

FORTIFIED HYDROCARBON
AND PROCESS FOR MAKING AND USING THE SAME

BACKGROUND OF THE INVENTION

Field of the Invention

5 The present invention relates to hydrocarbons including gas for use in cutting and/or welding torches, internal-combustion engine fuels and high temperature heating gas and oil fortified by the addition of a double additive or conditioner.

10 Prior Art

 Various attempts have been made heretofore to improve gas used in cutting and/or welding torches by adding an additive or a double additive to them. These prior art gases have been composed of various hydrocarbons from methane to octane and some have included propane and butane. Harris U.S. patent No. 1,565,935, issued December 15, 1925, for example, fortified a wet casinghead gas composed of methane, ethane, propane, butane and hexane by the addition of ethyl ether or methyl ether. Another patent that proposed to add ethyl ether or ethyl oxide to a gas including propane or butane and propane is U.S. patent No. 2,513,769, issued July 4, 1950 (White).

 British patent specification No. 813,981, published May 27, 1959 (Oxy-Ferrolene Limited) proposes to add to hydrocarbon gas an oxygen-containing compound such as isopropyl ether, methyl isopropyl ether, methyl propyl ether, normal propyl ether, ethanol and methanol.

30 British patent No. 813,981 suggests the incorporation of more than one compound but does not suggest any specific double compounds. Seley U.S. patent No. 2,411,759, issued November 26, 1946, does suggest the use of double additives, namely, ethyl oxide and benzine.

 The White United States patent No. 2,951,750, issued September 6, 1960, refers to the prior double



additives for torch gas of dimethyl ether and benzine at column 1, lines 21 to 25, presumably as disclosed in the Seley patent, and then proposes the use of the double additive of propylene oxide and dimethyl ether at column 1, lines 55 to 62, instead of using benzine and dimethyl ether.

In addition, Kessler U.S. patent No. 3,591,355, issued July 6, 1971, proposed the addition of a double additive to torch gas, composed of a liquid alkanol such as methanol and a mixture of alkanes such as pentane and isopentane. White U.S. patent No. 3,989,479, issued November 2, 1976, also proposed the addition of methanol and British patent specification No. 569,108, accepted May 4, 1945, proposed the addition of ammonia. This British patent also recommended increasing the amount of propane in producer gas, water gas, Mond gas and other commercially available gas mixtures in which methane predominated.

Medsker U.S. patent No. 2,908,599, issued October 13, 1959, stated that methyl borate and acetone had been used previously in a fuel for torch use citing U.S. patent No. 2,281,910. The Medsker patent proposed a mixture of methyl borate and hexane as an additive for a gaseous fuel. The Bialosky et al. patent No. 2,281,910, issued May 5, 1942, discloses a liquid flux containing methyl borate and a ketone, such as acetone or methyl ethyl ketone, to be subjected to a stream of acetylene, hydrogen or similar combustible gas for coating the work with boric acid or oxide.

The principal torch gas used heretofore has been acetylene which is comparatively expensive, difficult to store and to transport, requires the use of almost pure oxygen with it and forms persistently adherent scoria when used for cutting ferrous metal.

Internal-combustion engine fuels, such as gasoline, have been inclined to detonate in reciprocating piston internal-combustion engines, and



it has been found that high-octane gasoline can reduce or eliminate detonation-causing combustion knock and increase power. Another expedient used to deter detonation has been the addition of antiknock material, particularly tetraethyl lead. Also, aromatic amines have been used in amounts averaging 2.6 g. of metal per gallon. Such amines are not commercially used, however, because of their higher cost than tetraethyl lead or mixed methyl ethyl lead alkyls. Also, methylcyclopentadienyl manganese tricarbonyl has been used. In addition, use of other metallic antiknock compounds have been proposed, such as thallium, selenium and tellurium organic compounds, but these have not proven to be useful.

A disadvantage of using tetraethyl lead is that the lead has been discharged into the air, and lead is physically harmful, so that its use in gasoline for internal-combustion engines has been phased out. Methyl tertiary butyl ether by itself has been used as an additive for unleaded gasoline as an octane booster and to reduce harmful emission products.

SUMMARY OF THE INVENTION

A principal object of this invention is to provide fortified hydrocarbon such as torch gas having characteristics superior to those of acetylene, especially for cutting ferrous metal, and also for welding. Such object also includes providing fortified hydrocarbon having characteristics superior to those of hydrocarbon fortified only by the addition of methyl ethyl ketone.

A particular object is to provide a torch gas which will have high flame temperature and intense heating capability.

A further object is to provide torch gas that can be stored and transported easily and economically.

Another object is to provide a torch gas having a base gas which is readily available in almost



the entire world, can be provided more economically and is easy to fortify for enhancing its attributes.

It is also an object to provide a torch gas enabling ferrous metal to be cut faster and cleaner.

5 Another object is to provide a gas that can be used by torches for cutting under water at considerable depths.

10 An additional object is to provide a gas that can be used for torch cutting more economically because it will combine effectively with oxygen containing a higher proportion of adulterating gases which cannot be used with acetylene.

15 The foregoing objects can be accomplished by utilizing liquefied petroleum gas fortified with methyl ethyl ketone (MEK) alone or enhanced with tertiary butyl alcohol (TBA) or with methyl tertiary butyl ether (MTBE).

20 A further object of this invention is to provide fortified hydrocarbon for purposes other than torch gas, such as high-temperature heating gas or oil for heating industrial furnaces such as for melting metals for pouring, and blast furnaces.

25 This further object can be accomplished by utilizing liquid petroleum gas, natural gas or liquid hydrocarbon, such as diesel oil or fuel oil, fortified with MEK alone or enhanced with TBA or MTBE.

30 Still another object is to fortify liquid hydrocarbon, especially gasoline, for use as an internal-combustion engine fuel to deter detonation and promote uniformity of combustion.

This still further object can be accomplished by adding to the gasoline MEK alone or enhanced with TBA or MTBE as an additive.

DETAILED DESCRIPTION

35 Liquefied petroleum gas (LPG) is the preferred base gas for the fortified torch gas of the present invention because of its high butane and propane content. Both the n-butane and isobutane



isomers of butane are usually present in LPG, but a substantial amount of butane may have been removed from LPG sold as fuel because of the demand from industry for butane derivatives, in which case the LPG is composed largely of propane. It is, however, desirable that there be a reasonable proportion of butane in the LPG, such as from 5% to 40%. Alternatively, the base gas could be propane or butane alone or any mixture of these gases or propylene.

10 The additive or conditioner used to fortify the base gas is methyl ethyl ketone (MEK), otherwise known as 2-butanone, having the formula $\text{CH}_3\text{COCH}_2\text{CH}_3$ which may be enhanced with tertiary butyl alcohol or tert-butyl alcohol (TBA), having the formula $(\text{CH}_3)_3\text{COH}$ or methyl tertiary butyl ether, otherwise known as methyl tert-butyl ether (MTBE) having the formula $(\text{CH}_3)_3\text{COCH}_3$. MEK is a liquid with a boiling point of 70.6 degrees C. and a specific gravity of 0.805 at 20 degrees C. At ambient temperature TBA is a waxy solid which melts at 25.6 degrees C. and has a specific gravity of 0.779 at 26 degrees C. At ambient temperature MTBE is a colorless liquid having a boiling point of 55 degrees C. and a freezing point of -110 degrees C. and has a specific gravity of 0.74.

25 LPG must be stored under pressure to keep it in a liquid state, but relatively heavy pressurized storage tanks and handling equipment for LPG is commercially practical and customary.

30 Without being fortified, LPG mixed with oxygen is not very effective for torch cutting and welding, not nearly as effective as acetylene gas mixed with substantially pure oxygen, but by enriching the base LPG with MEK alone or enhanced with TBA or MTBE as an additive the flame temperature is considerably increased and the heating capability is greatly improved.

35 The amount of additive used will depend on the extent to which it is desired to improve the





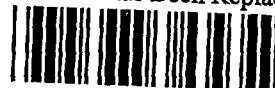
characteristics of the base gas, but the amount preferably would be 6% to 20% MEK of the base gas by weight, preferably 10% to 15%, or 3% to 10% MEK enhanced with 1% to 3% TBA or MTBE of the base gas by weight, preferably 5% of MEK and 3% of TBA or MTBE. For use in fortifying torch gas such as LPG, an amount of TBA or MTBE up to 3% of the LPG by weight could be mixed with 15% of the LPG by weight of MEK, but sufficiently beneficial results are usually obtained by the use of 2% of TBA or MTBE of the hydrocarbon base mixed with MEK in the amount of 10% of the LPG by weight.

