(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 4 286 496 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
06.12.2023 Bulletin 2023/49

(21) Application number: **22176738.7**

(22) Date of filing: **01.06.2022**

(51) International Patent Classification (IPC):
C10L 1/06 *(2006.01)*

(52) Cooperative Patent Classification (CPC):
C10L 1/06

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
KH MA MD TN

(71) Applicant: **Haltermann Carless Deutschland GmbH**
21107 Hamburg (DE)

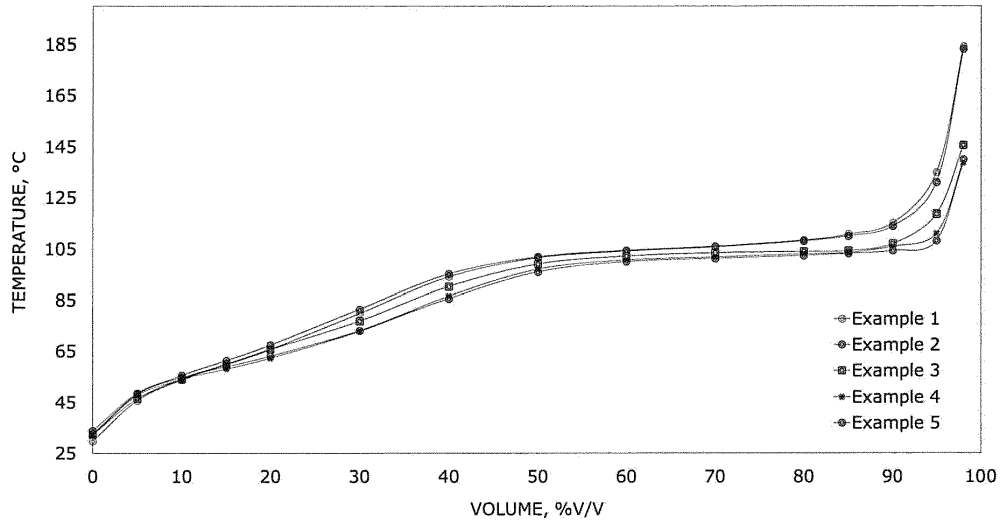
(72) Inventors:
- **SCHAAK, Jens**
  21107 Hamburg (DE)
- **GEISLER, Robert**
  21107 Hamburg (DE)

(74) Representative: **Hoefer & Partner Patentanwälte mbB**
Pilgersheimer Straße 20
81543 München (DE)

(54) SMALL ENGINE FUEL COMPOSITION WITH SPECIFIC CONTENT OF ISO-OCTANE

(57) The present invention is concerned with a gasoline composition for a small utility engine comprising 90 vol-% or more C5-C12 paraffins, 1 vol-% or less of naphthenes, 1 vol-% or less of aromatics, 1 vol-% or less of oxygenates, based on the total gasoline composition, and having a RON and/or MON of at least 92 wherein the content of iso-octane is at least 60.2 vol-%, the content of C5 isoparaffins is at least 10 vol-%, and the content of C10 to C14 isoparaffins is 1 to 5 vol-%, based on the total gasoline composition, a process for preparing the same and its use. It further pertains to the use of iso-octane in order to lower the final boiling point and/or the volume percentage vaporizing within 20°C, in particular within 10°C below the final boiling point of a gasoline composition for a small utility engine, and the use of renewable iso-octane for lowering the temperature at which 30 vol-%, preferably at which 40 vol-% of a gasoline for a small utility engine are vaporized, while increasing the temperature at which 80%, preferably at which 90% thereof are vaporized.

Fig. 1



EP 4 286 496 A1

Description

Technical Field

[0001] The present invention relates to the field of gasoline (or fuel) compositions for small utility engines. This term is used herein as a synonym for "SEF (small engine fuel)", "alkylate-based fuel" or "petrol fuel for small internal combustion engines". Such gasolines are very specific and different from the standard gasoline compositions that can be purchased e.g. at petrol stations, or aviation (jet) fuels, both regarding their requirements as well as their composition. In particular, the present invention pertains to a gasoline composition for a small utility engine wherein the content of iso-octane is within a specified elevated range as specified herein, the use of such an elevated content of iso-octane as such and of the small engine gasoline containing it, as well as a process for preparing the small engine gasoline according to the invention.

Background Art

[0002] Small utility engines, typically 2- or 4-stroke spark ignition engines, are used in various portable gasoline powered tools. Examples are chain saws or mowing machines. These engines are not as emission efficient as e.g. car engines. In order to avoid unacceptably high emission and health risks for the operators of small utility engine devices, specific gasoline compositions for small utility engines have been developed. They have low emission levels compared to e.g. standard 95 octane (Research Octane Number, RON) gasoline from the gas station, primarily comprise paraffins and contains no or very little aromatic compounds, naphthenes and olefins. Gasoline for small utility engines is thus a specific and different technical field. It has a mild odour and burns more cleanly, producing less particular emissions and fewer deposits. As specified above, the present invention is directed to a so called small engine gasoline or fuel. The present invention is thus not concerned with a jet
CONFIDENTIAL AND PRIVILEGED
fuel or aviation fuel, or a conventional fuel comprising naphthenes and/or aromatics in significant amounts above those as specified below.

[0003] WO2018/069137 A1 describes a gasoline composition, which comprises (a) admixing with an alkylate-base gasoline, such as a fossil alkylate base gasoline, comprising: 90 vol-% or more C5-C12 paraffins, 5 vol-% or less of naphthenes, 1 vol-% or less of aromatics, 1 vol-% or less of oxygenates, RON of at least 87, the alkylate base fuel in an amount in the range from 40 to 90 vol-% based on the total gasoline composition; (b) a renewable naphtha distillate comprising: 90 vol-% or more C5-C12 paraffins, 30 vol-% or more C5-C6 paraffins, 5 vol-% or less of naphthenes, 1 vol-% or less of aromatics, 1 vol-% or less of oxygenates, the renewable naphtha distillate in an amount of 1 vol-% or more, such as 3 vol-% or more, such as 5 vol-% or more, e.g. in the range from 3 to 10 vol-% based on the total gasoline composition; and (c) one or more C6-C12 isoparaffins having a RON of at least 95, the one or more isoparaffins in an amount in the range from 10 to 30 vol-% based on the total gasoline composition.

