

Composition and fuel mixture for reducing emissions and
fuel usage of combustion engines

The invention relates to a composition for use as a fuel additive and to a fuel mixture obtained by adding said composition to a fuel, for reducing harmful emissions and for reduction of fuel usage of combustion engines, and
5 to a method for reducing harmful emissions and/or reduction of fuel usage of combustion engines using said fuel mixture or said composition as a fuel additive.

Background

10 Combustion of hydrocarbon fuels results in the emission of gases and particulates that can be harmful for humans or for the environment. A major source of these harmful emissions are combustion engines, which are widely used in vehicles as power supply. These harmful emissions
15 comprise amongst others carbon dioxide (CO₂), carbon monoxide (CO), nitrogen oxides (NO_x) including nitric oxide (NO) and nitrogen dioxide (NO₂), hydrocarbons (HC), including methane (CH₄), non-methane hydrocarbons (NMHC), and particulate matter.

20 CH₄ and CO₂ are greenhouse gases that may contribute to global warming. NO_x comprise NO and NO₂, are harmful gases that are formed by the reaction between nitrogen (N₂) and oxygen (O₂) during combustion of fuels, and can cause air pollution, smog and acid rain. HC and CO are
25 formed by incomplete combustion of fuel and can adversely affect human health.

Hydrocarbons (HC) comprise methane (CH₄) and non-methane volatile organic compounds (NMHC). NMHC are in the

class of non-methane volatile compounds, this class of compounds is associated with long-term adverse health effects.

Particulates, also referred to as atmospheric particulate matter, are microscopic particles of solid or liquid matter suspended in liquid or air, such as soot. Airborne particulates can adversely affect human health upon inhalation.

Vehicle emission standards define quantitative limits on the amount of air pollutants released over a specific timeframe. In this context, European emission standards are regulations that control emissions of vehicles. These standards are becoming increasingly stringent. Accordingly, there is a need for reduction of harmful emissions produced by combustion engines.

It is also noted that the costs for fuel have increased significantly lately, so that consumers and companies are faced with high costs for transportation.

The present invention aims to reduce fuel consumption and harmful emissions of combustion engines.

Summary of the invention

The present invention relates in a first aspect to a composition that can be used as a fuel additive for reducing emissions and fuel usage of combustion engines comprising:

50 wt.% - 70 wt.% menthol;

10 wt.% - 20 wt.% essential oil, selected from the group of eucalyptus oil, tea tree oil, lemongrass oil and patchouli oil, or any mixture of two or more of these oils;

5 wt.% - 15 wt.% camphor;

5 wt.% - 15 wt.% naphthalene;

1.5 - 3.5 wt. % iron(III)oxide (Fe_2O_3); and
1.5 - 3.5 wt.% toluene.

The invention relates in a second aspect to a method
for reducing fuel usage and/or reducing harmful emissions
5 in exhaust gas of internal combustion engines comprising
the step of adding the composition of the first aspect to
fuel of an internal combustion engine.

The invention relates in a third aspect to a fuel
mixture obtained by adding the composition of the first
10 aspect to a fuel, preferably a liquid hydrocarbon fuel,
more preferably petrol (gasoline) or diesel oil.

The inventors have surprisingly found that by the use
of the composition of the first aspect as a fuel additive
harmful emissions and fuel usage of combustion engines are
15 reduced.

Brief description of the drawings

Figure 1 shows average bag emissions of hydrocarbons
(HC) of a test vehicle with and without the use of the
20 composition of the invention.

Figure 2 shows average bag emissions of methane (CH_4)
of a test vehicle with and without the use of the composi-
tion of the invention.

Figure 3 shows average bag emissions of non-methane
25 hydrocarbons (NMHC) of a test vehicle with and without the
use of the composition of the invention.

Figure 4 shows average bag emissions of nitrogen ox-
ides (NO_x) of a test vehicle with and without the use of
the composition of the invention.

30 Figure 5 shows average bag emissions of nitric oxide
(NO) of a test vehicle with and without the use of the
composition of the invention.

Figure 6 shows average bag emissions of hydrocarbons and nitrogen oxides ($\text{HC}+\text{NO}_x$) of a test vehicle with and without the use of the composition of the invention.

Figure 7 shows average bag emissions of carbon monoxide (CO) with and without the use of the composition of the invention.

Figure 8 shows average bag emissions of carbon dioxide (CO_2) with and without the use of the composition of the invention.

Figure 9 shows average bag emissions of particulates of a test vehicle with and without the use of the composition of the invention.

