ or 10,000+ automobiles be provided with such fuel in a highly congested area, e.g., within the limits of a city or county encompassing a population of 500,000 or more people. Most advantageously, the amount of fuel dispensed into automobile fuel tanks within the city or county should be sufficient to effect a noticeable decrease in the amount of one or more of NO_x, CO, and hydrocarbons in the air. At the present time, it is believed that, if as little as 10% of the gasoline fuel supplied to automobiles within a given city or county were a composition of the invention, a decrease in the pollution caused by one or more of these components would be obtained (assuming no significant increase in the automobile traffic within said city or county). Higher percentages, e.g., at least 25%,

were a fuel composition of the invention. In commercial practice, it is contemplated that usual procedures will result in at least 25%, often at least 50%, and sometimes at least 75% of the daily refinery output being a fuel composition of the invention. Such output would then be delivered to gasoline service stations for introduction into automobiles, with, again, the greatest significant advantage being if all the gasoline service stations so supplied-or some significant por À ñ±CE à 8àuc2l• icant adva

located in a congested area of high population density, e.g., a city or county as described above.

Accordingly, in view of the foregoing, it will be seen that there are many ways of employing the inventive concept on a large volume basis. Obviously, the best results will be obtained when the fuel composition of the invention is so blended in a refinery or the like as to reduce the emissions of hydrocarbons, CO, and ~~NO_x~~

fore shows the effect of different variables, the refiner is not constrained to producing one particular fuel,4 5 icularherein r -37vefi* T

ether as an additive for reducing CO emissions. The present invention, however, requires no methyl tertiary butyl ether to be present. Thus, while the invention in its broadest embodiment encompasses fuels with additives that may aid in reducing such emissions, the advantages of the invention can be obtained without the necessity, for example, of a refinery having to deliberately change its practices to provide for the continuous blending of an emission-reducing additive into the fuel.

The invention, of course, as described hereinbefore, offers significant reductions in NO_x, CO, and hydrocarbon emissions. Present indications are that, on a side-by-side basis, preferred fuels of the present invention offer at least a 10%, usually at least a

volume percent and a paraffin content greater than 68 volume percent.

14. A method as defined in claim 13 wherein the unleaded gasoline has a Reid Vapor Pressure less than 7.0 psi.

15. A method as defined in claim 14 wherein the unleaded gasoline has a 10% D-86 distillation point less than 140° F.

16. A method as defined in claim 1, 2, 3, 4, or 5 wherein the unleaded gasoline has an olefin content less than 6 volume percent, a paraffin content greater than 70 volume percent and a 10% D-86 distillation point less than 140° F.

17. A method as defined in claim 16 wherein the unleaded gasoline has a Reid Vapor Pressure less than 7.0 psi.

18. A method as defined in claim 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, or 11 wherein the unleaded gasoline has an octane value of at least 92.

19. A method as defined in claim 1, 2, 3, 4, 5, or 11 wherein the unleaded gasoline contains one or more oxygenates.

gasoline contains an octane value of at least 92.

25. A method as defined in claim 6, 8, 9, or 11 wherein the unleaded gasoline contains one or more oxygenates in a total oxygen concentration no greater than the equivalent provided by about 14.9 volume percent methyl tertiary butyl ether.

26. A method as defined in claim 25 wherein the unleaded gasoline has an octane value of at least 92.

27. A method as defined in claim 25 wherein the unleaded gasoline has a 90% D-86 distillation point less than 300° F. and an olefin content less than 6 volume percent.

28. A method as defined in claim 27 wherein the unleaded gasoline has an octane value of at least 92.

29. A method as defined in claim 27 wherein the unleaded gasoline has a Reid Vapor pressure less than 7.0 psi.

30. A method as defined in claim 29 wherein the unleaded gasoline has a 10% D-86 distillation point less than 140° F.

31. A method as defined in claim 30 wherein the unleaded gasoline has an octane value of at least 92.

32. A method as defined in claim 31 wherein the unleaded gasoline has a paraffin content greater than 75 volume percent.

33. A method as defined in claim 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, or 11 wherein the unleaded gasoline has a Reid Vapor Pressure less than 7.0 psi.

34. A method as defined in claim 6, 7, 8, 9,

paraffin content greater than 75 volume percent, a 10% D-86 distillation point less than 140° F., and a Reid Vapor Pressure less than 7.0 psi.

39. A method as defined in claim 38 wherein the unleaded gasoline has an octane value of at least 92.

40. A method as defined in claim 34 wherein the unleaded gasoline has an octane value of at least 92.

* * * * *