[0004] Within the development of gasoline compositions for small utility engines, there is however still the need to find specific compositions combining advantageous properties regarding the emissions and deposit, while at the same time providing the desired performance during the operation of the small utility engine, such as cold and warm start properties, rich come down behaviour and smooth long term operation.

Summary of the Invention

[0005] A first aspect of the present invention is directed to a gasoline composition for a small utility engine comprising 90 vol-% or more C5-C12 paraffins, 3 vol-% or less of naphthenes, 1 vol% or less of aromatics, 1 vol-% or less of oxygenates, based on the total gasoline composition, and having a RON and/or MON of at least 92, wherein the content of iso-octane is at least 60.2 vol-%, the content of C5 isoparaffins is at least 10 vol-%, and the content of C10 to C14 isoparaffins is 1 to 5 vol-%, based on the total gasoline composition. Preferably, the gasoline composition for a small utility engine according to the invention has a Motor Octane Number (MON) of at least 92, such as 92 to 98. Also, the content of C10 to C14 isoparaffins is preferably 1 to 4 vol-%, more preferably 1 to 3 vol-%, in particular 1 to 2 vol-%, based on the total gasoline composition.

[0006] A second aspect of the present invention is directed to the use of such a gasoline composition for a small utility engine in a spark ignition engine, preferably a 2-stroke engine or a 4-stroke engine in particular an engine for a garden tool, forestry tool, chain saw, clearing saw, outboard motor, lawn mower, lawn tractor, string trimmer, snow blower, snowmobile, backpack blower or sucker, water ski motor, jet ski, motocross, concrete mixers, or generator.

[0007] A third aspect of the present invention is directed to the use of iso-octane in a gasoline composition for a small utility engine to lower the final boiling point and/or the volume percentage vaporizing within 20°C, in particular within 10°C below the final boiling point of an alkylate based gasoline, pursuant to the determination of the distillation charac-

teristics according to DIN EN ISO 3405.

[0008] A fourth aspect of the present invention is directed to the use of renewable iso-octane instead of a fossil iso-octane for lowering the temperature at which 30 vol-%, preferably at which 40 vol-% of a gasoline for a small utility engine are vaporized, while increasing the temperature at which 80%, preferably at which 90% of the alkylate based gasoline are vaporized, pursuant to the determination of the distillation characteristics according to DIN EN ISO 3405.

[0009] A fifth aspect of the present invention is directed to a process for preparing a gasoline composition for a small utility engine as described herein, in particular according to any one of claims 1 to 11, comprising the following steps:

(a) selecting an alkylate base gasoline comprising 90 vol-% or more C5-C12 paraffins, 1 vol-% or less of naphthenes, 1 vol-% or less of aromatics, 1 vol-% or less of oxygenates, and preferably having a RON of at least 90, in particular at least 93,

(b) adjusting the levels of iso-octane, C5 isoparaffins and C10-C14 isoparaffins in the alkylate base fuel according to step (a) such that the content of iso-octane is in the range of 55 to 80 vol-%, the content of C5 isoparaffins is at least 10 vol-%, and the content of C10 to C14 isoparaffins is 1 to 5 vol-%, each based on the total gasoline composition. Preferably, the content of C10 to C14 isoparaffins is 1 to 4 vol-%, in particular 1 to 2 vol-%, based on the total gasoline composition.

[0010] As further detailed herein, the present invention allows a convenient and effective provision, preparation and use of small engine fuels having advantageous properties, in particular a reduced final boiling point and a smooth boiling point curve ensuring an even percentage of low evaporating proportions as well as high evaporating proportion and thus good starting properties at different temperatures as well as smooth operation of the small engines. Lowering the final boiling point has many advantages as known to the skilled person, e.g. reducing or avoiding the accumulation of unwanted residues in the combustion chamber engine and/or the production of potentially hazardous components, in particular those having a high boiling point.

Detailed Description of the Invention

[0011] It has been surprisingly found that an advantageous gasoline for small utility engines, also called "small engine fuel" or "SEF" herein, can be obtained if the total amount of iso-octane in the gasoline is in a specified (and elevated) range of at least 60.2 vol-%, preferably at least 60.5 vol-%, based on the total gasoline composition. This is particularly advantageous if the content of C5 isoparaffins is at least 10 vol-%, and the content of C10 to C14 isoparaffins is 1 to 5 vol-%, based on the total (volume of the) gasoline composition.

[0012] As used herein, the term "iso-octane" shall preferably mean all C8 isoparaffins.

[0013] It has been surprisingly found that at a total iso-octane content as specified herein, the final boiling point (FBP) of the SEF of the invention is surprisingly reduced, such that problems related to a high final boiling point are advantageously reduced or avoided.

[0014] It has also surprisingly been found that the effect on the (reduction of) the final boiling point is only seen if a certain overall content of iso-octane in the SEF is reached, namely a content as specified herein. In contrast, if an overall iso-octane content below the range as specified herein is present in the SEF, essentially no reduction of the final boiling point is observed.