Figure 10 shows average bag emissions of the number of particulates of a test vehicle with and without the use of the composition of the invention.

Figure 11 shows average bag emissions of hydrocarbons (HC) of a test vehicle with and without the use of the composition of the invention during the UDC-phase and the EUDC-phase of an NEDC-test.

Figure 12 shows average bag emissions of methane (CH_4) of a test vehicle with and without the use of the composition of the invention during the UDC-phase and the EUDC-phase of an NEDC-test.

Figure 13 shows average bag emissions of non-methane hydrocarbons (NMHC) of a test vehicle with and without the use of the composition of the invention during the UDC-phase and the EUDC-phase of an NEDC-test.

Figure 14 shows average bag emissions of nitrogen oxides (NO_x) of a test vehicle with and without the use of the composition of the invention during the UDC-phase and the EUDC-phase of an NEDC-test.

Figure 15 shows average bag emissions of nitric oxide (NO) of a test vehicle with and without the use of the

composition of the invention during the UDC-phase and the EUDC-phase of an NEDC-test.

Figure 16 shows average bag emissions of hydrocarbons and nitrogen oxides (HC+NO) of a test vehicle with and without the use of the composition of the invention during the UDC-phase and the EUDC-phase of an NEDC-test.

Figure 17 shows average bag emissions of carbon monoxide (CO₂) of a test vehicle with and without the use of the composition of the invention during the UDC-phase and the EUDC-phase of an NEDC-test.

Figure 18 shows average bag emissions of carbon dioxide (CO) of a test vehicle with and without the use of the composition of the invention during the UDC-phase and the EUDC-phase of an NEDC-test.

Figure 19 shows average bag emissions of the number of particulates of a test vehicle with and without the use of the composition of the invention during the UDC-phase and the EUDC-phase of an NEDC-test.

Detailed description of the invention

The invention is based on the finding that a composition comprising 50 wt.% - 70 wt.% menthol; 10 wt.% - 20 wt.% essential oil, selected from the group of eucalyptus oil, tea tree oil, lemongrass oil and patchouli oil, or any mixture of two or more of these oils; 5 wt.% - 15 wt.% camphor; 5 wt.% - 15 wt.% naphthalene; 1.5 - 3.5 % wt. iron(III)oxide (Fe₂O₃); and 1.5 - 3.5 wt.% toluene, with a total weight of components adding up to 100 wt.%, results in reduction of harmful emissions when added to the fuel of a combustion engine. In addition, the inventors have found that the composition when added to a fuel results in more efficient fuel usage, i.e. in a reduction of fuel consumption.

The term "combustion engine" described herein refers to a piston or rotary heat engine powered by the combustion of a fuel with an oxidiser in a combustion chamber. For example, combustion engines may without limitation include the primary power supply for vehicles including cars, boats and aircrafts.

The term "harmful emissions" described herein is meant to refer to gases and particulates that have a negative impact on human health or the environment in general. These harmful emissions include without limitation the emission of hydrocarbons (HC), carbon monoxide (CO), carbon dioxide (CO₂), nitric oxides (NO_x), including nitric oxide (NO) and nitrogen dioxide (NO₂) and particulates, as also disclosed above in the background section of this application.

The composition according to the invention contains menthol. Menthol is very suitable for use in the composition of the invention. It is a terpenoid that may for example be obtained from the leaves of the plant *Mentha arvensis*. Different stereoisomeric forms of menthol exist, of which mainly (-)-menthol having a (1R,2S,5R)-configuration occurs naturally. As physical properties, apart from polarisation of polarised-light, of both enantiomers are the same, both enantiomers can in principle be used in preparation of the composition. For practical reasons, suitably the natural form, which is commercially best available, may be used. In other words, in the context of the present invention (-)-menthol is preferred. Alternatively, the racemic mixture may be used.

Menthol is commercially available and/or may be produced by steam distillation of the leaves of *Mentha arvensis*. Refining of the crude mint oil obtained by steam distillation may be achieved by vacuum filtration and cooling

to about 5-10°C to obtain menthol crystals. Centrifugation of the crystals gives menthol.

The composition according to the invention also contains camphor (bornan-2-one). It is a terpenoid that can be found in nature, for example in wood of the camphor laurel (*Cinnamomum camphora*) and the kupur tree (*Dryobalanops sp.*). The major naturally occurring isomer of camphor is (+)-camphor ((1R,4R)-bornan-2-one). Camphor can also be industrially produced as a racemic mixture from alpha-pinene. As physical properties, apart from polarisation of polarised-light, of both enantiomers are the same, both enantiomers can be used in preparation of the composition. Alternatively, the racemic mixture can be used. For practical reasons, suitably the natural form ((+)-camphor ((1R,4R)-bornan-2-one)) or the racemic mixture which are commercially best available, may be used.