For internal-combustion engine fuel, the ratio of 20% of TBA or MTBE to MEK by weight is preferred, so that TBA or MTBE in the amount of 1% of the hydrocarbon base by weight can be mixed with MEK in the amount of 5% of the hydrocarbon base by weight. For most purposes TBA or MTBE in the amount of 0.5% of the internal-combustion fuel by weight mixed with MEK in the amount of 2.5% or 3% of the internal-combustion engine fuel by weight provides sufficient improvement in performance of the internal-combustion engine fuel.

The procedure for combining the additive with the LPG is simple. MEK is a liquid at normal temperatures. To combine the TBA with MEK, the TBA may be melted by subjecting its container to warm water such as at a temperature of 40 degrees C. to 45 degrees C., and the TBA liquid is then simply mixed with the MEK liquid before the additive liquid is mixed with the hydrocarbon. MTBE liquid can be mixed with the MEK liquid before the additive liquid is mixed with the hydrocarbon. The additive is a liquid at normal temperatures and is supplied to the storage tank in which the LPG is to be stored or transported. It is quite practical to supply the additive to standard 55-gallon drums.

The additive may be supplied in conjunction with a catalyst, preferably activated carbon in the

THIS SHEET HAS BEEN
REPLACED



form of powder, granules or pellets. The activated carbon is amorphous, preferably having been produced from coal or petroleum coke. Alternative catalysts that can be used are platinum, cupric oxide and granular silver carried by a suitable carrier.

The amount of activated carbon used is not critical, but it should be placed in the bottom of a storage container to facilitate mixing of the additive with the hydrocarbon base gas when it is supplied to the container under pressure. An amount of such catalyst between 1% and 5% of the weight of the additive would be satisfactory. The resulting mixture of base gas and additive or conditioner will be azeotropic so that the fortified torch gas will be homogeneous when it is released from the storage container to the torch.

In order to provide an effective cutting flame, it is necessary to supply to an acetylene torch oxygen that is in substantially pure form, such as at least 99% oxygen by volume. Satisfactory cutting temperatures can be provided by mixing with the fortified base gas of the present invention less pure oxygen such as oxygen having a purity of approximately 95%, the adulterant being nitrogen, carbon dioxide and other gas components of air. Even when oxygen of 90% purity is used, the flame temperature of base LPG of approximately 5,000 degrees F. can be raised to approximately 5,800 degrees F. to 6,000 degrees F. by use of the base LPG fortified by MEK and MTBE according to the present invention. Such impure oxygen can be produced economically by compressing air to about 4,000 psi, chilling it to minus 360 degrees F. which liquefies the air and then allowing the temperature of the liquefied air to rise gradually while venting the container to release the nitrogen component of the liquefied air which vaporizes at minus 320 degrees F. leaving the oxygen in liquid form.



In other processes for producing impure oxygen, nitrogen of the air is removed by zeolite resulting in oxygen of 90% to 95% purity.

An advantage of using the fortified base gas of the present invention over acetylene for cutting ferrous metal is that a clean precise kerf is obtained. Oxyacetylene cutting produces a hard scoria persistently adherent to the work which increases the heating required and usually must subsequently be chipped off the work. Utilization of the fortified torch gas of the present invention produces a soft friable scoria which is sloughed off the work and out of the kerf as the cutting progresses to leave a narrower clean kerf with virgin metal along opposite margins of the kerf.

A particular advantage which the fortified torch gas of the present invention has is that it can be used for flame cutting under water to a depth of 300 feet. The use of the oxyacetylene torch is limited to 20 feet under water because at pressures to which it would be necessary to subject the gas to enable it to be dispensed to the cutting torch at greater depths the acetylene will explode. Consequently, the only alternative that has been available for cutting under water at depths greater than about 20 feet prior to use of MEK as an additive to hydrocarbon gas has been the use of a carbon arc, the action of which is slow and the use of which is dangerous.

While the use of MEK has been beneficial in expediting cutting of metal and the use of MEK enhanced by the addition of TBA has increased the cutting speed from 5% to 10%, the use of MEK and MTBE in combination has increased the cutting speed to 20% to 25% faster than where MEK has been used alone as an additive and about 15% faster than the cutting speed where the MEK has been enhanced with TBA.

In addition to use of the present invention in fortified torch gas, the invention can be used for

THIS SHEET HAS BEEN
REPLACED



high-temperature hydrocarbon heating gas, such as LPG or natural gas and high-temperature hydrocarbon heating liquids, such as boiler fuel oil, stove oil or other oil used in such industrial processes as smelting or
5 other metal melting such as required for foundry casting, or for steam generating. For such purposes, the additive can be within the range of 2% to 10% of the hydrocarbon by weight. If the amount of additive is greater than 5%, a catalyst such as powdered
10 activated carbon should be used to facilitate thorough mixing of the additive with the hydrocarbon.

Use of hydrocarbon gas such as LPG for soldering, brazing or light metal cutting is rendered more effective if the additive including MEK alone or
15 enhanced with TBA or MTBE is mixed with the gas. For such use it is preferable to use less additive than in the case of torch gas for cutting or welding thick metal. For soldering, brazing or light cutting, an amount of additive within the range of 2% to 5% by
20 weight is adequate, and such an amount can be mixed sufficiently intimately with the hydrocarbon gas without the use of a catalyst.

Another use of MEK alone or enhanced by TBA or MTBE additive is for fortifying internal-combustion
25 engine fuel, such as automotive gasoline, aviation gasoline or diesel oil. For such use the additive functions as an antiknock agent as well as improving the uniformity of combustion and accelerating the rate of combustion, which consequently enhances the power-
30 producing characteristics of the fuel.

For internal-combustion engine fuel use, the range of additive used would be 0.5% to 6% of the hydrocarbon by weight but preferably within the range of 1% to 4% by weight.

35 To enhance the effectiveness of MEK as an additive for hydrocarbon base fuel, an amount of TBA or MTBE can be mixed with the MEK up to 20% by weight of the amount of MEK, but the total amount of TBA or MTBE

should not exceed 3% of the hydrocarbon base by weight in order to maintain azeotropic characteristics of the fortified hydrocarbon.

- 5 It should be emphasized that MEK is an effective additive for hydrocarbon without TBA or MTBE, but not as effective, and that TBA or MTBE without MEK is not an effective additive.

This Sheet Has Been Replaced



THIS SHEET HAS BEEN
REPLACED



Claims

1. Fortified hydrocarbon including a mixture of a major portion by weight of hydrocarbon base and a minor portion by weight of additive, characterized by the additive including MEK.

2. The hydrocarbon defined in claim 1, further characterized by the MEK being enhanced by mixing with it TBA or MTBE.

3. The hydrocarbon defined in claim 1 or claim 2, further characterized by the amount of additive being within the range of 0.5% to 20% of the hydrocarbon base by weight.

4. The hydrocarbon defined in claim 1, claim 2 or claim 3, further characterized by the hydrocarbon base being gas.

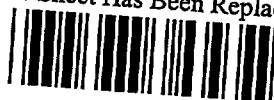
5. The hydrocarbon defined in claim 4, further characterized by the hydrocarbon being torch gas.

6. The hydrocarbon defined in claim 2, further characterized by the additive including an amount of MEK from 3% to 10% of the hydrocarbon base by weight and an amount of TBA or MTBE from 1% to 3% of the hydrocarbon base by weight.

7. The hydrocarbon defined in claim 4, further characterized by the base gas being LPG.

8. The hydrocarbon defined in claim 4, further characterized by the hydrocarbon base being natural gas.

This Sheet Has Been Replaced



THIS SHEET HAS BEEN
REPLACED



9. The hydrocarbon defined in claim 1 or claim 2, further characterized by the hydrocarbon base being gasoline.

5 10. The hydrocarbon defined in claim 9, further characterized by the amount of additive including an amount of MEK from 1% to 5% of the hydrocarbon base by weight and an amount of TBA or MTBE from 0.5% to 2% of the hydrocarbon base by weight.

10 11. The process of making fortified hydrocarbon including supplying additive and supplying a hydrocarbon base for mixing with the additive characterized by the additive including MEK.

12. The process defined in claim 11, further characterized by mixing TBA or MTBE with the MEK.

15 13. The process defined in claim 11, further characterized by supplying additive within the range of 0.5% to 20% of the base hydrocarbon by weight.

20 14. The process defined in claim 11, claim 12 or claim 13, further characterized by supplying the additive in conjunction with activated carbon.

15. The process defined in claim 11, claim 12 or claim 13, further characterized by supplying LPG as the hydrocarbon base.