[0015] According to a preferred embodiment of the present invention, the content of iso-octane in the gasoline (SEF) of the invention is at least 61%, more preferred at least 62 vol-%. Further, it is preferred that the content of iso-octane in the gasoline (SEF) of the invention is at most 80 vol-%, more preferred at most 78 vol-%, further at most 75 vol-%, in particular at most 70 vol-%, based on the total gasoline composition. Particular preferred ranges are from about 60.5 to about 80 vol-%, further from about 61% to about 75% vol-%, in particular from about 61.5% to about 70% vol-%, based on the total gasoline composition.

[0016] The effect of the elevated iso-octane content as specified herein on the reduction of the FBP is particularly advantageous if it is combined with a content of C5 isoparaffins of at least 10 vol-%, and the content of C10 to C14 isoparaffins is 1 to 5 vol-%, based on the total gasoline composition.

[0017] According to a further preferred embodiment of the present invention the content of C5 isoparaffins in the SEF of the invention is at least 15 vol-%, preferably at least 20 vol-%, and preferably not more than 30 vol-%, based on the total gasoline composition. More preferred, the content of C5 isoparaffins in the SEF of the invention is from about 21 to about 27 vol-%, as this was surprisingly found to have a very significant effect on the reduction of the FBP when combined with the iso-octane content as described herein (and preferably the content of C10 to C14 isoparaffins as described herein).

[0018] According to one preferred embodiment of the present invention, the SEF of the invention comprises a ratio of C5-isoparaffin to iso-octane between 0.34 to 0.45, in particular from 0.35 to 0.44. Such an addition of iso-pentane in the

specified range and ratio has been found to advantageously influence the boiling point curve in the lower temperature range, such that a higher percentage of the fuel composition will evaporate in a lower temperature range, providing superior cold start properties to the SEF of the invention.

[0019] It is also preferred that the content of C10 to C14 isoparaffins is less than 5 vol-%, in particular not more than 4 vol-% or even not more than 3 vol-%, based on the total gasoline composition. More preferred, the content of C10 to C14 isoparaffins is at the same time more than 0.5 vol-%, in particular at least 1 vol-%, based on the total gasoline composition. Thus, particular preferred ranges (convergent) are 1 to 4 vol-%, 1 to 3 vol-% or 1 to 2 vol-%, based on the total gasoline composition.

[0020] It has been surprisingly found that these specific contents of C5 isoparaffins on the one hand and C10-C14 isoparaffins on the other hand, together with the elevated content of iso-octane as specified herein, allow an advantageous reduction of the FBP, while at the same time ensuring the desired performance during the operation of the small utility engine, such as cold and warm start properties, rich come down behavior and smooth long term operation.

[0021] While some gasolines for small utility engines in the prior art contain a considerably higher content of C10 to C14 alkanes/isoparaffins, it has been surprisingly found that the fuel compositions according to the present invention do not require such a significantly higher content of C10 to C14 alkanes, and it is in fact disadvantageous to the surprising effect of a higher total iso-octane content on the reduction of the final boiling point and the reduction of unwanted residues in the combustion chamber engine.

[0022] According to a further preferred embodiment of the present invention, at least 25%, preferably at least 40%, in particular at least 50% of the iso-octane in the gasoline composition are from a renewable source, wherein the renewable content is determined by isotopic distribution involving ^{14}C, ^{13}C and/or ^{12}C as described in ASTM D6866. Unexpectedly, it was found that particular further advantages are obtained when at least a certain proportion of the overall iso-octane content of the SEF of the invention is iso-octane from a renewable source. Thus, it has been found that the overall boiling point curve of the SEF is advantageously modified such that a steeper and more even increase of the curve over a wide temperature range (or range of evaporated vol-%, respectively) is obtained. In particular, as also evident from Figure 2, the portion of the curve below about 50% of evaporated volume is lowered whereas the portion of the curve above about 50% of evaporated volume is increased, helping to avoid a too flat central part of the boiling point curve (which is undesired because a large volume percentage of the SEF evaporates within a very narrow temperature range). These modifications of the overall boiling point curve of the SEF of the invention are thus providing advantageous starting properties as well as smooth operation properties of the small combustion engines.

[0023] While the invention is not bound to any theory, it is believed that the slightly different composition of iso-octane from renewable sources, as compared to iso-octane from fossil sources may be responsible for the difference on the overall boiling point curve of the fuel. Therefore, it is preferred that the iso-octane from a renewable source has a total overall content of 2,2,4-Trimethylpentane, 2,3,4-Trimethylpentane and 2,2,3-Trimethylpentane of less than 90 vol-%, of the total volume of the iso-octane, and at least 10 vol-% of the iso-octane from a renewable source are other iso-C8 isomers, i.e. other isomers of a C8 isoparaffin.

[0024] According to a further preferred embodiment of the present invention, the SEF comprises at least 15 vol-%, preferably at least 20 vol-%, in particular at least 30 vol-%, based on the total gasoline composition, of iso-octane from a renewable source. The renewable content is determined by isotopic distribution involving ^{14}C, ^{13}C and/or ^{12}C as described in ASTM D6866.

[0025] In particular, the renewable iso-octane as used within the fuel of the present invention may be prepared by any process known in the art According to a preferred embodiment of the invention, the iso-octane from a renewable source can for example be prepared based on the methods described in US02015/0126787A1 (in particular Examples 38-40 and 42) or WO2011/140560 A1, i.e. methods comprising fermenting a biomass-derived feedstock to form one or more C2-C6 alcohols such as isobutanol, catalytically dehydrating and oligomerizing the alcohol(s) to form higher molecular weight olefins, and hydrogenating the olefins to form isoparaffins, including fractionation/distillation steps as appropriate to obtain renewable iso-octane (C8 isoparaffins).

[0026] Often, small engines are designed to run on 93 or higher octane rated fuels ((RON+MON)/2). The gasoline of the invention will generally have a RON and/or MON of at least 92, preferably a RON of at least 93, such as 93 to 98, and preferably a MON of 92 or higher, such as 92 to 97. Elevated engine temperatures require higher octane gasoline to prevent pre-ignition, which is to be avoided in small engines, so that higher octane numbers are often preferred. They are also preferred in high-end applications such as in outboard motors, snow mobiles, jet ski motors, motocross, and the like.