The composition according to the invention also contains one or more essential oils, selected from the group of eucalyptus oil, tea tree oil, lemongrass oil and patchouli oil, or any mixture of two or more of these oils. Essential oils, also known as volatile oils, ethereal oils or aetheroleum, can also be described as oil of the plant from which the oil is derived such as eucalyptus oil, tea tree oil, lemongrass oil or patchouli oil. Often, essential oils are derived from seeds, stems, peels, fruits and/or blossom, on which often extraction using distillation, often steam distillation, is used to obtain the oil. An essential oil in the context of the invention can be a specific oil or a mixture of any essential oils.

Eucalyptus oil has a favourable octane number and has been used as fuel additive to prevent the separation of ethanol and petrol (gasoline) in fuel compositions. Surprisingly, the present inventors have found that its pres-

ence in the composition of the invention contributes to reduced emission of harmful materials and more efficient fuel usage. Therefore, in the context of the present invention eucalyptus oil is a preferred essential oil.

5 The composition according to the invention also contains iron(III)oxide (Fe_2O_3) or also referred to as red oxide. Red oxide, also known as iron(III)oxide or ferric oxide is one of the three main oxides of iron, and has the formula Fe_2O_3 and is a preferred metal oxide in the context
10 of the present application. Red oxide is a red pigment that occurs naturally in the mineral hematite. It may be produced by calcination of copperas, calcination of iron hydrates which have been prepared by chemical precipitation from ferrous iron containing solutions, or by mixing
15 iron salts with alkaline materials in the dry state followed by calcination of the mixture.

The composition according to the invention also contains toluene and naphthalene.

Toluene is very suitable for use in the composition
20 of the invention. It is an aromatic compound that occurs in crude oil, natural gas deposits and the volatile emission from volcanoes and forest fires. Toluene can be produced by refining of petroleum. It is produced as an aromatic mixture with benzene and xylene (this mixture is also known as BTX) by catalytic reforming and pyrolytic
25 cracking. Toluene is used a blending agent in petrol (gasoline) due to its high octane number and low volatility.

Also naphthalene is very suitable for use in the composition of the invention. It is a polycyclic aromatic hydrocarbon (PAH) that can be obtained from coal tar or petroleum. Distillation and fractionation of coal tar is the
30 most common process to obtain naphthalene. Naphthalene is

known to increase the octane number of petrol (gasoline) fuel for internal combustion engines.

In a particularly preferred embodiment the composition comprises:

- 5 60 wt.% menthol;
- 15 wt.% essential oil, selected from the group of eucalyptus oil, tea tree oil, lemongrass oil and patchouli oil or any mixture of two or more of these oils;
- 10 wt.% naphthalene;
- 10 10 wt.% camphor;
- 2.5 wt.% iron(III)oxide (Fe_2O_3);
- 2.5 wt.% toluene;

wherein preferably the essential oil comprises eucalyptus oil.

- 15 Although the inventors do not wish to be bound by a theory, the composition is believed to work by increasing the octane number of the fuel, giving the fuel a higher ability to withstand compression in an internal combustion engines. The increase in octane number gives rise to liberation of more energy during the combustion cycle which as a result leads to the generation of more power. Increased kinetic energy from the exhaust gas leads to higher power output from the same amount of fuel, resulting in lower emission and improved fuel economy.
- 20

- 25 Additionally or alternatively, without wishing to be bound by theory, the composition is believed to work by removing accumulated carbon deposits in for example the induction system and combustion chambers of the engine. The engine is thus cleaned by lowering deposits on internal part of the engine, thereby allowing lower engine temperatures. Lower engine temperatures can lead to reduced emissions of NO_x . Additionally, the composition of the invention may lead to improved fuel oxidation, in turn lead-
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ing to reduced harmful emissions and less carbon deposition to be produced. Carbon deposits can saturate the engine oil, also known as motor oil or engine lubricant. By preventing deposition of carbon, less deposits will enter
5 the motor oil resulting in reduced oil usage.

