METHOD AND APPARATUS FOR ADDING TETRAMETHYL LEAD TO HYDROCARBON FUELS

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5 Claims

ABSTRACT OF THE DISCLOSURE

Apparatus is provided which allows for on-site blending of tetramethyl lead and a hydrocarbon fuel. Included are a tank and flow line for containing the hydrocarbon fuel, and a special tank and flow line for the tetramethyl lead. The flow lines of the two tanks are joined in a mixing chamber for mixing in desired proportions the lead and fuel. The special lead tank includes two separate openings, one of which is used for filling the tank and the other of which is used as an outlet. The outlet opening includes a removable plug for ordinary use, and a special connection for use when lead is being withdrawn. The special connection includes a lance member which is adapted to pierce a flexible seal in the tank interior, and an apertured portion which mates with the outlet opening, thus assuring that leakage does not occur.

This invention relates to method and apparatus for the blending and handling of tetramethyl lead and low-molecular-weight-hydrocarbons useful as fuel, such as liquefied petroleum gases including propane, butane, and propylene.

In the past, the low-molecular-weight-hydrocarbons such as propane, butane, propylene—liquefied petroleum gases [and propane will henceforth be used in this specification as an example] have been used for engine fuel purposes. It has been known that tetramethyl lead, added to propane, would greatly increase the octane number of the propane. As a matter of fact, the addition of only 0.5 gram of tetramethyl lead (TML) increases the Motor octane number of propane from 93.5 to 104.0 and 4.23 grams of tetramethyl lead (TML) per gallon of propane will increase the Motor octane number of the propane from 95.3 to 117.5, which latter figure approaches the Motor octane value of natural gas. This difference, of course, is a very important one and is the difference for a great many uses between commercial impracticality and commercial practicality.

While of course there exist satisfactory motor fuels, there are important reasons why it could be most desirable to have high octane propane available for use.

For example, there has been brought into the public attention recently the serious air pollution problem which is affecting many of our major cities and urbanized areas. Major contributors to the air pollution or smog problem are the exhaust fumes from the ever-growing number of motor vehicles which burn gasoline, the particles of the exhaust fumes being photo-chemically reactive to sunlight. Since propane, for example, is about 98.99% burned during combustion, compared to only about 75-85% for gasoline, it is seen that the smog problem could be considerably reduced if propane—instead of gasoline—were commonly used in motor vehicles, especially city transit buses.

Further, propane exhausts are quite sweet-smelling. Diesel exhausts, although they do not contribute to smog as heavily as gasoline exhausts, nevertheless are foul smelling from aldehydes, and are undesirable from the smoke standpoint.

Thus, it is seen that it would be considerably in the public interest if more vehicles could conveniently use as a fuel propane rather than gasoline or diesel fuel. Further, it is noted that propane is economically competitive or lower in cost than gasoline and diesel fuel.

The problem has been in the mixing of the tetramethyl lead with the propane. The "lead" (as tetramethyl lead will sometimes hereinafter be called) is, of course, extremely toxic, in concentrated form; hence, the mixing is very dangerous, unless established and acceptable safety precautions are followed. Therefore, with present methods and apparatus, it can be done only by licensed operators under very strict safety conditions.

As a consequence, it has been thought necessary to mix tetramethyl lead with propane, if at all, at the gasoline plant or refinery. But the cost of providing separate and parallel facilities (for leaded and unleaded propane), such as high pressure lines, tanks, controls and dispensing equipment all the way from gasoline plant or refinery to storage sufficiently close to the consumer, is readily seen to be prohibitive. The present invention eliminates the necessity for such duplicate facilities except, of course, at the point of ultimate use where, if the user also requires unleaded propane (e.g., for heating fuel), duplicate small tanks would be necessary.

And since it has never proved practical to transport propane more than a relatively short distance from storage to the point of intended use, the mixing of lead and propane has never been practiced to a significant extent despite the fact that it has been well known that lead would significantly increase the octane number of the propane.