[0027] The most common type of octane rating is the RON which is determined by running the fuel in a test engine with a variable compression ratio under controlled conditions, and comparing the results with those for 2,2,4-Trimethylpentane (having an octane number (RON and MON) of 100 by definition) and n-heptane (having an octane number (RON and MON) of 0 by definition). The compression ratio is varied during the test in order to challenge the fuel's antiknocking tendency as an increase in the compression ratio will increase the chances of knocking.

[0028] Another type of octane rating, called MON, is determined at 900 rpm engine speed instead of the 600 rpm for

RON. MON testing uses a similar test engine to that used in RON testing, but with a preheated fuel mixture, higher engine speed, and variable ignition timing to further stress the fuel's knock resistance. Depending on the composition of the fuel, the MON will be somewhat lower than the RON, but there is no direct link between RON and MON.

[0029] According to a further preferred embodiment of the present invention, the SEF has a content of isoparaffins of at least 90 vol-%, preferably at least 93 vol-%, in particular at least 95 vol-%, in order to ensure high performance.

[0030] In many cases, it is preferred that less than 20% vol-%, in particular less than 15 vol-% of the SEF of the invention evaporate at temperatures above 110°C, pursuant to the determination of the distillation characteristics according to DIN EN ISO 3405. This enhances the positive effect of the high iso-octane content on the lowering of the FBP and reduction of unwanted emissions and residue.

[0031] According to a further aspect of the present invention, it has been found that the addition of a (renewable) naphta component to the SEF of the invention, in particular a (renewable) naphtha distillate comprising: 90 vol-% or more C5-C12 paraffins, 30 vol-% or more C5-C6 paraffins, 5 vol-% or less of naphthenes, 1 vol-% or less of aromatics, 1 vol-% or less of oxygenates, wherein the renewable content is determined by isotopic distribution involving 14C, 13C and/or 12C as described in ASTM D6866, is detrimental to the advantageous effects of the enhanced levels of (renewable) iso-octane as specified herein, together with the specified contents of the C5 isoparaffins and the C10-C14 alkanes/isoparaffins as specified herein. It is thus strongly preferred not to include any such (renewable) Naphtha component in the SEF of the invention, such as described and claimed in WO 2018/069137 A1 because it is detrimental for a reduction of the final boiling point as achieved by the SEF according to the present invention. Also, the addition of a renewable Naphtha component is disadvantageous regarding the effect of a high iso-octane content, in particular high renewable iso-octane content as specified herein on a smooth distillation curve and the desired balance of a sufficient percentage of the fuel composition evaporating at a relatively low temperature versus the proportion evaporating at a relatively high temperature.

[0032] The SEF of the present invention does not comprise any lead or any lead-containing compounds, in particular no lead-containing organic compounds.

[0033] Furthermore, the fuel of the present invention has a content of aromatic compounds of less than 1 vol-%, in particular less than 0.5 vol-%.

[0034] Furthermore, the content of oxygenates preferably in the range of below 2%, in particular below 1%, more particular below 0.5%, most preferably below 0.1%. According to a preferred embodiment, the level of oxygenates is equated to and determined for example as "oxygen" in % (m/m) according to DIN EN ISO 22854 or an equivalent norm.

[0035] According to a preferred embodiment of the invention, no oxygenates are artificially added or present in the fuel of the present invention.

[0036] Furthermore, the content of cycloparaffins in the fuel of the present invention is less than 0.5 vol-%, in particular less than 0.2 vol-%. According to a preferred embodiment, the "content of cycloparaffins" is equated to and measured as "cyclohexane compounds (<= C8)" according to DIN EN ISO 22854.

[0037] According to a further preferred embodiment, the gasoline composition for a small utility engine according to the invention comprises 0.1 vol-% or less of benzene, 1.0 % or less, more preferably 0.5 vol-% or less of olefins, 1 vol-% or less of naphthenes, 0.5 vol-% or less of aromatics, 0.5 vol-% or less of oxygenates, based on the total gasoline composition.

[0038] Preferably, the SEF of the present invention has a boiling range of 25 to 210 °C, in particular 30 to 200 °C.

[0039] According to a preferred aspect, the SEF of the invention fulfils the requirements of

- the Swedish norm SS155461 (last edition 2017) and/or
- the Swiss norm SN181163 (last edition 2015-07) and/or
- DIN 51641:2020-09.

[0040] The distillation curve is preferably measured according to EN ISO 3405 or its national versions. It may also be measured in accordance with a corresponding standard norm.

[0041] As stated above, the content of renewable components, in particular renewable iso-octane is determined by known methods, in particularly ASTM D6866. It may also be determined by a comparable standard method.

[0042] According to a further aspect of the present invention, the gasoline composition for a small utility engine may be used in a spark ignition engine, preferably a 4-stroke engine or a 2-stroke engine in particular an engine for a garden tool, forestry tool, chain saw, clearing saw, outboard motor, lawn mower, lawn tractor, string trimmer, snow blower, snowmobile, backpack blower or sucker, water ski motor, jet ski, motocross, concrete mixers, or generator, as known in the art.

[0043] Based on the surprising finding of a reduction of the FBP specifically within the iso-octane content of the SEF as specified herein, a further aspect of the invention is directed to the use of iso-octane to lower the final boiling point

of a gasoline composition for a small utility engine. In addition (or alternatively), it may be used to lower the volume percentage vaporizing within 20° C, in particular within 10°C below the final boiling point of a gasoline composition for a small utility engine, pursuant to the determination of the distillation characteristics according to EN ISO 3405 or its national versions. Within this use aspect of the invention, the ranges for iso-octane, C5 isoparaffins and C10 to C14 isoparaffins in the gasoline composition are adjusted to the ranges as described herein. Preferably, iso-octane is adjusted to a range of 60.2 to 80 vol-%, in particular 60.5 to 75 vol-%, and C5 isoparaffins are adjusted to a range of 20 to 30 vol-%, in particular 21 to 27 vol-%, based on the (total volume of the) total gasoline composition.

