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MOTOR FUEL

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3 Claims. (Cl. 44—63)

The present invention relates to a motor fuel composition adapted to provide distinct improved motor operation under cool moist operating conditions. The motor fuel composition of the present invention comprises a hydrocarbon mixture boiling in the gasoline boiling range which contains as an ingredient a very small but critical percentage of morpholine. In addition, the fuel compositions of the present invention may contain solvent oil and other additives such as lead alkyl anti-detonants, dyes, gum inhibitors, oxidation inhibitors, and the like. This application is a division of application Serial Number 170,944, filed June 28, 1950, now U. S. Patent No. 2,706,677.

The novel fuel compositions of this invention are primarily intended to overcome certain operational difficulties in connection with automotive, marine, stationary, and airplane engines. The difficulties referred to result in frequent stalling of the engine under idling conditions. This stalling may be encountered whenever the weather conditions in which the engine is used are such as to provide a relatively high humidity, and a temperature below about 60° F.

While this problem has actually been existent for many years, attention has recently been focused on it due to numerous complaints of car owners particularly in the northern portion of the United States. These owners report that during cool, wet weather their cars give poor idling performance characterized by a high number of engine stalls. The difficulty is encountered in all types of cars employing all types of carburetors and utilizing all commercial brands of gasoline.

In order to indicate the magnitude of this difficulty, reference may be made to a survey conducted in the New Jersey area based on the experiences of 300 car owners driving twenty different car models, during the fall and winter period. These cars employed the winter grade of regular and premium commercial gasolines. Table I gives a summary of the results obtained, showing the substantial number of stalls encountered in the operation of the cars under the indicated conditions.

TABLE I

	Number of Complaints of Two Stalls or More (Per 100 Cars)				
Temperature, ° F.	32	35	37	52	56.
Relative Humidity, Percent.	52	70	96	100	96.
Weather	Clear	Overcast.	Light Rain.	Heavy Rain.	Rain.
Winter Regular Users	5	15	20	21	7.
Winter Premium Users	6	38	40	42	2.

The bare statistics of Table I coupled with the common experience of all automotive users serves to indicate the magnitude of the problem of engine stalling encountered under cool, humid temperature conditions. However, it is significant to note that this problem has of late become of increased importance due to certain specific factors. First, most post-war cars are now provided without a manual throttle so that car owners are no longer able to increase the idle speed during the warm-up period to prevent stalling. Second, the idle speed of cars with automatic transmissions is rather critical during a warm-up and the fastest idle which may be used must not be too fast, increasing the criticality of stalling conditions. Third, stalling of a car with automatic transmission frequently does not occur until the driver is ready to accelerate, so that just at this most inconvenient time it is necessary to shift the car to neutral, restart the engine, and shift back into gear—magnifying the inconvenience of frequent stalls. A fourth factor affecting the magnitude of stalling difficulties relates to the volatility of the fuels now provided for automotive use. The volatility of commercial fuels over a period of years has been increased sufficiently to increase stalling difficulties as will be brought out herein.

On investigating this problem, it has been determined that the cause of repeated engine stalling in cool, humid weather is the formation of ice in the carburetor of the engine. On a cool, moist day, gasoline evaporating in the carburetor exerts sufficient refrigerating effect to condense and freeze moisture present in the air entering the carburetor. Normal fuel vaporization within the carburetor can cause a temperature reduction of the metal parts of the carburetor up to 50° F. below that of the entering air. Consequently, prior to the time of complete engine and radiator warm-up, this drop in temperature may cause formation of ice in the carburetor. Ice formation probably occurs most readily under conditions of light load operation. The result is that after a period of light load operation, when the throttle is closed to the idle position, ice already formed on the throttle plate and adjacent walls, plus ice which then forms, restricts the narrow air openings to cause engine stalling.

To more clearly define the problem of engine stalling due to carburetor icing, data were tabulated based on customer reaction surveys, carefully controlled road tests, and laboratory cold room engine performance tests. These tests show that carburetor icing depends primarily upon atmospheric temperature and humidity conditions. The tests show that stalling difficulties due to ice formation in the carburetor are not encountered below about 30° F., nor above about 60° F. when employing fuels having conventional volatility characteristics. Similarly, these tests demonstate that stalling is only encountered when the humidity is in excess of about 65%.

