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SPECIFICATION

FUEL MODIFIER



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FIELD OF THE INVENTION

The present invention relates to a fuel modifier.

PROBLEMS TO BE SOLVED

Problems to be solved are improving combustion efficiency and reducing production of carbon monoxide CO and NOX.

DISCLOSURE OF THE INVENTION

The present invention provides a fuel modifier comprising an iron salt as a means to solve said problems. Generally, said fuel modifier is provided by adding and mixing an alcohol solution of said iron salt to a mineral oil. Said iron salt is ferric-ferrous iron salt and/or ferrous iron salt and/or ferric iron salt.

PRECISE DESCRIPTION OF THE INVENTION

The fuel modifier of the present invention comprises ferric-ferrous iron salt and/or ferrous iron salt and/or ferric iron salt.

[FERROUS IRON SALTS, FERRIC IRON SALTS]

Ferrous iron salts and/or ferric iron salts used as the fuel modifier in this invention include inorganic acid salts such as hydrochloride, sulfate, nitrate, phosphate and the like, organic acid salts such as acetate, formate, oxalate, citrate and the like, mixtures thereof. Two or more kinds of ferrous iron salts and/or ferric iron salts may be used together.

[FERRIC-FERROUS IRON SALTS]

Ferric-ferrous iron salt of the present invention is iron salt having properties between ferrous iron salt and ferric iron salt and said iron salt is such as inorganic acid salts (e.g. hydrochloride, sulfate, phosphate, nitrate and the like), organic acid salts (e.g. formate, acetate, propionate and the like). Said ferric-ferrous iron salt is prepared by putting

ferric iron salt in a large quantity of strong alkaline aqueous solution such as sodium hydroxide, potassium hydroxide, lithium hydroxide, calcium hydroxide and the like to cause valence conversion from ferric iron to ferrous iron or putting ferrous iron salt in a large quantity of strong acid aqueous solution such as hydrochloride acid, sulfuric acid and the like to cause valence conversion from ferrous iron to ferric iron and said ferric-ferrous iron salt is obtained as transition form during said valence conversion. Concrete illustrations of methods of production of said ferric-ferrous iron salt are shown hereafter.

Commonly, two methods described below are applied to prepare said ferric-ferrous iron salt.

1. Method 1 (Preparation from ferric iron salt)

Ferric chloride ($\text{FeCl}_3 \cdot 6\text{H}_2\text{O}$), 1.0 mg was dissolved in 100 ml of 0.5 N sodium hydroxide aqueous solution and stirred, then the solution was allowed to stand for overnight. After filtering out some insoluble products in the solution, the solution was neutralized with hydrochloric acid then concentrated in a reduced pressure desiccator to get a dried and crystallized product. Thus the crystallized product with sodium chloride, that is, chloride of ferric-ferrous iron (hereinafter sometimes referred to as iron chloride (II, III)), was prepared.

In case of extracting iron chloride (II, III) from the crystallized product with sodium chloride, the product was dissolved in 50 ml of 80% by weight isopropyl alcohol aqueous solution to elute iron chloride (II, III). After separating the solution containing eluted iron chloride (II, III), the solution was concentrated at reduced pressure in order to remove the solvent and dry. Then the procedure consisting of elution, concentration and dry was repeated a few times. Thus iron chloride (II, III), 0.25 mg was extracted from the crystallized product with sodium chloride.

2. Method 2 (Preparation from ferrous iron salt)

Ferrous sulfate ($\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$), 1.0 mg was dissolved in 100 ml of 0.5 N HCl aqueous solution and stirred, then the solution was allowed to stand for overnight. After filtering out some insoluble products in the solution, the solution was concentrated in a reduced pressure desiccator to get a dried product. The dried product in powder was dissolved in 10 ml of 80% by weight isopropyl alcohol aqueous solution to elute iron

chloride (II, III). After separating the solution containing eluted iron chloride (II, III), the solution was concentrated at reduced pressure in order to remove the solvent and dry. Then the procedure consisting of elution, concentration and dry was repeated a few times. Thus iron chloride (II, III), 0.6 mg was extracted from the crystallized product with sodium chloride.

Ferric-ferrous iron salts in this invention may include other compounds such as inorganic compounds (e.g. sodium chloride, sodium sulfate, ammonium chloride, ammonium sulfate, zinc chloride, zinc sulfate, zinc oxide, zinc hydroxide, zinc acetate, diatomite, bentonite, silica, alumina and the like), organic compounds (e.g. vitamin, hormone, protein, lipid and the like). In the case of using the ferric-ferrous iron salt including other compound, its ability is not changed.

[PREPARATION OF THE FUEL MODIFIER]

To prepare said fuel modifier of the present invention, said ferric-ferrous iron salt and/or ferrous iron salt and/or ferric iron salt is(are) dissolved in an alcohol such as ethyl alcohol, isopropyl alcohol, normal butyl alcohol, isobutyl alcohol, tertiary butyl alcohol, and the like, or solvent mixture of said alcohol(s) and water and then said solution is added to mix to a petroleum solvent such as gasoline, kerosene, light oil and the like. Generally, the resulting fuel modifier of the present invention contains 1 to 5 ppm of ferric-ferrous iron salt and/or ferrous iron salt and/or ferric iron salt.