The present invention solves these long existing problems by providing method and apparatus for the mixing of lead and propane whereby the fuel may be readily and safely mixed at or near the point of intended use of the fuel.

The invention is herein described in terms of a particularly advantageous embodiment which is illustrated in the accompanying drawings, which form a part of this specification and wherein:

FIGURE 1 is a schematic flow diagram illustrating one embodiment of a system useful in this invention;

FIGURE 2 is a partial cross-sectional view of the tank 12 of the system illustrated in FIGURE 1, after the tank has been loaded and before it is hooked into the FIGURE 1 system.

FIGURE 3 is a view similar to FIGURE 2, wherein the tank is in position for operating in the FIGURE 1 system.

FIGURE 4 is an enlarged cross-sectional view illustrating a portion of the FIGURE 3 apparatus in detail.

Referring now more particularly to FIGURE 1, there is illustrated one embodiment of a system wherein tetramethyl lead may be introduced in proportionate amounts into a stream of liquid propane, and readily and thoroughly mixed therewith. The system seen in FIGURE 1, in fact, is operable with or without the addition of tetramethyl lead.

If unleaded propane is desired, the propane from tank 1 (which may for example be mounted on a terminal loading rack, on a bulk plant platform or a transport truck) is drawn into the line 5 by means of a pump 3, through suitable flow control means such as the valve 2. The propane then flows through the gas line 11 into the line 8 to the customer's tank (not shown).

Joining the line from tank 1 between the meter 11 and the line 8 to the customer tank, is a line 40 which emanates from the tank 12. The specially constructed tank 12 is designed to contain the tetramethyl lead which is to be added to the propane. When actuated by the control
line 9 from the meter 11, a proportioning pump 10 withdraws a predetermined amount of lead from the tank 12 in proportion to the fuel from tank 1, and feeds it through the line 40 to mix with the propane in the line 8 before feeding into the line to the customer's tank.

The outlet end of a specially-constructed tank 12 and the connection thereto are illustrated in FIGURES 2 and 3. It is seen that the outlet end of the tank 12 is provided with a generally cylindrically-shaped threaded recess 14, this recess extending from the exterior of the tank to a point spaced from the tank interior. Communication between the exterior of the tank interior is provided by the generally cylindrical bore 15, which is beveled (as shown at 16) at the end where it joins the recess 14.

Disposed on the interior of tank 12 over the point where bore 15 meets the interior surface of the tank, is a flexible seal 18 which may be constructed of synthetic rubber or other suitable material or of any suitable design. This seal is of a size and configuration such that it will fit into the tank to form a smooth surface around its perimeter with the interior tank surface, and such that it will adequately cover the opening in the tank occasioned by the bore 15 and will effectively seal that opening against the flow of fluid from the tank. This seal is constructed so that a lance or probe entering the bore 15 toward the tank interior will break the seal, but fluid flow will not be allowed around the exterior of the lance or probe—rather, the seal is effective around the lance or probe to allow fluid only through the interior thereof. And of course the seal is effective to prevent any fluid flow upon removal of the lance or probe.

Also disposed in the tank 12, which may be of any suitable shape (such as cylindrical or spherical), of any suitable construction (such as stainless steel for withstanding a pressure of, e.g., 250 p.s.i.) and of any suitable size (such as five or ten gallons), is another threaded opening 35 extending throughout the thickness of the tank wall. Into this opening is adapted to fit a specially made solid plug 36, which may be screwed into the opening 35 to such an extent that it is recessed (as in FIGURE 3) and cannot be removed from the outside of the tank, at least not without the use of a special tool. The opening 35 is used to fill the tank 12 with tetramethyl lead.

Before the tank 12 is put into use in the system illustrated in FIGURE 1, the threaded recess 14 is fitted with a mating solid plug 19 (see FIGURE 2), which conveniently includes a hexagonal head which is of a configuration to facilitate insertion and removal of the plug 19. This plug is of course additional insurance against the escape of lead from the tank 12 during shipment.