[0044] Based on the surprising finding regarding the renewable iso-octane content as specified herein, a further aspect of the invention is directed to the use of renewable iso-octane instead of a fossil iso-octane for lowering the temperature at which 30 vol-%, preferably at which 40 vol-% of a gasoline for a small utility engine are vaporized, while increasing the temperature at which 80%, preferably at which 90% of the gasoline for a small utility engine are vaporized, pursuant to the determination of the distillation characteristics according to EN ISO 3405 or its national versions. Within this use aspect of the invention, the ranges for iso-octane, C5 isoparaffins and C10 to C14 isoparaffins in the gasoline composition are adjusted to the ranges as described herein. Preferably, iso-octane is adjusted to a range of 60.2 to 80 vol-%, in particular 60.5 to 75 vol-%, and C5 isoparaffins are adjusted to a range of 20 to 30 vol-%, in particular 21 to 27 vol-%, based on the (total volume of the) total gasoline composition.

[0045] Preferably, within the aforementioned use aspects of the present invention, the gasoline composition for a small utility engine is as described herein, in particular it may comprise: 90 vol-% or more C5-C12 paraffins, 3 vol-% or less of naphthenes, 1 vol-% or less of aromatics, 2 vol-% or less, in particular 1 vol-% or less of oxygenates, based on the total gasoline composition, and has a RON and/or MON of at least 92. Further preferred, it has a RON of at least 93, such as 93 to 98. Further preferred, it has a MON of at least 92, such as 92 to 97. Further preferred, the specific (iso)paraffin contents and other components of the gasoline for a small utility engine are within the more narrow and more preferred range limits as specified herein.

[0046] A further aspect of the present invention is directed to a process for preparing a gasoline composition for a small utility engine according to any one of claims 1 to 12, comprising the following steps:

(a) selecting an alkylate base gasoline comprising 90 vol-% or more C5-C12 paraffins, in particular isoparaffins, 1 vol-% or less of naphthenes, 1 vol-% or less of aromatics, 1 vol-% or less of oxygenates, and preferably having a RON of at least 90, in particular 92. Preferably, the MON is at least 90.

(b) adjusting the levels of iso-octane, C5 isoparaffins and C10-C14 isoparaffins in the alkylate base fuel according to step (a) such that the content of iso-octane is in the range of 55 to 80 vol-%, the content of C5 isoparaffins is at least 10 vol-%, and the content of C10 to C14 isoparaffins is 1 to 5 vol-%, each based on the total gasoline composition. If the contents of C5 isoparaffins and C10-C14 isoparaffins, respectively, are already in the aforementioned ranges after adjusting the content of iso-octane, no separate adjustment is necessary. Thus, preferably, the iso-octane content is adjusted first, and then the contents of C5 isoparaffins and/or C10-C14 isoparaffins, if (or as) required to achieve a content of iso-octane in the range of 55 to 80 vol-%, a content of C5 isoparaffins of at least 10 vol-%, and a content of C10 to C14 isoparaffins of 1 to 5 vol-%, each based on the total gasoline composition.

[0047] For preparing or providing a gasoline for small utility engines according to the invention, it is possible to start with an alkylate base gasoline as known in the art. As described e.g. in WO2018/069137A, such alkylate base gasoline compositions are mostly paraffinic with often very little naphthenes, aromatics and oxygenates. They may be derived from the refining of crude oil and are sometimes blended from several petroleum refinery process streams. They may also be obtained by direct distillation of crude oil, catalytic and thermal cracking, hydrocracking, catalytic reforming, alkylation and polymerisation. Thus, alkylate base gasoline comprises often many different compounds, sometimes in the range of 40 or more different compounds. As an example, they may have an initial boiling point (IBP) of about 30°C or about 35°C and a final boiling point (FBP) of about 200°C. The hydrocarbons present in that distillation range usually range from those containing 4 or 5 carbon atoms to those containing about 10 to 12 carbon atoms. Preparation by admixing defined (single) components as specified herein for the SEF compositions of the invention is often a preferred embodiment.

[0048] The SEF of the present invention is mainly comprised of paraffins (alkanes), which can be straight-chain paraffins or the branched isoparaffins. The alkylate base gasoline, and also the gasoline for small utility engines according to the present invention will generally have 90 vol-% or more C5-C12 paraffins (in particular isoparaffins), such as preferably 95 vol-% or more C5-C12 paraffins. The SEF of the present invention may be a fossil gasoline composition or the major part of the gasoline composition may be of fossil origin. However, according to one embodiment of the present invention, at least a part of the SEF of the invention is from a renewable source.

[0049] The gasoline for small utility engines according to the present invention, and in fact an alkylate base fuel used as a starting material, has no or a very low content of naphthenes (cycloalkanes), which are alkanes with at least one

non-aromatic ring structure. In general, the gasoline may have about 1 vol-% or less, in particular 0.5 vol-% or less of naphthenes. It has no or a very low content of aromatics, i.e. compounds containing a benzene ring or other ring structure that is aromatic. In general, it contains 1 vol-%, preferably 0.5 vol-% or less, in particular 0.1 vol-% or less of aromatics. It also has no or a very low content of oxygenates, i.e. organic molecules that contain oxygen as part of their chemical structure. Those oxygenates, such as alcohols, ethers and esters, are usually employed as gasoline additives in order to reduce carbon oxides and soot created during the burning of the fuel. In general, the gasoline contains 1 vol-% or less, preferably 0.5 vol-% or less in particular 0.1 vol-% or less of oxygenates. Preferably, the gasoline of the invention contains no oxygenates at all.