25 16. The process of heating by burning a base hydrocarbon characterized by the hydrocarbon base being fortified by the addition of MEK.

30 17. The process of torch cutting ferrous metal under water characterized by supplying to a torch deeply submerged in water a mixture of oxygen with torch gas fortified by MEK.

This Sheet Has Been Replaced



THIS SHEET HAS BEEN
REPLACED



18. The process of cutting ferrous metal by supplying fortified torch gas to a cutting torch and simultaneously supplying oxygen to the cutting torch, further characterized by the oxygen having a purity
5 within the range of 90% to 98% by volume.

19. The process defined in claim 16, claim 17 or claim 18, further characterized by supplying fortified LPG as the fortified torch gas.

This Sheet Has Been Replaced



THIS SHEET HAS BEEN
REPLACED

ABSTRACT OF THE DISCLOSURE

Fortified hydrocarbon, preferably LPG gas, is fortified with methyl ethyl ketone (MEK) which may be enhanced with tertiary butyl alcohol (TBA) or methyl tert-butyl ether (MTBE) in an amount 0.5% to 20% of the base hydrocarbon by weight for use as torch gas, for heating or for motor fuel. Cutting of ferrous metal can be accomplished even under water by mixing the fortified torch gas with oxygen having a purity as low as 90%.

This Sheet Has Been Replaced

THIS SHEET HAS BEEN
REPLACED



21 FEB 1997

FORTIFIED HYDROCARBON
AND PROCESS FOR MAKING AND USING THE SAME

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to hydrocarbons including gas for use in cutting and/or welding torches, internal-combustion engine fuels and high temperature heating gas and oil fortified by the addition of a double additive or conditioner.

Prior Art

Various attempts have been made heretofore to improve gas used in cutting and/or welding torches by adding an additive or a double additive to them. These prior art gases have been composed of various hydrocarbons from methane to octane and some have included propane and butane. Harris U.S. patent No. 1,565,935, issued December 15, 1925, for example, fortified a wet casinghead gas composed of methane, ethane, propane, butane and hexane by the addition of ethyl ether or methyl ether. Another patent that proposed to add ethyl ether or ethyl oxide to a gas including propane or butane and propane is U.S. patent No. 2,513,769, issued July 4, 1950 (White).

British patent specification No. 813,981, published May 27, 1959 (Oxy-Ferrolene Limited) proposes to add to hydrocarbon gas an oxygen-containing compound such as isopropyl ether, methyl isopropyl ether, methyl propyl ether, normal propyl ether, ethanol and methanol.

British patent No. 813,981 suggests the incorporation of more than one compound but does not suggest any specific double compounds. Seley U.S. patent No. 2,411,759, issued November 26, 1946, does suggest the use of double additives, namely, ethyl oxide and benzine.

The White United States patent No. 2,951,750, issued September 6, 1960, refers to the prior double

THIS SHEET HAS BEEN
REPLACED



21 FEB 1977

additives for torch gas of dimethyl ether and benzine at column 1, lines 21 to 25, presumably as disclosed in the Seley patent, and then proposes the use of the double additive of propylene oxide and dimethyl ether at column 1, lines 55 to 62, instead of using benzine and dimethyl ether.

In addition, Kessler U.S. patent No. 3,591,355, issued July 6, 1971, proposed the addition of a double additive to torch gas, composed of a liquid alkanol such as methanol and a mixture of alkanes such as pentane and isopentane. White U.S. patent No. 3,989,479, issued November 2, 1976, also proposed the addition of methanol and British patent specification No. 569,108, accepted May 4, 1945, proposed the addition of ammonia. This British patent also recommended increasing the amount of propane in producer gas, water gas, Mond gas and other commercially available gas mixtures in which methane predominated.

Medsker U.S. patent No. 2,908,599, issued October 13, 1959, stated that methyl borate and acetone had been used previously in a fuel for torch use citing U.S. patent No. 2,281,910. The Medsker patent proposed a mixture of methyl borate and hexane as an additive for a gaseous fuel. The Bialosky et al. patent No. 2,281,910, issued May 5, 1942, discloses a liquid flux containing methyl borate and a ketone, such as acetone or methyl ethyl ketone, to be subjected to a stream of acetylene, hydrogen or similar combustible gas for coating the work with boric acid or oxide.

The principal torch gas used heretofore has been acetylene which is comparatively expensive, difficult to store and to transport, requires the use of almost pure oxygen with it and forms persistently adherent scoria when used for cutting ferrous metal.

Internal-combustion engine fuels, such as gasoline, have been inclined to detonate in reciprocating piston internal-combustion engines, and

THIS SHEET HAS BEEN
REPLACED



21 FEB 1997

it has been found that high-octane gasoline can reduce or eliminate detonation-causing combustion knock and increase power. Another expedient used to deter detonation has been the addition of antiknock material, particularly tetraethyl lead. Also, aromatic amines have been used in amounts averaging 2.6 g. of metal per gallon. Such amines are not commercially used, however, because of their higher cost than tetraethyl lead or mixed methyl ethyl lead alkyls. Also, methylcyclopentadienyl manganese tricarbonyl has been used. In addition, use of other metallic antiknock compounds have been proposed, such as thallium, selenium and tellurium organic compounds, but these have not proven to be useful.

A disadvantage of using tetraethyl lead is that the lead has been discharged into the air, and lead is physically harmful, so that its use in gasoline for internal-combustion engines has been phased out. Methyl tertiary butyl ether by itself has been used as an additive for unleaded gasoline as an octane booster and to reduce harmful emission products.

SUMMARY OF THE INVENTION

A principal object of this invention is to provide fortified hydrocarbon such as torch gas having characteristics superior to those of acetylene, especially for cutting ferrous metal, and also for welding. Such object also includes providing fortified hydrocarbon having characteristics superior to those of hydrocarbon fortified only by the addition of methyl ethyl ketone.

A particular object is to provide a torch gas which will have high flame temperature and intense heating capability.

A further object is to provide torch gas that can be stored and transported easily and economically.

Another object is to provide a torch gas having a base gas which is readily available in almost



21 FEB 1997

the entire world, can be provided more economically and is easy to fortify for enhancing its attributes.

It is also an object to provide a torch gas enabling ferrous metal to be cut faster and cleaner.

Another object is to provide a gas that can be used by torches for cutting under water at considerable depths.

An additional object is to provide a gas that can be used for torch cutting more economically because it will combine effectively with oxygen containing a higher proportion of adulterating gases which cannot be used with acetylene.

The foregoing objects can be accomplished by utilizing liquefied petroleum gas fortified with methyl ethyl ketone (MEK) alone or enhanced with tertiary butyl alcohol (TBA) or with methyl tertiary butyl ether (MTBE).

A further object of this invention is to provide fortified hydrocarbon for purposes other than torch gas, such as high-temperature heating gas or oil for heating industrial furnaces such as for melting metals for pouring, and blast furnaces.

This further object can be accomplished by utilizing liquid petroleum gas, natural gas or liquid hydrocarbon, such as diesel oil or fuel oil, fortified with MEK alone or enhanced with TBA or MTBE.

Still another object is to fortify liquid hydrocarbon, especially gasoline, for use as an internal-combustion engine fuel to deter detonation and promote uniformity of combustion.

This still further object can be accomplished by adding to the gasoline MEK alone or enhanced with TBA or MTBE as an additive.

DETAILED DESCRIPTION

Liquefied petroleum gas (LPG) is the preferred base gas for the fortified torch gas of the present invention because of its high butane and propane content. Both the n-butane and isobutane

THIS SHEET HAS BEEN
REPLACED



21 FEB 1997

isomers of butane are usually present in LPG, but a substantial amount of butane may have been removed from LPG sold as fuel because of the demand from industry for butane derivatives, in which case the LPG is composed largely of propane. It is, however, desirable that there be a reasonable proportion of butane in the LPG, such as from 5% to 40%. Alternatively, the base gas could be propane or butane alone or any mixture of these gases or propylene.

The additive or conditioner used to fortify the base gas is methyl ethyl ketone (MEK), otherwise known as 2-butanone, having the formula $\text{CH}_3\text{COCH}_2\text{CH}_3$ which may be enhanced with tertiary butyl alcohol or tert-butyl alcohol (TBA), having the formula $(\text{CH}_3)_3\text{COH}$ or methyl tertiary butyl ether, otherwise known as methyl tert-butyl ether (MTBE) having the formula $(\text{CH}_3)_3\text{COCH}_3$. MEK is a liquid with a boiling point of 70.6 degrees C. and a specific gravity of 0.805 at 20 degrees C. At ambient temperature TBA is a waxy solid which melts at 25.6 degrees C. and has a specific gravity of 0.779 at 26 degrees C. At ambient temperature MTBE is a colorless liquid having a boiling point of 55 degrees C. and a freezing point of -110 degrees C. and has a specific gravity of 0.74.