Another factor having a bearing on the formation of ice in the carburetor, is the volatility of the fuel employed. To determine this effect laboratory cold room tests were conducted to evaluate the stalling characteristics during warm-up of a number of fuels varying in volatility. In these tests a 1947 Chrysler car was installed in a room equipped with temperature and humidity controls. While the temperature and humidity were maintained at particular levels, the stalling characteristics of the car were determined during the warm-up period. The procedure employed was to start the car and to then immediately raise the engine speed to 1500 R. P. M. This speed was maintained for 30 seconds, after which the engine was allowed to idle for 15 seconds. If the engine stalled before 15 seconds had expired, the car was again started and raised to a speed of 1500 R. P. M. for 30 seconds, while if stalling did not occur, the speed was immediately increased to 1500 R. P. M. after the 15 second idling time. The alternate cycles of 30 seconds at 1500 R. P. M. followed by 15 seconds at idling were repeated until the engine was completely warmed up. The number of stalls encountered during this procedure, and up to the time of complete engine warm-up were then recorded. Tests were conducted at 40° F. and a relative humidity of 100% employing three

fuels of varying volatilities. The most volatile fuel was a premium grade of commercial gasoline having a 10% ASTM distillation point of 110° F., a 50% point of 190° F., and a 90% point of 294° F. It was found that this fuel resulted in about 14 or 15 stalls during warm-up. A medium volatility fuel was also tested, consisting of a regular grade commercial gasoline having ASTM distillation characteristics such that 10% distilled at 121° F., 50% distilled at 220° F., and 90% distilled at 342° F. The number of stalls encountered with this fuel were 11. Finally a low volatility gasoline was subjected to the same test procedure. The gasoline had ASTM distillation 10, 50, and 90% points, at 126° F., 270° F. and 387° F. It was found that 5 stalls were encountered with this fuel.

As indicated by these data, carburetor icing is related to the volatility of the fuel employed. Thus, the least volatile fuel tested above, having a 50% distillation point of 270°, only resulted in 5 stalls, while the highest volatility fuel, having a 50% distillation point of 190° F., resulted in 15 stalls. Extrapolating these data as to the volatility of the fuel, it appears that a fuel having a volatility such that the ASTM 50% distillation point is 310° F., or higher would not be subject to stalling difficulties during warm-up. It must be appreciated, however, that a fuel having ASTM distillation characteristics of this nature would not be desirable as regards warm-up time, cold engine acceleration, economy and crankcase dilution. However, in appreciating the scope of the present invention, it is important to note that this invention is only of application to gasoline fuels having an ASTM 50% distillation point below about 310° F. At the same time, as will be brought out, it is possible to correlate the quantity of additives required to overcome icing problems with the volatility of the fuel to be improved. In other words, smaller proportions of additives may be employed with fuels of relatively low volatility, while higher proportions of additives may be required with fuels of higher volatility. Also, it should be appreciated that even when complete stalling does not occur there may be a marked loss of power output due to icing. This is particularly serious in the case of aviation engines. For example, 30% of the light plane mishaps occurring in the United States in 1947 and 1948 were attributed to the formation of ice in the carburetor or intake manifold, which reduced power output by restricting the flow of combustible mixture to the cylinders.

It has now been discovered that distinct operating advantages are secured with respect to stalling, providing a relatively small critical amount of morpholine is utilized.

The amount of morpholine employed should be appreciably less than about 1% by volume based upon the volume of gasoline present. The preferred concentration is in the range from about .2 to .5%, especially in the range of from about .3 to .5% by volume.

The present invention may be more fully understood by the following example illustrating the same:

EXAMPLE

A Continental light aircraft engine was operated on an aviation grade fuel, and on a blend of the fuel and 0.5 volume percent of various compounds. The base fuel had the following distillation characteristics:

Engler distillation

Initial	°F.	100
50%	°F.	200
Final	°F.	325
Reid vapor pressure	p. s. i.	7

The intake air had a temperature of 50° F. and a relative humidity of 97±3%. The temperature of the air surrounding the carburetor was 50° F. The throttle was fixed to give an initial engine speed of 1750 R. P. M. and the loss in speed after operation for 3 minutes and for 10 minutes was determined. The results secured are as follows:

CARBURETOR ICING IN CONTINENTAL ENGINE
ANTI-ICING ADDITIVE EFFECTIVENESS

[Initial engine speed (fixed throttle), 1750 R. P. M.: Intake air, 50° F., 97±3% relative humidity; air surrounding carburetor, 50° F.]

[Amount of carburetor ice accumulated is reflected in magnitude of speed loss.]

Additive	Concentration in Fuel, Vol. Percent	Loss in Speed Due to Icing After 3 Minutes, R. P. M.
None		425
Dimethyl Formamide	.25	0
Morpholine	.25	0
Cocoanut Amine	0.10	95

From the above it is apparent that morpholine is very effective.

Having described the invention, it is claimed:

1. An anti-stalling gasoline comprising essentially a mixture of hydrocarbons boiling in the gasoline boiling range containing from about .2 to .5% by volume of morpholine.

2. An anti-stalling gasoline as defined by claim 1 wherein the concentration of the morpholine is in the range from .3 to .5%.

3. An anti-stalling gasoline as defined by claim 2 wherein said gasoline comprises an aviation motor fuel.

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