In one embodiment the composition of the invention is in solid form, preferably in a unit dose form, such as a tablet which can for example be formed by moulding or by compression, optionally along with binders. Binders may be
10 used to keep the unit dose of the composition together and may for instance comprise natural or synthetic polymers, resins, waxes, oils, and/or gums. It is noted that the above disclosed preferred composition comprising:

60 wt.% menthol;
15 15 wt.% essential oil, selected from the group of eucalyptus oil, tea tree oil, lemongrass oil and patchouli oil or any mixture of two or more of these oils, preferably eucalyptus oil;
10 wt.% naphthalene;
20 10 wt.% camphor;
2.5 wt.% iron(III)oxide (Fe_2O_3);
2.5 wt.% toluene, does not require the addition of a binder. The inventors have found that this composition advantageously binds together spontaneously and can as such
25 be pressed into a unit dosage form.

Apart from binders, the composition of the invention may in addition or alternatively comprise further components. It is however preferred that the composition consists of the abovementioned and specified at least one
30 terpenoid, at least one essential oil, at least one metal oxide, and at least one aromatic compound, optionally with incidental impurities.

In another embodiment, the solid unit dose form comprising the composition of the invention is used to supplement fuel, wherein the solid unit dose contains preferably 0.5-5 grams, 1-4 grams, 1.5-2 grams, such as about 5 1.6 grams of said composition to supplement a pre-determined amount of fuel, such as 10 litres of fuel.

In a particularly preferred embodiment the unit dose form comprises 0.96 gram menthol, 0.24 gram essential oil, preferably eucalyptus oil, 0.16 gram naphthalene, 0.16 10 gram camphor, 0.04 gram toluene and 0.04 gram red oxide, based on a composition comprising 60 wt.% menthol; 15 wt.% essential oil, selected from the group of eucalyptus oil, tea tree oil, lemongrass oil and patchouli oil or any mixture of two or more of these oils, preferably eucalyptus 15 oil; 10 wt.% naphthalene; 10 wt.% camphor; 2.5 wt.% iron(III)oxide (Fe_2O_3); 2.5 wt.% toluene.

In another embodiment the composition of the invention is added to the fuel of a combustion engine, to form a fuel mixture in which the composition is dissolved. Fuel 20 for combustion engines may be different of types, including liquid fuel for internal combustion engines, hydrocarbon fuels, alcohol-based fuel. Preferably, the fuel is a hydrocarbon fuel, more preferably petrol (gasoline) or diesel oil.

25 In another embodiment, the fuel of the combustion engine is diesel oil.

In yet another embodiment, a method of reducing emissions and/or fuel consumption includes addition of one dosage form comprising 1-5 grams, 1-4 grams, 1.5-2 grams, 30 such as about 1.6 grams of the composition according to the invention to the fuel tank per 10 litres of fuel, preferably based on based on a composition comprising 60 wt.% menthol; 15 wt.% essential oil, selected from the

group of eucalyptus oil, tea tree oil, lemongrass oil and patchouli oil or any mixture of two or more of these oils, preferably eucalyptus oil; 10 wt.% naphthalene; 10 wt.% camphor; 2.5 wt.% iron(III)oxide (Fe_2O_3); and 2.5 wt.% toluene. The dosage form may be allowed to mix with the fuel for about 5-10 minutes.

Preferably, during a first use of the composition as fuel supplement for a combustion engine, an initial use of the composition is in a relatively high dose compared to a later use.

Preferably, during the initial use, a double dose of the composition is used, for example to two dosage forms as defined above per 10 litres of fuel in a full fuel tank of the corresponding vehicle. After the full tank containing two dosage forms per 10 litres of fuel is used up, one unit dose per 10 litres of fuel can be used upon refill of the tank. For consecutive refills a single dose will also suffice.

Optimal results for petrol (gasoline) engines are obtained after use of at least twice the volume of a full fuel tank from the corresponding vehicle of fuel containing the added optimal amount of the composition.

Optimal results for diesel engines are obtained after use of at least three times the volume of a full fuel tank from the corresponding vehicle of fuel containing the added optimal amount of the composition.

Optimal results for old or polluted diesel engines, for examples diesel engines that do not meet the European Emission standards, such as Euro 1 to Euro 6, are obtained after use of at least four times the volume of a full fuel tank of the corresponding vehicle of fuel containing the added optimal amount of the composition.

Examples

The following examples are meant to illustrate the invention and not to limit the claims. In the following examples the inventors performed experiments to show reduced emissions for HC, CH₄, NMHC, NO, NO_x, HC+NO_x, CO, CO₂, particulates, number of particulates when the composition according to the invention is used. Furthermore, the experiments show reduced fuel use when the composition according to the invention is used, comprising:

- 10 60 wt.% (-)-menthol (natural form);
 15 wt.% eucalyptus oil;
 10 wt.% naphthalene;
 10 wt.% camphor (natural form);
 2.5 wt.% toluene;
15 2.5 wt.% iron(III)oxide (Fe₂O₃). This composition is
 in the form a solid unit dosage of 1.6 grams, pressed as a
 tablet without addition of (additional) binders.