[0050] As specified herein, all percentages given are %-vol/vol, i.e. vol-% based on the total volume of the fuel composition, unless otherwise specified.

[0051] According to a preferred embodiment of the present invention, the SEF may have a vapour pressure of 50 kPa or more, such as at least 55 kPa or more and as high as 65 kPa.

Explanation of Figures

[0052] Fig. 1 shows as an embodiment the reduction of the final boiling point (FBP) by SEF compositions according to the invention, in dependence of the overall iso-octane content of the composition.

[0053] As evident from Fig.1, whereas an overall iso-octane content below the range as specified herein provided virtually no reduction of the FBP, overall iso-octane contents within the range as specified herein for SEFs of the invention provided a significant reduction of the FBP.

[0054] Fig. 2 shows as an embodiment a comparison of the distillation curve for SEFs according to the invention comprising the same overall amount of iso-octane, either with or without a proportion of iso-octane from a renewable source. It is evident that if 40% of the iso-octane in the SEF according to the invention was from a renewable source, the overall gradient of the distillation curve was increased, i.e. more equal proportions of the overall fuel composition evaporated continuously over a wide temperature range, providing the performance advantages of the SEF as specified herein.

[0055] The invention is now illustrated by the following examples. Those are not intended to limit the scope of the present invention, which is defined solely by the appended claims.

EXAMPLES

[0056] The following gasoline compositions for small utility engines were prepared. The alkylate base fuel used as a starting material was a commercial alkylate composition as available in the art, having 99.5 vol-% C5-C12 paraffins (93.2 vol-% isoparaffins), less than 0.1 vol-% naphthenes, less than 0.3 vol-% aromatics, 0.1 vol-% of olefins and no oxygenates, based on the total composition.

[0057] The content of iso-octane and C5 isoparaffins was adjusted by the addition of (renewable) iso-octane as indicated below and C5 isoparaffins to a content of about 23 to 24 vol-%. The content of C10 to C14 isoparaffins in the final SEFs was below 5 vol-% in all final SEFs. The RON was in the 93 to 96 range, and MON was in the 92 to 94 range.

[0058] Three SEF compositions according to Swedish norm SS 155461:2017 were prepared, differing in their total content of iso-octane as follows. The final boiling points (determined in accordance with DIN EN ISO 3405 are also given in Table 1 below.

Table 1

Example	Total iso-octane content, calc.	Final Boiling point (FBP)
1	56.4 vol.-%	184 °C
2	60.1 vol.-%	183 °C
3	61.4 vol.-%	146 °C
4	62.0 vol.-%	139 °C
5	63.1 vol.-%	140 °C

[0059] The distillation curves (pursuant to the determination of the distillation characteristics according to DIN EN ISO 3405) are given in Figure 1. As can be seen therefrom, SEFs having a total content of iso-octane below the claimed range had a significantly higher FBP (which was basically unchanged if the content of isooctane was increased but still below the claimed range). In contrast, the SEFs according to the invention showed surprisingly a significant reduction

of the FBP.

[0060] In order to further illustrate the effect of using iso-octane from a renewable source (partially) instead of fossil iso-octane, starting from another alkylate base fuel (93,2 vol.-% C5-C12 paraffins (91,8 vol.-% isoparaffins), less than 0,1 vol.-% naphthenes, less than 0,3 vol.-% aromatics, less than 0,2 vol.-% olefins, less than 0,1 vol.-% oxygenates), an amount of 40 vol-% iso-octane from a renewable source (Renewable Isooctane 95, Haltermann Carless Deutschland GmbH) or 40 vol-% iso-octane from a fossil source (Iso-Oktan 100, Haltermann Carless Deutschland GmbH) were added, respectively, in order to bring the total iso-octane content in the SEF composition to the claimed range. The distillation curves (pursuant to the determination of the distillation characteristics according to DIN EN ISO 3405) are given in Figure 2. As can be seen therefrom, the portion of the distillation curve below about 50% of evaporated volume is lowered by the addition of renewable versus fossil iso-octane, whereas the portion of the curve above about 50% of evaporated volume is increased. This helps to avoid a flat central part of the boiling point curve (which is undesired because a large volume percentage of the SEF evaporates within a very narrow temperature range).

Claims

1. Gasoline composition for a small utility engine comprising:

90 vol-% or more C5-C12 paraffins,
3 vol-% or less of naphthenes,
1 vol-% or less of aromatics,
1 vol-% or less of oxygenates,
based on the total gasoline composition,
and having a RON and/or MON of at least 92,
wherein the content of iso-octane is at least 60.2 vol-%,
the content of C5 isoparaffins is at least 10 vol-%,
and the content of C10 to C14 isoparaffins is 1 to 5 vol-%,
based on the total gasoline composition.

2. Gasoline composition for a small utility engine according to claim 1, wherein the content of iso-octane is at least 60.5 vol-%, preferably at least 61% vol-%, in particular at least 62% vol-%, based on the total gasoline composition.

3. Gasoline composition for a small utility engine according to claim 1 or 2, wherein the content of iso-octane is at most 80 vol-%, preferably at most 78 vol-%, in particular at most 75% vol-%, based on the total gasoline composition.

4. Gasoline composition for a small utility engine according to any of the preceding claims, wherein the content of C5 isoparaffins is at least 15 vol-%, preferably at least 20 vol-%, and not more than 30 vol-%, preferably not more than 28vol-%, in particular 21 to 27 vol-%, based on the total gasoline composition.