When the tank is desired to be put into use in the system illustrated in FIGURE 1, the plug 19 is removed and the special connection 17 illustrated in FIGURES 3 and 4 is inserted into mating engagement in the section 13 of the tank 12. This special connection 17 is preferably made as an integral unit so that replacement of individual parts may not be made by unauthorized personnel. This, it will be recognized, is an added safety factor in the prevention of escape of the poisonous lead.

The special connection 17 comprises a generally tubular shaped lance 22 which is connected (as by welding) to a valve 23 at one end thereof, and terminates at the opposite end thereof at an inwardly tapered end 24, leaving an opening 33 for communication from the ambient surrounding the lance into the interior chamber formed by the tubular wall. Near the end 24 of the lance is conveniently located on the interior of the tubular wall of the lance an interiorly projecting rim 25, upon which rests one end of a coil spring 26, the other end of which the coil spring being disposed near the end 24 of the lance. Just inside the end 24 of the lance, a ball 27 is disposed at the end of coil spring 26. This ball is seen to function as a check valve against flow at all times the ball is disposed against the inwardly tapered end 24 of the lance, but to allow flow when the ball compresses the spring and is moved away from the end 24. This acts to insure complete immersion in the liquid in tank 12 and to avoid any air lock of the line 34 and the pump 10.

The lance 22 is rigidly connected, as by welding, to a threaded plug 28 which is similar in construction to the plug 19 except that it has, through the middle thereof, a bore of size convenient for receiving the lance 22. Again, the plug is conveniently provided with a hexagonal head 29 to facilitate fixation of the special connection assembly onto the tank.

Mounted around the lance 22 at the end of the plug 28 nearest the tank interior, is a washer 30 and, adjacent washer 31 on the side opposite the plug 28, an O-ring seal 32. The O-ring seal is adapted to fit into the recess provided by the beveled end 16 of the bore 15. This seal, of course, insures that lead will flow from the tank around the exterior of the lance 22, and is an additional safety factor.

As a still further safety factor, all threads may be constructed of odd sizes so that parts may not be interchanged and the correct parts must be in place.

Liquid from the tank 12 is communicated through the lance 22 and the valve 23 to the line 34 before entering the proportioning pump 10. The line 34 may be a flexible hose connection to facilitate handling.

Proportioning pump 10 is controlled by line 9 from the meter 11, and measures a selected and known volume of lead per gallon of propane flowing through the meter 11. For example, it may be desirable in many instances to add anywhere from 0.1 to 4 milliliters (4.23 grams) of tetramethyl lead per gallon of propane, to thus increase the Motor octane number desired from 95.3 to as much as 117.5.

From proportioning pump 10, the tetramethyl lead flows through line 40 and thence intermixed with propane from line 5, the mixture thence flowing into the line 8 to the customer's tank.

Suitable flow control means, such as the valves 41 and 43, may be included in the lines 5 and 40 as desired. Gauge 42 is conveniently attached to the line 40 to indicate delivery of lead.

An example of the operation of the system may be explained as follows:

The plug 36 of any empty tank 12, is removed, and tetramethyl lead is added by an authorized agent through the opening 35 until the tank is approximately 85–90% full. The plug 36 is then inserted into the position illustrated in FIGURE 3 so that it is recessed and cannot be removed from the exterior of the tank. Then a small amount, for example about 14 milliliters per 10 gallons of tetramethyl lead, of a gas such as LPG or an inert gas (for example, nitrogen gas) is added through a lance 22 (less check ball 27) to provide a drive pressure to the tank and prevent a vacuum-lock of line 34 and pump 10, when the tank 12 is emptied of TML.