LPG must be stored under pressure to keep it in a liquid state, but relatively heavy pressurized storage tanks and handling equipment for LPG is commercially practical and customary.

Without being fortified, LPG mixed with oxygen is not very effective for torch cutting and welding, not nearly as effective as acetylene gas mixed with substantially pure oxygen, but by enriching the base LPG with MEK alone or enhanced with TBA or MTBE as an additive the flame temperature is considerably increased and the heating capability is greatly improved.

The amount of additive used will depend on the extent to which it is desired to improve the

THIS SHEET HAS BEEN
REPLACED



21 FEB 1997

characteristics of the base gas, but the amount preferably would be 6% to 20% MEK of the base gas by weight, preferably 10% to 15%, or 3% to 10% MEK enhanced with 1% to 3% TBA or MTBE of the base gas by weight, preferably 5% of MEK and 3% of TBA or MTBE. For use in fortifying torch gas such as LPG, an amount of TBA or MTBE up to 3% of the LPG by weight could be mixed with 15% of the LPG by weight of MEK, but sufficiently beneficial results are usually obtained by the use of 2% of TBA or MTBE of the hydrocarbon base mixed with MEK in the amount of 10% of the LPG by weight.

For internal-combustion engine fuel, the ratio of 20% of TBA or MTBE to MEK by weight is preferred, so that TBA or MTBE in the amount of 1% of the hydrocarbon base by weight can be mixed with MEK in the amount of 5% of the hydrocarbon base by weight. For most purposes TBA or MTBE in the amount of 0.5% of the internal-combustion fuel by weight mixed with MEK in the amount of 2.5% or 3% of the internal-combustion engine fuel by weight provides sufficient improvement in performance of the internal-combustion engine fuel.

The procedure for combining the additive with the LPG is simple. MEK is a liquid at normal temperatures. To combine the TBA with MEK, the TBA may be melted by subjecting its container to warm water such as at a temperature of 40 degrees C. to 45 degrees C., and the TBA liquid is then simply mixed with the MEK liquid before the additive liquid is mixed with the hydrocarbon. MTBE liquid can be mixed with the MEK liquid before the additive liquid is mixed with the hydrocarbon. The additive is a liquid at normal temperatures and is supplied to the storage tank in which the LPG is to be stored or transported. It is quite practical to supply the additive to standard 55-gallon drums.

The additive may be supplied in conjunction with a catalyst, preferably activated carbon in the

THIS SHEET HAS BEEN
REPLACED



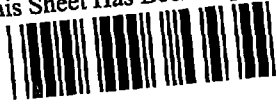
21 FEB 1977

form of powder, granules or pellets. The activated carbon is amorphous, preferably having been produced from coal or petroleum coke. Alternative catalysts that can be used are platinum, cupric oxide and granular silver carried by a suitable carrier.

The amount of activated carbon used is not critical, but it should be placed in the bottom of a storage container to facilitate mixing of the additive with the hydrocarbon base gas when it is supplied to the container under pressure. An amount of such catalyst between 1% and 5% of the weight of the additive would be satisfactory. The resulting mixture of base gas and additive or conditioner will be azeotropic so that the fortified torch gas will be homogeneous when it is released from the storage container to the torch.

In order to provide an effective cutting flame, it is necessary to supply to an acetylene torch oxygen that is in substantially pure form, such as at least 99% oxygen by volume. Satisfactory cutting temperatures can be provided by mixing with the fortified base gas of the present invention less pure oxygen such as oxygen having a purity of approximately 95%, the adulterant being nitrogen, carbon dioxide and other gas components of air. Even when oxygen of 90% purity is used, the flame temperature of base LPG of approximately 5,000 degrees F. can be raised to approximately 5,800 degrees F. to 6,000 degrees F. by use of the base LPG fortified by MEK and MTBE according to the present invention. Such impure oxygen can be produced economically by compressing air to about 4,000 psi, chilling it to minus 360 degrees F. which liquefies the air and then allowing the temperature of the liquefied air to rise gradually while venting the container to release the nitrogen component of the liquefied air which vaporizes at minus 320 degrees F. leaving the oxygen in liquid form.

THIS SHEET HAS BEEN
REPLACED



24 FEB 1997

In other processes for producing impure oxygen, nitrogen of the air is removed by zeolite resulting in oxygen of 90% to 95% purity.

An advantage of using the fortified base gas of the present invention over acetylene for cutting ferrous metal is that a clean precise kerf is obtained. Oxyacetylene cutting produces a hard scoria persistently adherent to the work which increases the heating required and usually must subsequently be chipped off the work. Utilization of the fortified torch gas of the present invention produces a soft friable scoria which is sloughed off the work and out of the kerf as the cutting progresses to leave a narrower clean kerf with virgin metal along opposite margins of the kerf.

A particular advantage which the fortified torch gas of the present invention has is that it can be used for flame cutting under water to a depth of 300 feet. The use of the oxyacetylene torch is limited to 20 feet under water because at pressures to which it would be necessary to subject the gas to enable it to be dispensed to the cutting torch at greater depths the acetylene will explode. Consequently, the only alternative that has been available for cutting under water at depths greater than about 20 feet prior to use of MEK as an additive to hydrocarbon gas has been the use of a carbon arc, the action of which is slow and the use of which is dangerous.

While the use of MEK has been beneficial in expediting cutting of metal and the use of MEK enhanced by the addition of TBA has increased the cutting speed from 5% to 10%, the use of MEK and MTBE in combination has increased the cutting speed to 20% to 25% faster than where MEK has been used alone as an additive and about 15% faster than the cutting speed where the MEK has been enhanced with TBA.

In addition to use of the present invention in fortified torch gas, the invention can be used for



21 FEB 1997

high-temperature hydrocarbon heating gas, such as LPG or natural gas and high-temperature hydrocarbon heating liquids, such as boiler fuel oil, stove oil or other oil used in such industrial processes as smelting or other metal melting such as required for foundry casting, or for steam generating. For such purposes, the additive can be within the range of 2% to 10% of the hydrocarbon by weight. If the amount of additive is greater than 5%, a catalyst such as powdered activated carbon should be used to facilitate thorough mixing of the additive with the hydrocarbon.

Use of hydrocarbon gas such as LPG for soldering, brazing or light metal cutting is rendered more effective if the additive including MEK alone or enhanced with TBA or MTBE is mixed with the gas. For such use it is preferable to use less additive than in the case of torch gas for cutting or welding thick metal. For soldering, brazing or light cutting, an amount of additive within the range of 2% to 5% by weight is adequate, and such an amount can be mixed sufficiently intimately with the hydrocarbon gas without the use of a catalyst.

Another use of MEK alone or enhanced by TBA or MTBE additive is for fortifying internal-combustion engine fuel, such as automotive gasoline, aviation gasoline or diesel oil. For such use the additive functions as an antiknock agent as well as improving the uniformity of combustion and accelerating the rate of combustion, which consequently enhances the power-producing characteristics of the fuel.

For internal-combustion engine fuel use, the range of additive used would be 0.5% to 6% of the hydrocarbon by weight but preferably within the range of 1% to 4% by weight.

To enhance the effectiveness of MEK as an additive for hydrocarbon base fuel, an amount of TBA or MTBE can be mixed with the MEK up to 20% by weight of the amount of MEK, but the total amount of TBA or MTBE

THIS SHEET HAS BEEN
REPLACED

21 FEB 1997

10

should not exceed 3% of the hydrocarbon base by weight in order to maintain azeotropic characteristics of the fortified hydrocarbon.

It should be emphasized that MEK is an effective additive for hydrocarbon without TBA or MTBE, but not as effective, and that TBA or MTBE without MEK is not an effective additive.

This Sheet Has Been Replaced

THIS SHEET HAS BEEN
REPLACED



REPLACEMENT SHEET

21 FEB 1997

11

Claims

1. Fortified hydrocarbon including a mixture of a major portion by weight of hydrocarbon base and a minor portion by weight of additive, characterized by the additive including MEK.

2. The hydrocarbon defined in claim 1, further characterized by the MEK being enhanced by mixing with it TBA or MTBE.

3. The hydrocarbon defined in claim 1 or claim 2, further characterized by the amount of additive being within the range of 0.5% to 20% of the hydrocarbon base by weight.