5. Gasoline composition for a small utility engine according to any of the preceding claims, wherein the content of C10 to C14 isoparaffins is 1 to 5 vol-%, based on the total gasoline composition, preferably 1 to 4 vol-%, more preferably 1 to 3 vol-%, in particular 1 to 2 vol-%, based on the total gasoline composition.

6. Gasoline composition for a small utility engine according to any of the preceding claims, wherein at least 15%, preferably at least 40%, in particular at least 60% of the iso-octane in the gasoline composition are from a renewable source, wherein the renewable content is determined by isotopic distribution involving ^{14}C, ^{13}C and/or ^{12}C as described in ASTM D6866, and/or
comprising at least 15 vol-%, preferably at least 20 vol-%, in particular at least 30 vol-%, based on the total gasoline composition, of iso-octane from a renewable source, wherein the renewable content is determined by isotopic distribution involving ^{14}C, ^{13}C and/or ^{12}C as described in ASTM D6866.

7. Gasoline composition for a small utility engine according to any of the preceding claims, having a RON of at least 93, preferably at least 94, in particular 94 to 98, and/or a MON of at least 92, preferably at least 93, in particular 92 to 97.

8. Gasoline composition for a small utility engine according to any of the preceding claims, having a content of isoparaffins of at least 90 vol-%, preferably at least 93 vol-%, in particular at least 95 vol-%.

9. Gasoline composition for a small utility engine according to any of the preceding claims, wherein at most 20% by

volume of the fuel composition evaporate at temperatures above 110°C, pursuant to the determination of the distillation characteristics according to DIN EN ISO 3405.

10. Gasoline composition for a small utility engine according to any of the preceding claims, not comprising any renewable C5-C6 paraffins, in particular no renewable naphtha distillate comprising: 90 vol-% or more C5-C12 paraffins, 30 vol-% or more C5-C6 paraffins, 5 vol-% or less of naphthenes, 1 vol-% or less of aromatics, 1 vol-% or less of oxygenates, wherein the renewable content is determined by isotopic distribution involving ^{14}C, ^{13}C and/or ^{12}C as described in ASTM D6866.

11. Gasoline composition for a small utility engine according to any one of the preceding claims, comprising 0.1 vol-% or less of benzene, 1.0 % or less, more preferably 0.5 vol-% or less of olefins, 1 vol-% or less of naphthenes, 0.5 vol-% or less of aromatics, 0.5 vol-% or less of oxygenates, based on the total gasoline composition

12. Use of iso-octane to lower the final boiling point and/or the volume percentage vaporizing within 20°C, in particular within 10°C below the final boiling point of a gasoline composition for a small utility engine, pursuant to the determination of the distillation characteristics according to DIN EN ISO 3405.

13. Use of renewable iso-octane for lowering the temperature at which 30 vol-%, preferably at which 40 vol-% of a gasoline for a small utility engine are vaporized, while increasing the temperature at which 80%, preferably at which 90% of the gasoline for a small utility engine are vaporized, pursuant to the determination of the distillation characteristics according to DIN EN ISO 3405.

14. Use according to claim 12 or 13, wherein the gasoline composition for a small utility engine comprises:

90 vol-% or more C_5-C_{12} paraffins,
1 vol-% or less of naphthenes,
1 vol-% or less of aromatics,
1 vol-% or less of oxygenates,
based on the total gasoline composition,
and has a RON and /or MON of at least 92.

15. Process for preparing a gasoline composition for a small utility engine according to any one of claims 1 to 11, comprising the following steps:

(a) selecting an alkylate base gasoline comprising 90 vol-% or more C_5-C_{12} paraffins, 3 vol-% or less of naphthenes, 1 vol-% or less of aromatics, 1 vol-% or less of oxygenates, and preferably having a RON of at least 90,
(b) adjusting the levels of iso-octane, C5 isoparaffins and C10-C14 isoparaffins in the alkylate base fuel according to step (a) such that the content of iso-octane is in the range of 55 to 80 vol-%, the content of C5 isoparaffins is at least 10 vol-%, and the content of C10 to C14 isoparaffins is 1 to 5 vol-%, each based on the total gasoline composition.