20 **Example 1: Reduction of emissions using the composition**
 according to the invention.

The inventors carried out a series of emission tests to measure the effect of the composition according to the invention on emission of HC, CH₄, NMHC, NO, NO_x, HC+NO_x, CO, CO₂, mass of particulates and number of particulates.

25 The experiments were carried out by subjecting a test vehicle to a series of three emission tests using a dynamometer test using the New European Driving Cycle (NEDC) in which the composition according to the invention is added to the fuel mixture and three emission tests wherein said composition is not added to the fuel mixture.

30 One unit dose of 1.6 grams of the composition according to the invention per 10 litres of fuel is added to the fuel of the test vehicle, wherein twice the volume of a

full fuel tanks containing the composition are used prior to the emission test. Technical details retrieved from the Dutch motor authority (RDW) of the test vehicle are described in table 1.

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Table 1: General data of the test vehicle

Manufacturer	Mercedes Benz
Type:	Citan 3175
Year:	2017
Engine type:	Diesel
Power:	55 kW (75 hp)
Number of cylinders:	4
Engine displacement:	1461 cm ³
Registered fuel consumption(combined):	4.5 l/100km (22.2 km/L)
Registered CO ₂ emission (NEDC, combined):	116 g/km
Transmission:	Manual, 5 gears

The NEDC is a standardised test procedure wherein the driving cycle represents the speed of a vehicle versus time by a series of data points. The test is run on a cold vehicle (between 20-30°C).

The NEDC comprises two phases, the first phase comprises four consecutive ECE-15 urban driving cycles, collectively referred to as Urban Driving Cycle (UDC) and

takes a total of 780 seconds. The UDC-phase is designed to represent typical driving conditions of European cities.

The second phase of the NEDC-test comprises one Extra-Urban driving cycle (EUDC) and takes 400 seconds.

5 EUDC-phase represents a higher speed driving mode.

Harmful emissions are sampled by a constant volume sampling (CVS) system. During the test a constant volume sample of the exhaust is diluted and collected in a bag. The concentration of each harmful component in this bag
10 may be measured at the end of the test.

Bag emission values for HC, CH₄, NMHC, NO, NO_x, HC+NO_x, CO, CO₂, particulates and number of particulates are reported for the New European Driving Cycle (NEDC).

Table 2 shows the values measured by the NEDC-test
15 with and without use of the composition according to the invention.

Bag emission values for HC, CH₄, NMHC, NO, NO_x, HC+NO_x, CO, CO₂, particulates and number of particulates are reduced when the composition of the invention is used.

20 Average emission data with and without the use of the composition of the invention, as shown in table 2, are represented in diagram form in figures 1-10.

Table 2: NEDC Emission data of the test vehicle in triplicate with and without the composition of the invention added to the fuel.

	Without additive				With additive				Reduction with additive
	Test 1	Test 2	Test 3	Average	Test 1	Test 2	Test 3	Average	
HC (mg/km)	35.594	32.443	27.342	31.793	48.178	12.399	7.507	22.69467	28.6%
CH ₄ (mg/km)	10.182	8.435	8.793	9.136667	6.079	5.04	6.899	6.006	34.3%
NMHC (mg/km)	26.7106	25.0834	19.6699	23.8213	39.6287	14.6925	17.614	23.9784	N/A
NO _x (mg/km)	187.8803	187.0946	195.3919	190.1223	111.0123	92.0854	74.1074	92.4017	51.4%
NO (mg/km)	112.5467	111.553	116.9888	113.6962	81.6981	69.5063	55.0384	68.7476	39.5%
HC+NO _x (mg/km)	223.4748	219.5379	222.7339	221.9155	167.7274	137.4848	127.614	144.2754	35.0%
CO (mg/km)	239.6437	190.4516	200.7956	210.297	119.87	104.8619	106.1107	110.2809	47.6%
CO ₂ (g/km)	141.27	141.06	140.19	140.84	80.47	68.57	52.47	67.17	52.3%
Particulates (mg/km)	0.062	0.067	0.016	0.048333	0.038	0.012	0.032	0.027333	43.4%
Number of particulates (1/km)	5.93E+10	2.02E+10	7.34E+09	2.89E+10	2.08E+10	3.12E+09	2.44E+09	8.79E+09	69.7%

Example 2: Reduction of emissions using the composition according to the invention during the two phases of the NEDC-test.