4. The hydrocarbon defined in claim 1, claim 2 or claim 3, further characterized by the hydrocarbon base being gas.

5. The hydrocarbon defined in claim 4, further characterized by the hydrocarbon being torch gas.

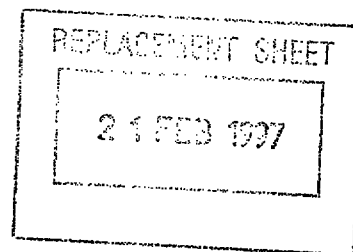
6. The hydrocarbon defined in claim 2, further characterized by the additive including an amount of MEK from 3% to 10% of the hydrocarbon base by weight and an amount of TBA or MTBE from 1% to 3% of the hydrocarbon base by weight.

7. The hydrocarbon defined in claim 4, further characterized by the base gas being LPG.

8. The hydrocarbon defined in claim 4, further characterized by the hydrocarbon base being natural gas.

This Sheet Has Been Replaced

THIS SHEET HAS BEEN
REPLACED



12

9. The hydrocarbon defined in claim 1 or claim 2, further characterized by the hydrocarbon base being gasoline.

10. The hydrocarbon defined in claim 9, further characterized by the amount of additive including an amount of MEK from 1% to 5% of the hydrocarbon base by weight and an amount of TBA or MTBE from 0.5% to 2% of the hydrocarbon base by weight.

11. The process of making fortified hydrocarbon including supplying additive and supplying a hydrocarbon base for mixing with the additive characterized by the additive including MEK.

12. The process defined in claim 11, further characterized by mixing TBA or MTBE with the MEK.

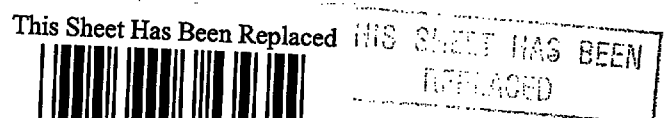
13. The process defined in claim 11, further characterized by supplying additive within the range of 0.5% to 20% of the base hydrocarbon by weight.

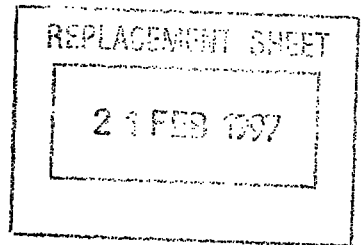
14. The process defined in claim 11, claim 12 or claim 13, further characterized by supplying the additive in conjunction with activated carbon.

15. The process defined in claim 11, claim 12 or claim 13, further characterized by supplying LPG as the hydrocarbon base.

16. The process of heating by burning a base hydrocarbon characterized by the hydrocarbon base being fortified by the addition of MEK.

17. The process of torch cutting ferrous metal under water characterized by supplying to a torch deeply submerged in water a mixture of oxygen with torch gas fortified by MEK.



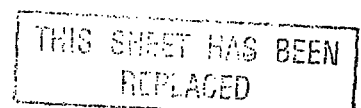


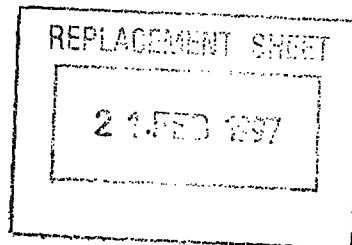
13

18. The process of cutting ferrous metal by supplying fortified torch gas to a cutting torch and simultaneously supplying oxygen to the cutting torch, further characterized by the oxygen having a purity within the range of 90% to 98% by volume.

19. The process defined in claim 16, claim 17 or claim 18, further characterized by supplying fortified LPG as the fortified torch gas.

This Sheet Has Been Replaced





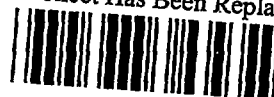
- 14 -

FORTIFIED HYDROCARBON AND PROCESS FOR
MAKING AND USING THE SAME

ABSTRACT OF THE DISCLOSURE

Fortified hydrocarbon, preferably LPG gas, is fortified with methyl ethyl ketone (MEK) which may be enhanced with tertiary butyl alcohol (TBA) or methyl tert-butyl ether (MTBE) in an amount 0.5% to 20% of the base hydrocarbon by weight for use as torch gas, for heating or for motor fuel. Cutting of ferrous metal can be accomplished even under water by mixing the fortified torch gas with oxygen having a purity as low as 90%.

This Sheet Has Been Replaced



THIS SHEET HAS BEEN
REPLACED



11 MAR 1998

FORTIFIED HYDROCARBON AND PROCESS FOR MARKING AND USING
THE SAME

The present invention relates to hydrocarbons including gas for use in cutting and/or welding torches.

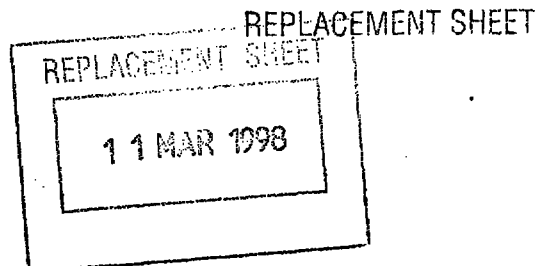
Various attempts have been made heretofore to improve gas used in cutting and/or welding torches by adding an additive or a double additive to them. These prior art gases have been composed of various hydrocarbons from methane to octane and some have included propane and butane. Harris U.S. patent No. 1,565,935, issued December 15, 1925, for example, fortified a wet casinghead gas composed of methane, ethane, propane, butane and hexane by the addition of ethyl ether or methyl ether. Another patent that proposed to add ethyl ether or ethyl oxide to a gas including propane or butane and propane is U.S. patent No. 2,513,769, issued July 4, 1950 (White). BE - A - 697 274 discloses mixtures containing a liquid hydrocarbon and are oxygenated derivative of a hydrocarbon. Among the oxygenated derivatives, propanone and methyl ethyl - ketone are cited.

British patent specification No. 813,981, published May 27, 1959 (Oxy-Ferrolene Limited) proposes to add to hydrocarbon gas an oxygen-containing compound such as isopropyl ether, methyl isopropyl ether, methyl propyl ether, normal propyl ether, ethanol and methanol.

British patent No. 813,981 suggests the incorporation of more than one compound but does not suggest any specific double compounds. Seley U.S. patent No. 2,411,759, issued November 26, 1946, does suggest the use of double additives, namely, ethyl oxide and benzine.

The White United States patent No. 2,951,750, issued September 6, 1960, refers to the prior double

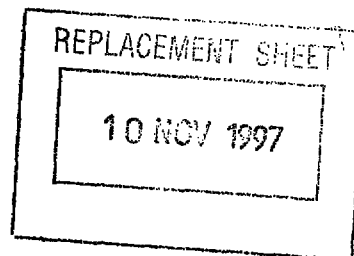
THIS SHEET HAS BEEN
REPLACED



FORTIFIED HYDROCARBON AND PROCESS FOR
MAKING AND USING THE SAME

ABSTRACT OF THE DISCLOSURE

Fortified hydrocarbon, preferably LPG gas, is fortified with methyl ethyl ketone (MEK) which may be enhanced with tertiary butyl alcohol (TBA) or methyl tert-butyl ether (MTBE) in an amount 0.5% to 20% of the base hydrocarbon by weight for use as torch gas, for heating or for motor fuel. Cutting of ferrous metal can be accomplished even under water by mixing the fortified torch gas with oxygen having a purity as low as 90%.



The present invention relates to hydrocarbons including gas for use in cutting and/or welding torches.

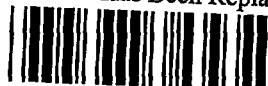
Various attempts have been made heretofore to improve gas used in cutting and/or welding torches by adding an additive or a double additive to them. These prior art gases have been composed of various hydrocarbons from methane to octane and some have included propane and butane. Harris U.S. patent No. 1,565,935, issued December 15, 1925, for example, fortified a wet casinghead gas composed of methane, ethane, propane, butane and hexane by the addition of ethyl ether or methyl ether. Another patent that proposed to add ethyl ether or ethyl oxide to a gas including propane or butane and propane is U.S. patent No. 2,513,769, issued July 4, 1950 (White). BE - A - 697 274 discloses mixtures containing a liquid hydrocarbon and are oxygenated derivative of a hydrocarbon. Among the oxygenated derivatives, propanone and methyl ethyl - ketone are cited.

British patent specification No. 813,981, published May 27, 1959 (Oxy-Ferrolene Limited) proposes to add to hydrocarbon gas an oxygen-containing compound such as isopropyl ether, methyl isopropyl ether, methyl propyl ether, normal propyl ether, ethanol and methanol.