During filling of the tank, air in the tank may be vented by use of the special connection 17. After the tank is filled and pressurized the special connection may then be removed and the solid plug 19 inserted into recess 14. The tank 12, loaded with tetramethyl lead under pressure, may then be transported to the point of ultimate use, such as pipeline or marine terminal, or a bulk plant for use in upgrading the LPG fuel.

At such point, for instance the terminal or bulk plant, the tank 1, meter 11, and associated equipment are customarily already in use. The plug 19 is removed, and the special connection 17 is substituted onto the outlet end of the tank. Then, onto the previously-mentioned system, the tank, special connection, proportioning pump 10, and line 40 (and associated valves, gauges, etc.) are added. The control line 9 (which may be for example any suitable electronic control well known to those skilled in the art) is attached to the meter 11 and regulated to supply through proportioning pump 10 a selected amount of tetramethyl lead per gallon of propane flowing through the meter, for example 0.1 to 4 milliliters per gallon.
Then, as propane is drawn by means of the pump 3 through the line 5 and through the meter 11, a proportionate amount of tetramethyl lead is drawn through the pump 10 and into the line 40. The propane in line 5 and the tetramethyl lead in line 49 are then mixed at the point 50 to form the leaded propane mixture which flows through the line 8 into a transport for delivery to the customer, or into the customer's tank. Propane and tetramethyl lead are readily miscible to form a homogeneous mixture, and further mixing occurs in the line 8 and the transport and/or customer's tank without the necessity of special mixing equipment. It is noted that the system described permits delivery of either straight propane or suitably leaded propane as desired.

It is significant that tetramethyl lead may be used to upgrade the octave rating of any LPG mixture. Whereas the discussion in this specification has been in terms of propane, it is emphasized that the method and apparatus here described are applicable also to LPG mixtures, propylene, butane, etc. Although the use of pure propane is described, it is generally more convenient and commercially practical for the customer to use "Propane HD-5," which contains a minimum of 90% but usually about 95% propane, with the balance primarily ethane, butane, and propylene. The invention, of course, works with equal facility with pure propane or any mixture of liquefied petroleum gases are used.

The following table illustrates the dramatic increase in Motor octave number occasioned by the addition of tetramethyl lead to some example hydrocarbon fuels:

<table>
<thead>
<tr>
<th>Hydrocarbon fuel</th>
<th>Motor octave number added</th>
<th>No lead</th>
<th>0.5 g./gal. lead</th>
<th>2.5 g./gal. lead</th>
</tr>
</thead>
<tbody>
<tr>
<td>Propane</td>
<td></td>
<td>95.4</td>
<td>104.0</td>
<td>117.5</td>
</tr>
<tr>
<td>Propane 20% butane</td>
<td></td>
<td>92.9</td>
<td>102.7</td>
<td>117.0</td>
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<tr>
<td>Butane</td>
<td></td>
<td>90.0</td>
<td>100.0</td>
<td>113.0</td>
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</table>

1 0.50 g./gal. lead added.

It is seen from the foregoing table that propane containing butane or propylene has a lower octave rating than pure propane. For this reason, it is evident that the presence of such impurities in propane may be compensated by the addition of tetramethyl lead.

It is seen that the invention provides, safely and economically, method and apparatus for the mixing of tetramethyl lead with a liquid hydrocarbon fuel to significantly upgrade the octane rating of the fuel and hence make the fuel much more useful in many contexts of use. With the use of this invention, the user of propane or LPG, etc., is given very slight additional expense an alternative supply of much-higher-octane fuel. This is an extremely desirable benefit for a number of reasons. As one example, many users of engines burning natural gas have an option of being on an "interrupted rate" or an "uninterrupted rate." The uninterrupted rate user must pay a premium for his service, but he is assured that, during periods of short supply and high demand, his supply of fuel will continue. Nevertheless, many must retain this uninterrupted rate because they have available no comparable fuel supply of high enough octave for the full load operation of necessary equipment. This invention provides such a customer with an alternative fuel supply with an octave rating very comparable to that of natural gas; thus, the customer may take advantage of the lower cost to him of the interrupted rate and yet be assured of ready available high octave fuel when it is needed.