5 The effect of the composition of the invention on the reduction of emissions during the two different phases of the NEDC-test of example 1 is compared. The first phase (UDC) includes a cold start, therefore emissions of harmful gases and particulates during this phase are typically
10 higher. Lower engine temperature relative to normal operating temperature as a result of the cold start can lead to increased levels of incomplete combustion. In addition, before the operating temperature of the catalytic converter is reached, the 3-way catalytic converter is not completely
15 able to convert CO, HC and NO_x to CO₂, H₂O and N₂, resulting in higher emission of harmful gases and particulates.

 The effect of the use of the composition during both phases of the NEDC is therefore compared. Table 3 shows
20 the bag emission values for the UDC-phase of the NEDC. Table 4 shows the bag emission values for the EUDC phase of the NEDC. The decrease in harmful emissions during both the UDC and EUDC phase of the NEDC when the composition according to the invention is used is compared in table 5.

25 Average emission data with and without the use of the composition of the invention during the UDC-phase and the EUDC-phase of an NEDC-test, as shown in table 3 and 4, are represented in diagram form in figures 11-19.

Table 3: UDC-Emission data of the test vehicle in triplicate with and without the composition of the invention added to the fuel.

	Without additive				With additive				Reduction with additive
	Test 1	Test 2	Test 3	Average	Test 1	Test 2	Test 3	Average	
HC (mg/km)	64.686	62.822	54.707	60.73833	76.065	36.148	27.304	46.50567	23.4%
CH ₄ (mg/km)	9.766	8.69	8.588	9.014667	6.511	5.455	4.211	5.392333	40.2%
NMHC (mg/km)	56.1648	55.2397	47.2137	52.87273	65.6391	33.7706	29.1393	42.84967	19.0%
NO _x (mg/km)	253.891	256.8131	281.427	264.0437	145.751	126.3645	101.4583	124.5246	52.8%
NO (mg/km)	149.2961	149.7269	164.7992	154.6074	105.4228	93.7127	71.5258	90.22043	41.6%
HC+NO _x (mg/km)	318.5768	319.6354	336.1343	324.7822	240.8159	183.5129	157.7622	194.0303	40.3%
CO (mg/km)	368.7964	348.1234	342.3554	353.0917	236.9548	210.2792	190.0642	212.4327	39.8%
CO ₂ (g/km)	158.02	159.28	157.83	158.3767	115.75	95.05	73.8	94.86667	40.1%
Particulates (mg/km)	0.062	0.067	0.016	0.048333	0.038	0.012	0.032	0.027333	43.4%
Number of particulates (1/km)	1.55E+11	5.00E+10	1.63E+10	7.38E+10	5.26E+10	4.05E+09	3.61E+09	2.01E+10	72.8%

Table 4: EUDC-Emission data of the test vehicle in triplicate with without the composition of the invention added to the fuel.

	Without additive				With additive				Avg Re-duction with additive
	Test 1	Test 2	Test 3	Average	Test 1	Test 2	Test 3	Average	
HC (mg/km)	18.595	14.685	11.266	14.84867	20.291	5.144	4.827	4.827	67.5%
CH ₄ (mg/km)	10.425	8.286	8.913	9.208	5.647	4.419	3,717	3.717	59.6%
NMHC (mg/km)	9.4988	7.4552	3.4887	6.814233	13.6184	3.4162	3.0938	3.0938	54.6%
NO _x (mg/km)	149.3067	146,3398	144.8486	146.8317	56.2613	47.5197	44.2531	44.2531	69.9%
NO (mg/km)	91.072	89.238	88.9016	89.7372	64.1812	43.8412	39.3914	39.3914	56.1%
HC+NO _x (mg/km)	167.9015	161.0248	156.1142	161.6802	105.5524	91.664	120.0804	120.0804	25.7%
CO (mg/km)	164.9015	98.2829	117.633	126.9391	12.2673	1.6014	3.8288	3.8288	97.0%
CO ₂ (g/km)	131.49	130.42	129.82	130.5767	56.85	48.92	37.91	37.91	71.0%
Number of particulates (1/km)	3.32E+09	2.70E+09	2.10E+09	2.71E+09	2.36E+09	2.19E+09	1.76E+09	1.76E+09	35.0%

Table 5: Comparison of emission reduction by use of the composition of the invention in the UDC and EUDC phase of the NEDC-emission test.