British patent No. 813,981 suggests the incorporation of more than one compound but does not suggest any specific double compounds. Seley U.S. patent No. 2,411,759, issued November 26, 1946, does suggest the use of double additives, namely, ethyl oxide and benzine.

The White United States patent No. 2,951,750, issued September 6, 1960, refers to the prior double

This Sheet Has Been Replaced



THIS SHEET HAS BEEN
REPLACED

10 NOV 1997

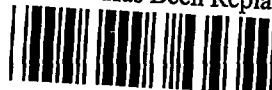
additives for torch gas of dimethyl ether and benzene at column 1, lines 21 to 25, presumably as disclosed in the Seley patent, and then proposes the use of the double additive of propylene oxide and dimethyl ether at column 1, lines 55 to 62, instead of using benzene and dimethyl ether.

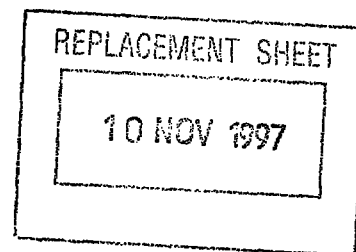
In addition, Kessler U.S. patent No. 3,591,355, issued July 6, 1971, proposed the addition of a double additive to torch gas, composed of a liquid alkanol such as methanol and a mixture of alkanes such as pentane and isopentane. White U.S. patent No. 3,989,479, issued November 2, 1976, also proposed the addition of methanol and British patent specification No. 569,108, accepted May 4, 1945, proposed the addition of ammonia. This British patent also recommended increasing the amount of propane in producer gas, water gas, Mond gas and other commercially available gas mixtures in which methane predominated.

Medsker U.S. patent No. 2,908,599, issued October 13, 1959, stated that methyl borate and acetone had been used previously in a fuel for torch use citing Bialosky et al US patent No. 2,281,910. The Medsker patent proposed a mixture of methyl borate and hexane as an additive for a gaseous fuel. The Bialosky et al. patent No. 2,281,910, issued May 5, 1942, discloses a liquid flux containing methyl borate and a ketone, such as acetone or methyl ethyl ketone, to be subjected to a stream of acetylene, hydrogen or similar combustible gas for coating the work with boric acid or oxide.

The principal torch gas used heretofore has been acetylene which is comparatively expensive, difficult to store and to transport, requires the use of almost pure oxygen with it and forms persistently adherent scoria when used for cutting ferrous metal.

This Sheet Has Been Replaced

THIS SHEET HAS BEEN
REPLACED



According to one aspect of the present invention there is provided a fortified hydrocarbon liquid vaporizable at ambient atmospheric pressure to torch gas, including a mixture of liquefied hydrocarbon gas base which is gas at ambient atmospheric pressure and is kept in liquefied form by being held under pressure and additive, characterized by the additive comprising MEK within the range of 1% to 15% of the hydrocarbon gas base by weight mixed with at least one of TBA and MTBE in an amount of 0.5% to 3% of the hydrocarbon gas base by weight as additional additive.

In another aspect, the present invention provides a process of making fortified hydrocarbon liquid vaporizable at ambient atmospheric pressure to torch gas comprising mixing liquid additive and liquefied hydrocarbon gas base which is gas at ambient atmospheric pressure, characterized by the additive comprising MEK in the range of 1% to 15% of the liquefied hydrocarbon gas base by weight and at least one of TBA and MTBE in an amount 0.5% to 3% of the liquefied hydrocarbon gas base by weight, and maintaining the hydrocarbon gas base in liquefied form by holding it under pressure while mixing such liquefied gas with the liquid additive.

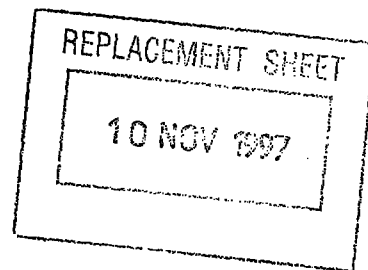
A principal object of this invention is to provide fortified hydrocarbon such as torch gas having characteristics superior to those of acetylene, especially for cutting ferrous metal, and also for welding. Such object also includes providing fortified hydrocarbon having characteristics superior to those of hydrocarbon fortified only by the addition of methyl ethyl ketone.

A particular object is to provide a torch gas which will have high flame temperature and intense heating capability.

This Sheet Has Been Replaced



THIS SHEET HAS BEEN
REPLACED



4

A further object is to provide torch gas that can be stored and transported easily and economically.

Another object is to provide a torch gas having a liquefied hydrocarbon gas base which is readily available in almost the entire world, can be provided more economically and is easy to fortify for enhancing its attributes.

It is also an object to provide a torch gas enabling ferrous metal to be cut faster and cleaner.

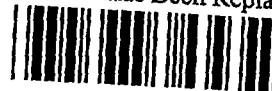
Another object is to provide a gas that can be used by torches for cutting under water at considerable depths.

An additional object is to provide a gas that can be used for torch cutting more economically because it will combine effectively with oxygen containing a higher proportion of adulterating gases which cannot be used with acetylene.

The foregoing objects can be accomplished by utilizing liquefied petroleum gas fortified with methyl ethyl ketone (MEK) and tertiary butyl alcohol (TBA) and/or methyl tertiary butyl ether (MTBE).

Liquefied petroleum gas (LPG) is the preferred base gas for the fortified torch gas of the present invention because of its high butane and propane content. Both the n-butane and isobutane

This Sheet Has Been Replaced



THIS SHEET HAS BEEN
REPLACED



10 NOV 1997

isomers of butane are usually present in LPG, but a substantial amount of butane may have been removed from LPG sold as fuel because of the demand from industry for butane derivatives, in which case the LPG is composed largely of propane. It is, however, desirable that there be a reasonable proportion of butane in the LPG, such as from 5% to 40%. Alternatively, the base gas could be propane or butane alone or any mixture of these gases or propylene.

The additive or conditioner used to fortify the base gas is methyl ethyl ketone (MEK), otherwise known as 2-butanone, having the formula $\text{CH}_3\text{COCH}_2\text{CH}_3$, which is enhanced with tertiary butyl alcohol or tert-butyl alcohol (TBA), having the formula $(\text{CH}_3)_3\text{COH}$, and/or methyl tert-butyl ether (MTBE), having the formula $(\text{CH}_3)_3\text{COCH}_3$. MEK is a liquid with a boiling point of 70.6 degrees C. and a specific gravity of 0.805 at 20 degrees C. At ambient temperature TBA is a waxy solid which melts at 25.6 degrees C. and has a specific gravity of 0.779 at 26 degrees C. At ambient temperature MTBE is a colourless liquid having a boiling point of 55 degrees C. and a freezing point of -110 degrees C. and has a specific gravity of 0.74.

LPG must be stored under pressure to keep it in a liquid state, but relatively heavy pressurized storage tanks and handling equipment for LPG is commercially practical and customary.

Without being fortified, LPG mixed with oxygen is not very effective for torch cutting and welding, not nearly as effective as acetylene gas mixed with substantially pure oxygen, but by enriching the base LPG with MEK enhanced with TBA and/or MTBE as an additive the flame temperature is considerably increased and the heating capability is greatly improved.

The amount of additive used will depend on the extent to which it is desired to improved the

THIS SHEET HAS BEEN
REPLACED

10 NOV 1997

characteristics of the base gas, but the amount preferably would be 1% to 15% MEK of the base gas by weight, preferably 3% to 10% MEK, enhanced with 0.5% to 3% TBA and/or MTBE of the base gas by weight, preferably 1% to 3% of TBA and/or MTBE. For use in fortifying torch gas such as LPG, an amount of TBA and/or MTBE up to 3% of the LPG by weight could be mixed with up to 15% of the LPG by weight of MEK, but sufficiently beneficial results are usually obtained by the use of 2% of TBA or MTBE of the LPG mixed with MEK in the amount of 10% of the LPG by weight.

The procedure for combining the additive with the LPG may be conducted as follows. MEK is a liquid at normal temperatures. To combine the TBA with MEK, the TBA may be melted by subjecting its container to warm water such as at a temperature of 40 degrees C. to 45 degrees C., and the TBA liquid is then simply mixed with the MEK liquid before the additive liquid is mixed with the hydrocarbon. MTBE liquid can be mixed with the MEK liquid before the additive liquid is mixed with the hydrocarbon. The additive is a liquid at normal temperatures and is supplied to the storage tank in which the LPG is to be stored or transported. It is quite practical to supply the additive to standard 55-gallon ≈ 208 drums.