Provision of available supplies of leaded high-octane propane and LPG is further of great importance since use of such fuel by motor vehicles, rather than the presently used fuels, will result in much less air pollution for the same or greater economy. The advantages might be illustrated in yet another way. Some present users of propane are having to abandon this fuel because their present engines designed for LPG are underpowered for today's traffic requirements, and are going to diesel engines. As an example, buses in the city of Chicago have long burned propane. But with the engines designed to utilize the octave rating of propane, the buses that were performing adequately some ten years ago are now underpowered when compared with the balance of the traffic on the streets of Chicago. As a consequence, the buses in Chicago are a traffic bottleneck, and consideration has been given to the abandonment of propane as a fuel. The provision of a readily available supply of leaded high-octane propane would allow the Chicago buses to use higher compression ratios in their engines and continue the use of propane, with its beneficial quality of noncontribution to the smog already existing in the city.

While the invention has been described in terms of one embodiment, it is apparent various changes may be made in the structure illustrated herein without departing from the scope of the present invention, which is defined by the following claims.

I claim:
1. Apparatus suitable for use in mixing tetramethyl lead to a hydrocarbon fuel to upgrade the octave rating of said hydrocarbon fuel, comprising:
   a tank suitable for containing tetramethyl lead, said tank containing an outlet opening connection which includes a threaded recess adjacent the exterior of said tank, and a bore extending from said recess to the interior of said tank,
   a flexible seal on the interior wall of said tank covering said bore so that fluid cannot escape from said tank through said bore unless said seal is pierced,
   an opening through which said tank may be filled, and
   a plug adapted for fitting into said opening in such manner that it may not be readily removed from the outside of said tank;

   means matingly fitting said outlet opening connection, for piercing said seal and withdrawing fluid from said tank such that leakage of fluid to the ambient is prevented;
   means for containing a hydrocarbon fuel; and
   means for mixing the tetramethyl lead to said hydrocarbon fuel to upgrade the octave rating of said fuel.

2. Apparatus according to claim 1, wherein means are included for mixing selected proportionate amounts of tetramethyl lead with said hydrocarbon fuel.

3. Apparatus according to claim 1, wherein said means for withdrawing fluid from said tank includes a lance which fits into said bore, and a plug affixed to said lance for matingly fitting into said recess.

4. Apparatus according to claim 3, wherein said lance includes a check valve in the end thereof.

5. Apparatus suitable for use in mixing tetramethyl lead to a hydrocarbon fuel to upgrade the octave rating of said hydrocarbon fuel, comprising:
   a first tank suitable for containing tetramethyl lead, said tank including an outlet opening which includes a bore extending through a wall of said tank, and
   a flexible seal covering said bore on the interior wall of said tank, so that the fluid in said tank cannot flow through said bore unless said seal is pierced;

   means adapted to fit into said outlet opening and to be readily removed therefrom, said means including
   a plug having an aperture therethrough, said plug being adapted to fit into at least a portion of said bore, mating with said bore in a manner such that fluid flow is permitted through said aperture but is otherwise prevented through said bore,
   a lance adapted to pierce said flexible seal, said lance forming a passageway through which fluid
may flow from said tank, said passageway being in fluid communication with said aperture, and a check valve in the end of said lance, said valve being biased toward an opening in the end of said lance so that fluid from said tank will enter said lance only when the bias of said check valve is overcome.
a first flow line in fluid communication with said aperture, adapted to receive fluid withdrawn from said first tank;
a second tank proximate to said first tank, for containing a hydrocarbon fuel;
a second flow line in fluid communication with said second tank, adapted to receive fluid withdrawn from said second tank; and
mixing means connected to each said first and second flow lines, adapted to mix the tetramethyl lead from said first tank with the hydrocarbon fuel from said second tank, thereby to upgrade the octane rating of said fuel.

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