	Average reduction with additive during UDC	Average re-duction with additive during EUDC	Difference (UDC-EUDC)
HC (mg/km)	23.4%	67.5%	+44.1%
CH ₄ (mg/km)	40.2%	59.6%	+19.5%
NMHC (mg/km)	19.0%	54.6%	+35.6%
NO _x (mg/km)	52.8%	69.9%	+17.0%
NO (mg/km)	41.6%	56.1%	+14.5%
HC+NO _x (mg/km)	40.3%	25.7%	-14.5%
CO (mg/km)	39.8%	97.0%	+57.1%
CO ₂ (g/km)	40.1%	71.0%	+30.9%
Number of par-ticulates (1/km)	72.8%	35.0%	-37.8%

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The data in table 5 show that reduction of emission of HC, CH₄, NHMC, NO_x, NO, HC+NO_x, CO and CO₂ is larger in the EUDC phase of the NEDC-test. Furthermore the data in table 5 shows that the reduction of mass and number of particulates is larger during the UDC-phase of the NEDC-test.

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Example 3: Reduction of emissions using the composition in relation to the Euro 6 emission norm.

Emissions of the test vehicle of example 1 with and without use of the composition according to the invention are compared to the Euro 6 standard. The Euro 6 standard is the most recent European vehicle emission standard in which the emission of NO_x , $\text{HC}+\text{NO}_x$, CO, particulates and number of particulates are regulated. Bag emission data from an NEDC-test in respect to the Euro 6 standard are shown in table 6.

The data in table 6 show that without the use of the composition according to the invention the NO_x and $\text{HC}+\text{NO}_x$ emission limits are exceeded without the use of any additive. When the composition according to the invention is used, the requirements of the Euro 6 norm are met for both NO_x and $\text{HC}+\text{NO}_x$.

The average value for NO_x emission is at 237,7% of the Euro 6 standard limit without the use of any additive and therefore does not comply with the Euro 6 standard. When the composition according to the invention is used, the value for NO_x emission is at 30,3% of the Euro 6 standard limit, and therefore complies with the Euro 6 standard.

The average value for $\text{HC}+\text{NO}_x$ emission is at 130,3% of the Euro 6 standard limit without the use of any additive and therefore does not comply with the Euro 6 standard. When the composition according to the invention is used, the average value for $\text{HC}+\text{NO}_x$ emission is at 29,3% of the Euro 6 standard, and therefore complies with the Euro 6 standard.

The average value for CO emission is at 42% of the Euro 6 standard limit without the use of any additive. When the composition according to the invention is used,

the average value for HC+NO_x emission is at 19,7% of the Euro 6 standard.

The average emission value for the number of particulates is at 4.7% of the Euro 6 standard limit without the
5 use of any additive. When the composition according to the invention is used, the average value for HC+NO_x emission is at 1.3% of the Euro 6 standard.

Table 6: NEDC-Emission data of the test vehicle in triplicate with and without the composition of the invention added to the fuel compared to the Euro 6 standard.

	Test 1 without additive		Test 2 without additive		Test 3 without additive		Average	
	Euro 6 Threshold	Value	% of threshold	Value	% of threshold	Value	Value	% of threshold
NO _x (mg/km)	80.000	187.8803	235	187.09	234	195.3919	190.1207	237.7%
HC+NO _x (mg/km)	170	223.4748	131	219.5379	129	222.7339	221.9155	130.3%
CO (mg/km)	500	239.6437	48	190.45	38	200.7956	210.2964	42%
Particulates (mg/km)	4.5	0.06236	1	0.06688	1	0.01646	0.048567	0.67%
Number of particulates (1/km)	6.00E+11	5.93E+10	10	2.02E+10	3	7.34E+11	2.71E+11	4.7%
		Test 1 with additive		Test 2 with additive		Test 3 with additive		
NO _x (mg/km)	80	24.4147	30	15.0854	19	11.1074	16.86917	21%
HC+NO _x (mg/km)	170	66.7274	31	55.4848	32	42.614	54.94207	29.3%
CO (mg/km)	500	126.87	25	103.8619	20	72.1107	100.9475	19.7%
Particulates (mg/km)	4.5	0.03783	1	0.01225	0	0.03249	0.027523	0.67%
Number of particulates (1/km)	6.00E+11	2.08E+10	3	4.17E+09	1	2.44E+11	8.97E+10	1.3%

Example 4: Reduction of fuel usage using the composition according to the invention.

Fuel consumption with and without the use of the composition of the invention during an NEDC-test according to example 1 is described in table 7. The fuel consumption with and without the use of the composition of the invention during the UDC-phase and the EUDC-phase of the NEDC-test are shown in table 8 and 9 respectively.