Fig. 1

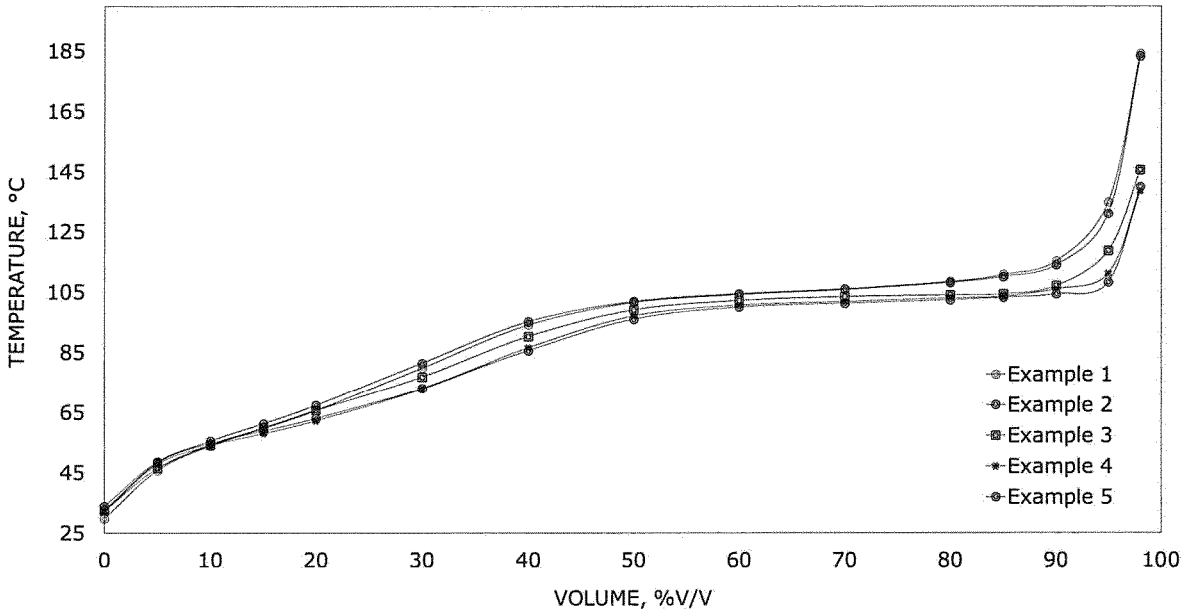
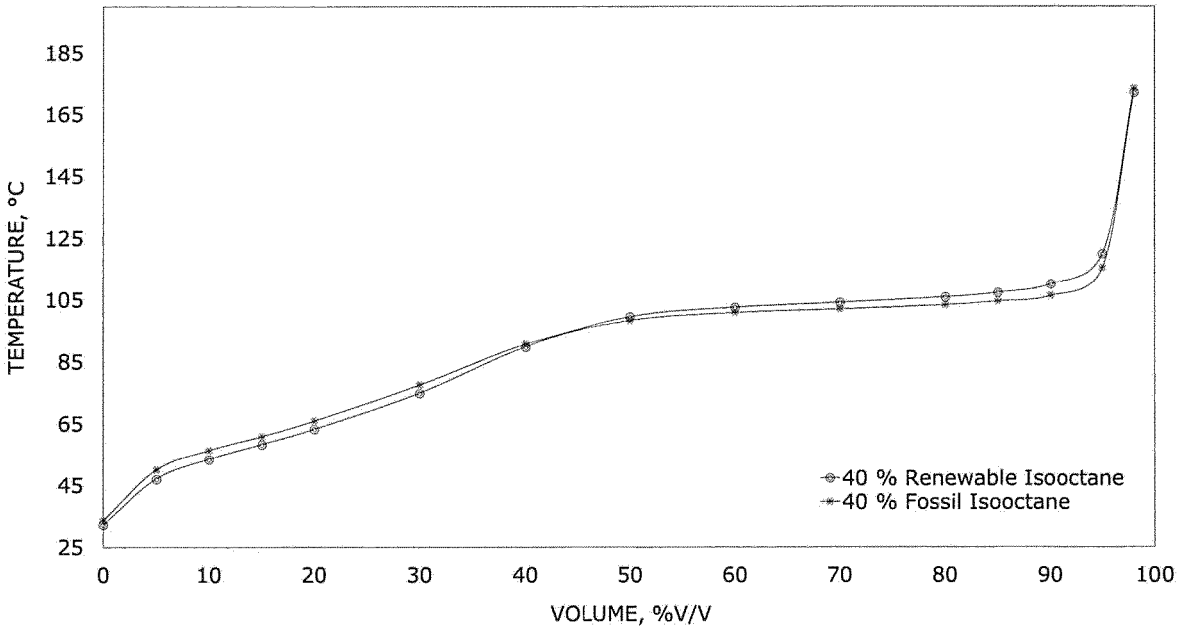

TEMPERATURE, °C
185
165
145
125
105
85
65
45
25
0
10
20
30
40
50
60
70
80
90
100
VOLUME, %V/V
Example 1
Example 2
Example 3
Example 4
Example 5

Fig. 2


TEMPERATURE, °C
185
165
145
125
105
85
65
45
25
0
10
20
30
40
50
60
70
80
90
100
VOLUME, %V/V
40 % Renewable Isooctane
40 % Fossil Isooctane

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 22 17 6738

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	WO 2008/073118 A1 (SHELL INT RESEARCH [NL]; LANDSCHOF JOERG [DE] ET AL.) 19 June 2008 (2008-06-19) * page 25, line 1 - line 7 *	1-11,15	INV. C10L1/06
X	GB 465 459 A (INT HYDROGENATION PATENTS CO) 3 May 1937 (1937-05-03) * page 1, line 37 - line 42 *	1-11,15	
X	FR 2 846 003 A1 (TOTAL FRANCE [FR]) 23 April 2004 (2004-04-23) * table 5 *	1-11,15	
X,D	WO 2018/069137 A1 (NESTE OYJ [FI]) 19 April 2018 (2018-04-19) * page 4, line 13 - line 30; claim 1; table 2 * * page 10, line 5 - line 11 * * page 14, line 7 - line 13 * * page 15, line 18 - page 16, line 2 *	12-14	
			TECHNICAL FIELDS SEARCHED (IPC)
			C10L C10G

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	1 November 2022	Deurinck, Patricia

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 22 17 6738

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

01-11-2022

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2008073118 A1	19-06-2008	AU 2006351908 A1	19-06-2008
		CA 2672211 A1	19-06-2008
		EP 2108032 A1	14-10-2009
		EP 2537913 A1	26-12-2012
		WO 2008073118 A1	19-06-2008
GB 465459 A	03-05-1937	NONE	
FR 2846003 A1	23-04-2004	NONE	
WO 2018069137 A1	19-04-2018	AU 2017343503 A1	11-04-2019
		BR 112019007510 A2	02-07-2019
		CA 3038000 A1	19-04-2018
		CN 109844073 A	04-06-2019
		DK 3526314 T3	28-09-2020
		EP 3526314 A1	21-08-2019
		JP 6774566 B2	28-10-2020
		JP 2019534925 A	05-12-2019
		KR 20190041527 A	22-04-2019
		SG 11201903222P A	30-05-2019
		US 2020048569 A1	13-02-2020
		WO 2018069137 A1	19-04-2018

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- WO 2018069137 A1 **[0003] [0031]**
- US 020150126787 A1 **[0025]**
- WO 2011140560 A1 **[0025]**
- WO 2018069137 A **[0047]**