The liquid additive may be supplied in conjunction with a catalyst, preferably activated carbon in the form of powder, granules or pellets. The activated carbon is amorphous, preferably having been produced from coal or petroleum coke. Alternative catalysts that can be used are platinum, cupric oxide and granular silver carried by a suitable carrier.

The amount of activated carbon used is not critical, but a sufficient amount should be placed in the bottom

This Sheet Has Been Replaced



REPLACEMENT SHEET

10 NOV 1997

7

of a storage container to facilitate blending of the additive with the hydrocarbon base gas when it is supplied to the container under pressure to liquefy it. An amount of such catalyst between 1% and 5% of the weight of the additive would be satisfactory. The resulting liquid mixture of pressure-liquefied gas base and liquid additive or conditioner will be azeotropic so that the fortified torch gas will be homogeneous when it is released from the pressurized storage container to the torch.

In order to provide an effective cutting flame, it is necessary to supply to an acetylene torch oxygen that is in substantially pure form, such as at least 99% oxygen by volume. Satisfactory cutting temperatures can be provided by mixing with the fortified gas base of the present invention less pure oxygen such as oxygen having a purity of approximately 95%, the adulterant being nitrogen, carbon dioxide and other gas components of air. Even when oxygen of 90% purity is used, the flame temperature of base LPG of approximately 2200°C (5000°F.) can be raised to approximately 3200°C (5800°F.) to 3310°C (6000 degrees F.) by use of the base LPG fortified by MEK and/or MTBE according to the present invention. Such impure oxygen can be produced economically by compressing air to about 4000 psi, ^($\approx 27.6 \text{ MPa}$) chilling it to minus 220°C (minus 360 degrees F.) which liquefies the air and then allowing the temperature of the liquefied air to rise gradually while venting the container to release the nitrogen component of the liquefied air which vaporizes at minus 200°C (minus 320 degrees F.) leaving the oxygen in liquid form.

THIS SHEET HAS BEEN
REPLACED

10 NOV 1967

In other processes for producing impure oxygen, nitrogen of the air is removed by zeolite resulting in oxygen of 90% to 95% purity.

An advantage of using the fortified base gas of the present invention over acetylene for cutting ferrous metal is that a clean precise kerf is obtained. Oxyacetylene cutting produces a hard scoria persistently adherent to the work which increases the heating required and usually must subsequently be chipped off the work. Utilization of the fortified torch gas of the present invention produces a soft friable scoria which is sloughed off the work and out of the kerf as the cutting progresses to leave a narrower clean kerf with virgin metal along opposite margins of the kerf.

A particular advantage which the fortified torch gas of the present invention has is that it can be used for flame cutting under water to a depth of 91.4m. (300 feet). The use of the oxyacetylene torch is limited to 6m (20 feet) under water because at pressures to which it would be necessary to subject the gas to enable it to be dispensed to the cutting torch at greater depths the acetylene will explode. Consequently, the only alternative that has been available for cutting under water at depths greater than about 6m (20 feet) prior to use of MEK as an additive to hydrocarbon gas has been the use of a carbon arc, the action of which is slow and the use of which is dangerous.

While the use of MEK has been beneficial in expediting cutting of metal and the use of MEK enhanced by the addition of TBA has increased the cutting speed from 5% to 10%, the use of MEK and MTBE in combination has increased the cutting speed to 20% to 25% faster than where MEK has been used alone as an additive and about 15% faster than the cutting speed where the MEK has been enhanced with TBA.

REPLACEMENT SHEET

10 NOV 1997

9

If the amount of additive is greater than 5%, a catalyst such as powdered activated carbon may be used to facilitate thorough mixing of the additive with the hydrocarbon.

To enhance the effectiveness of MEK as an additive for hydrocarbon base, an amount of TBA and/or MTBE can be mixed with the MEK up to 20% by weight of the amount of MEK.



REPLACEMENT SHEET

10 NOV 1997

10

CLAIMS

1. Fortified hydrocarbon liquid vaporizable at ambient atmospheric pressure to torch gas, including a mixture of liquefied hydrocarbon gas base which is gas at ambient atmospheric pressure and is kept in liquefied form by being held under pressure and additive, characterized by the additive comprising MEK within the range of 1% to 15% of the hydrocarbon gas base by weight mixed with at least one of TBA and MTBE in an amount of 0.5% to 3% of the hydrocarbon gas base by weight as additional additive.

2. The fortified hydrocarbon defined in claim 1, further characterised by the additive including an amount of MEK from 3% to 10% of the hydrocarbon gas base by weight, and the additional additive being ⁱⁿ the amount of 1% to 3% of the hydrocarbon base by weight.

3. The fortified hydrocarbon defined in claim 1 or claim 2, further characterized by the liquefied hydrocarbon gas base being LPG.

4. Process of making fortified hydrocarbon liquid vaporizable at ambient atmospheric pressure to torch gas comprising mixing liquid additive and liquefied hydrocarbon gas base which is gas at ambient atmospheric pressure, characterized by the additive comprising MEK in the range of 1% to 15% of the liquified hydrocarbon gas base by weight and at least one of TBA and MTBE in an amount 0.5% to 3% of the liquefied hydrocarbon gas base by weight, and maintaining the hydrocarbon gas base in liquefied form by holding it under pressure while mixing such liquefied gas with the liquid additive.



REPLACEMENT SHEET

10 NOV 1997

11

5. The process of making fortified hydrocarbon liquid defined in claim 4, further characterized by mixing the liquefied hydrocarbon base gas with additive in liquid form in the presence of activated carbon for facilitating the blending of the liquefied hydrocarbon gas base and the liquid additive into an azeotrope.

6. The process of making fortified hydrocarbon liquid defined in claim 4 or claim 5, further characterized by the liquefied hydrocarbon gas base being LPG.

7. Process of using fortified torch gas defined in claim 1, claim 2 or claim 3, including delivering the vaporized fortified torch gas to a cutting torch and simultaneously supplying oxygen to the cutting torch, characterised by the oxygen having a purity within the range of 90% to 98% by volume.

8. Process of torch cutting ferrous metal under water, characterized by supplying to a torch submerged in water a mixture of oxygen with vaporized fortified torch gas defined in claim 1, claim 2, or claim 3.

This Sheet Has Been Replaced



THIS SHEET HAS BEEN
REPLACED

05 OCT 1993

FORTIFIED HYDROCARBON AND PROCESS FOR MARKING AND USING
THE SAME

The present invention relates to hydrocarbons including gas for use in cutting and/or welding torches.

Various attempts have been made heretofore to improve gas used in cutting and/or welding torches by adding an additive or a double additive to them. These prior art gases have been composed of various hydrocarbons from methane to octane and some have included propane and butane. Harris U.S. patent No. 1,565,935, issued December 15, 1925, for example, fortified a wet casinghead gas composed of methane, ethane, propane, butane and hexane by the addition of ethyl ether or methyl ether. Another patent that proposed to add ethyl ether or ethyl oxide to a gas including propane or butane and propane is U.S. patent No. 2,513,769, issued July 4, 1950 (White). BE - A - 697 274 discloses mixtures containing a liquid hydrocarbon and an oxygenated derivative of a hydrocarbon. Among the oxygenated derivatives, propanone and methyl ethyl - ketone are cited.

British patent specification No. 813,981, published May 27, 1959 (Oxy-Ferrolene Limited) proposes to add to hydrocarbon gas an oxygen-containing compound such as isopropyl ether, methyl isopropyl ether, methyl propyl ether, normal propyl ether, ethanol and methanol.

British patent No. 813,981 suggests the incorporation of more than one compound but does not suggest any specific double compounds. Seley U.S. patent No. 2,411,759, issued November 26, 1946, does suggest the use of double additives, namely, ethyl oxide and benzine.

The White United States patent No. 2,951,750, issued September 6, 1960, refers to the prior double

05 OCT 1993

additives for torch gas of dimethyl ether and benzene at column 1, lines 21 to 25, presumably as disclosed in the Seley US patent No. 2,411,759 and then proposes the use of the double additive of propylene oxide and dimethyl ether at column 1, lines 55 to 62, instead of using benzene and dimethyl ether.

In addition, Kessler U.S. patent No. 3,591,355, issued July 6, 1971, proposed the addition of a double additive to torch gas, composed of a liquid alkanol such as methanol and a mixture of alkanes such as pentane and isopentane. White U.S. patent No. 3,989,479, issued November 2, 1976, also proposed the addition of methanol and British patent specification No. 569,108, accepted May 4, 1945, proposed the addition of ammonia. This British patent also recommended increasing the amount of propane in producer gas, water gas, Mond gas and other commercially available gas mixtures in which methane predominated.