Table 7: Average fuel usage during the NEDC-test of the test vehicle with and without additive.

		Fuel use	Fuel economy	
		L/100km	km/L	mi/gal
Without additive	Test 1	5.384	18.573	43.686
	Test 2	5.373	18.612	43.778
	Test 3	5.34	18.728	44.051
	Average	5.366	18.638	43.838
With additive	Test 1	5.239	19.089	44.9
	Test 2	5.274	18.963	44.603
	Test 3	5.235	19.104	44.935
	Average	5.249	19.052	44.813

Table 8: Average fuel usage during the UDC-phase of the NEDC-test of the test vehicle with and without additive

	Test	Fuel use	Fuel economy	
		L/100km	km/L	mi/gal
Without additive	Test 1	6.031	16.58	38.998
	Test 2	6.078	16.454	38.701
	Test 3	6.021	16.607	39.063
	Average	6.043	16.547	38.921
With additive	Test 1	5.955	16.793	39.499
	Test 2	5.915	16.905	39.764
	Test 3	5.871	17.032	40.062
	Average	5.914	16.910	39.775

Table 9: Average fuel usage during the EUDC-phase of the NEDC-test of the test vehicle with and without additive.

	Test	Fuel use	Fuel economy	
		L/100km	km/L	mi/gal
Without additive	Test 1	5.006	19.976	46.987
	Test 2	4.961	20.158	47.414
	Test 3	4.939	20.247	47.623
	Average	4.969	20.127	47.341
With additive	Test 1	4.822	20.737	48.777
	Test 2	4.898	20.418	48.027
	Test 3	4.862	20.568	48.379
	Average	4.8606	20.574	48.394

Table 7 shows an average decrease in fuel consumption of about 2% during the NEDC. Table 8 shows an average increase in fuel economy of about 2% during the UDC-phase of the NEDC-test. Table 9 shows an average increase in fuel economy of about 2% during the EUDC-phase of the NEDC-test.

CLAIMS

1. Composition for reducing harmful emissions and fuel usage of combustion engines comprising:

50 wt.% - 70 wt.% menthol;

10 wt.% - 20 wt.% essential oil, selected from the
5 group of eucalyptus oil, tea tree oil, lemongrass oil and patchouli oil, or any mixture of two or more of these oils;

5 wt.% - 15 wt.% camphor;

5 wt.% - 15 wt.% naphthalene;

10 1.5 - 3.5 wt.% iron(III)oxide (Fe_2O_3); and

1.5 - 3.5 wt.% toluene.

2. Composition according to claim 1 wherein the composition comprises:

15 60 wt.% menthol;

15 wt.% essential oil, selected from the group of eucalyptus oil, tea tree oil, lemongrass oil and patchouli oil, or any mixture of two or more of these oils;

10 wt.% naphthalene;

20 10 wt.% camphor;

2.5 wt.% iron(III)oxide (Fe_2O_3); and

2.5 wt.% toluene.

3. Composition according to claim 2 wherein the essential oil comprises eucalyptus oil.
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4. Composition according to any of the previous claims, wherein the composition is formulated as a solid unit dose form.

5 5. Composition according to claim 4, wherein said unit dose has a weight 1-5 grams, preferably 1-4 grams, more preferably 1.5-2 grams, most preferably of 1.6 grams.

6. Method for reducing fuel usage and/or reducing
10 harmful emissions in the exhaust gas of internal combustion engines comprising the step of adding the composition of any of the claims 1 to 5 to the fuel of an internal combustion engine.

15 7. Method according to claim 6 further comprising the step of leaving the composition to blend with the fuel.

8. Method according to claim 7, wherein the composition is left to blend for 5-10 minutes.
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9. Method according to any of claims 6 to 8 wherein the internal combustion engine is a petrol (gasoline) engine.

25 10. Method according to any of claims 6 to 8 wherein the internal combustion engine is a diesel engine.

11. Fuel mixture obtained by adding the composition of claim 1 to 5 to a fuel.
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12. Fuel mixture according to claim 11, wherein said fuel is a liquid hydrocarbon fuel.

13. Fuel mixture according to claim 11 or 12, wherein said fuel is petrol (gasoline).

14. Fuel mixture according to claim 11 or 12, wherein
5 said fuel is diesel oil.

15. Fuel mixture according to any of the claims 11 to
14 obtained by adding 1-2 unit doses of the composition
defined in claim 5, to 10 litres of fuel, preferably 1
10 unit dose per 10 litres of fuel.