Medsker U.S. patent No. 2,908,599, issued October 13, 1959, stated that methyl borate and acetone had been used previously in a fuel for torch use citing Bialosky et al US patent No. 2,281,910. The Medsker patent proposed a mixture of methyl borate and hexane as an additive for a gaseous fuel. The Bialosky et al. patent No. 2,281,910, issued May 5, 1942, discloses a liquid flux containing methyl borate and a ketone, such as acetone or methyl ethyl ketone, to be subjected to a stream of acetylene, hydrogen or similar combustible gas for coating the work with boric acid or oxide.

The principal torch gas used heretofore has been acetylene which is comparatively expensive, difficult to store and to transport, requires the use of almost pure oxygen with it and forms persistently adherent scoria when used for cutting ferrous metal.

05 OCT 1959

According to one aspect of the present invention there is provided a fortified hydrocarbon liquid vaporizable at ambient atmospheric pressure to torch gas, including a mixture of liquefied hydrocarbon gas base which is gas at ambient atmospheric pressure and is kept in liquefied form by being held under pressure and additive, characterized by the additive comprising methyl ethyl ketone (MEK) within the range of 1% to 15% of the hydrocarbon gas base by weight mixed with at least one of tertiary butyl alcohol (TBA) and methyl tertiary butyl ether (MTBE) in an amount of 0.5% to 3% of the hydrocarbon gas base by weight as additional additive.

In another aspect, the present invention provides a process of making fortified hydrocarbon liquid vaporizable at ambient atmospheric pressure to torch gas comprising mixing liquid additive and liquefied hydrocarbon gas base which is gas at ambient atmospheric pressure, characterized by the additive comprising MEK in the range of 1% to 15% of the liquefied hydrocarbon gas base by weight and at least one of TBA and MTBE in an amount 0.5% to 3% of the liquefied hydrocarbon gas base by weight, and maintaining the hydrocarbon gas base in liquefied form by holding it under pressure while mixing such liquefied gas with the liquid additive.

A principal object of this invention is to provide fortified hydrocarbon such as torch gas having characteristics superior to those of acetylene, especially for cutting ferrous metal, and also for welding. Such object also includes providing fortified hydrocarbon having characteristics superior to those of hydrocarbon fortified only by the addition of methyl ethyl ketone.

A particular object is to provide a torch gas which will have high flame temperature and intense heating capability.

REPLACEMENT SHEET

05 OCT 1980

4

A further object is to provide torch gas that can be stored and transported easily and economically.

Another object is to provide a torch gas having a liquefied hydrocarbon gas base which is readily available in almost the entire world, can be provided more economically than acetylene and is easy to fortify for enhancing its attributes.

It is also an object to provide a torch gas enabling ferrous metal to be cut faster and cleaner.

Another object is to provide a gas that can be used by torches for cutting under water at considerable depths.

An additional object is to provide a gas that can be used for torch cutting more economically than using acetylene because it will combine effectively with oxygen containing a higher proportion of adulterating gases which cannot be used with acetylene.

The foregoing objects can be accomplished by utilizing liquefied petroleum gas (LPQ) fortified with methyl ethyl ketone (MEK) and tertiary butyl alcohol (TBA) and/or methyl tertiary butyl ether (MTBE).

Liquefied petroleum gas (LPG) is the preferred base gas for the fortified torch gas of the present invention because of its high butane and propane content. Both the n-butane and isobutane

This Sheet Has Been Replaced



05 OCT 1990

isomers of butane are usually present in LPG, but a substantial amount of butane may have been removed from LPG sold as fuel because of the demand from industry for butane derivatives, in which case the LPG is composed largely of propane. It is, however, desirable that there be a reasonable proportion of butane in the LPG, such as from 5% to 40%. Alternatively, the base gas could be propane or butane alone or any mixture of these gases or propylene.

The additive or conditioner used to fortify the base gas is methyl ethyl ketone (MEK), otherwise known as 2-butanone, having the formula $\text{CH}_3\text{COCH}_2\text{CH}_3$, which is enhanced with tertiary butyl alcohol or tert-butyl alcohol (TBA), having the formula $(\text{CH}_3)_3\text{COH}$, and/or methyl tert-butyl ether (MTBE), having the formula $(\text{CH}_3)_3\text{COCH}_3$. MEK is a liquid with a boiling point of 70.6 degrees C. and a specific gravity of 0.805 at 20 degrees C. At ambient temperature TBA is a waxy solid which melts at 25.6 degrees C. and has a specific gravity of 0.779 at 26 degrees C. At ambient temperature MTBE is a colourless liquid having a boiling point of 55 degrees C. and a freezing point of -110 degrees C. and has a specific gravity of 0.74.

LPG must be stored under pressure to keep it in a liquid state, but relatively heavy pressurized storage tanks and handling equipment for LPG is commercially practical and customary.

Without being fortified, LPG mixed with oxygen is not very effective for torch cutting and welding, not nearly as effective as acetylene gas mixed with substantially pure oxygen, but by enriching the base LPG with MEK enhanced with TBA and/or MTBE as an additive the flame temperature is considerably increased and the heating capability is greatly improved.

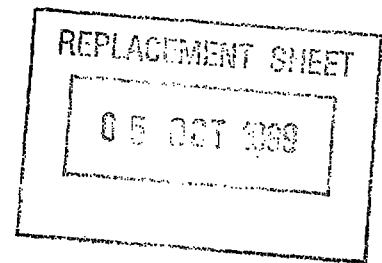
The amount of additive used will depend on the extent to which it is desired to improve the

05 OCT 1999

7

of a storage container to facilitate blending of the additive with the hydrocarbon base gas when it is supplied to the container under pressure to liquefy it. An amount of such catalyst between 1% and 5% of the weight of the additive would be satisfactory.

In order to provide an effective cutting flame, it is necessary to supply to an acetylene torch oxygen that is in substantially pure form, such as at least 99% oxygen by volume. Satisfactory cutting temperatures can be provided by mixing with the fortified gas base of the present invention less pure oxygen such as oxygen having a purity of approximately 95%, the adulterant being nitrogen, carbon dioxide and other gas components of air. Even when oxygen of 90% purity is used, the flame temperature of base LPG of approximately 2200°C (5000°F.) can be raised to approximately 3200°C (5800°F.) to 3310°C (6000 degrees F.) by use of the base LPG fortified by MEK and MTBE according to the present invention. Such impure oxygen can be produced economically by compressing air to about 4000 psi^(≈ 27.6 MPa), chilling it to minus 220°C (minus 360 degrees F.) which liquefies the air and then allowing the temperature of the liquefied air to rise gradually while venting the container to release the nitrogen component of the liquefied air which vaporizes at minus 200°C (minus 320 degrees F.) leaving the oxygen in liquid form.



11

5. The process of making fortified hydrocarbon liquid defined in claim 4, further characterized by mixing the liquefied hydrocarbon base gas with additive in liquid form in the presence of activated carbon for facilitating the blending of the liquefied hydrocarbon gas base and the liquid additive.

6. The process of making fortified hydrocarbon liquid defined in claim 4 or claim 5, further characterized by the liquefied hydrocarbon gas base being LPG.

7. Process of using fortified torch gas defined in claim 1, claim 2 or claim 3, including delivering the vaporized fortified torch gas to a cutting torch and simultaneously supplying oxygen to the cutting torch, characterised by the oxygen having a purity within the range of 90% to 98% by volume.

8. Process of torch cutting ferrous metal under water, characterized by supplying to a torch submerged in water a mixture of oxygen with vaporized fortified torch gas defined in claim 1, claim 2, or claim 3.



REPLACEMENT SHEET
10 NOV 1999
9600576-4

A further object is to provide torch gas that can be stored and transported easily and economically.

Another object is to provide a torch gas having a liquefied hydrocarbon gas base which is readily available in almost the entire world, can be provided more economically than acetylene and is easy to fortify for enhancing its attributes.

It is also an object to provide a torch gas enabling ferrous metal to be cut faster and cleaner.

Another object is to provide a gas that can be used by torches for cutting under water at considerable depths.

An additional object is to provide a gas that can be used for torch cutting more economically than using acetylene because it will combine effectively with oxygen containing a higher proportion of adulterating gases which cannot be used with acetylene.

The foregoing objects can be accomplished by utilizing liquefied petroleum gas (LPG) fortified with methyl ethyl ketone (MEK) and tertiary butyl alcohol (TBA) and/or methyl tertiary butyl ether (MTBE).

Liquefied petroleum gas (LPG) is the preferred base gas for the fortified torch gas of the present invention because of its high butane and propane content. Both the n-butane and isobutane