[FUEL MODIFICATION]

Generally, about 0.1 to 1.0 ml of said fuel modifier of the present invention is added to 1000 ml of the fuel such as gasoline, kerosene, light oil, heavy oil and the like. In said fuel modifier modified by said fuel modifier, the combustion efficiency is improved and production of toxic substance such as CO, NOX and the like are suppressed.

[EFFECT OF THE INVENTION]

In said fuel modified by said fuel modifier, the combustion efficiency is improved and when said fuel is used as fuel of the car, the efficiency of fuel consumption is much improved and content of toxic substance such as CO, NOX and the like in exhaust gas is much reduced.

[Example 1]

Ferrous sulfate ($\text{FeSO}_4 \cdot 6\text{H}_2\text{O}$), 1 g was dissolved in 5 ml of 12 N HCl aqueous solution and stirred. Then the solution was filtered by filter paper (No. 5C) to remove some insoluble products. A portion of the filtered solution for sampling was concentrated in a reduced pressure desiccator to get a dried product. The dried product in powder was dissolved in 80% by weight isopropyl alcohol aqueous solution. Then the solution containing eluted component was concentrated at reduced pressure in order to remove the solvent and dry. In addition, the procedure consisting of elution, concentration and dry was repeated a few times. Thus crystallized product was prepared.

5% by weight aqueous solution of the crystallized product, 0.01 ml was spotted on a point from 3 cm of the bottom of paper chromatography (PC) filter paper ($2\text{ cm} \times 40\text{ cm}$), then was developed by n-butyl alcohol : acetic acid : H_2O (5 : 1 : 4, v/v/v) as developing solvent for 15 hours. After developing the filter paper was dried out then colored by spray of 1% by weight potassium ferricyanide aqueous solution as coloring reagent. As a result, it was confirmed that the developed point of the crystallized product was one spot ($R_f = 0.07$).

In addition, a mixture of FeCl_2 and FeCl_3 was spotted on a paper chromatography (PC) filter paper as the same way. As a result, it was confirmed that there were two developed points (FeCl_2 , $R_f = 0.095$, FeCl_3 , $R_f = 0.36$) on the filter paper. These paper chromatography (PC) tests mentioned above accounted for the crystallized product as homogeneous product not mixtures.

Further, a sample solution, 100 ml was prepared by means of dissolving the crystallized product in distilled water. The sample solution (2.5 ml), 0.1% by weight orthophenanthroline aqueous solution (2.5 ml), and sodium acetate-acetic acid buffer solution, $\text{pH} = 4.5$, (25 ml) were put into a mess-flask then distilled water was put into the mess-flask until its marked line. After being allowed to stand for 30 minutes at room temperature, an absorbance (510 nm) of the solution was measured. Ferrous iron in the sample solution was 0.019 g/100 ml calculated from standard curve, obtained by FeCl_2 solution in the same way.

Moreover, in the case of putting sample solution into the mess-flask, then hydroxyl mine hydrochloride aqueous solution, 1.0 ml was added to the mess-flask beforehand in order to reduce ferric iron in the sample solution to ferrous iron. As a result, ferrous iron, 0.038 g/100 ml was gotten. It was confirmed that the crystallized product

consisted of ferrous iron and ferric iron equivalently because of calculation of ferric iron, 0.019 g/100 ml (= 0.038 g/100 ml – 0.019 g/100 ml). From consideration of the above-mentioned test, it was concluded that the crystallized product would be $\text{Fe}_2\text{Cl}_5 \cdot x\text{H}_2\text{O}$.

[Example 2] (Preparation of ferrous-ferric iron salt)

Ferric chloride (1.0 mg) was dissolved in 5 ml of 10 N sodium hydroxide aqueous solution and stirred. After stirring, the solution was neutralized with 10 N hydrochloric acid, then was filtered by a filter paper (No.5C) to remove some insoluble products. A portion of the filtered solution for sampling was concentrated in a reduced pressure desiccator to get a dried product. The dried product in powder was dissolved in 80% by weight isopropyl alcohol aqueous solution. Then the solution containing eluted component was concentrated at reduced pressure in order to remove the solvent and dry. In addition, the procedure consisting of elution, concentration and dry was repeated a few times. Thus the crystallized product was prepared. The crystallized product in this example was tested by the same way as Example 1 mentioned above. Thus, it was concluded that the crystallized product would be $\text{Fe}_2\text{Cl}_5 \cdot x\text{H}_2\text{O}$.

[Example 3]

2 g of ferric-ferrous iron salt prepared in Example 1 was dissolved in 100 ml of a mixture of isopropyl alcohol and water (80:20 weight ratio) and the resulting solution was then added and mixed in kerosene to prepare a fuel modifier No.1 containing 2 ppm of said ferric-ferrous iron salt.

[Example 4]

2 g of ferric-ferrous iron salt prepared in Example 2 was dissolved in 100 ml of a mixture of isopropyl alcohol and water (80:20 weight ratio) and the resulting solution was then added and mixed in kerosene to prepare a fuel modifier No.2 containing 2 ppm of said ferric-ferrous iron salt.

[Example 5]

5 g of ferric chloride (FeCl_3) anhydride was dissolved in 100ml of a mixture of isopropyl alcohol and water (75:25 weight ratio) and the resulting solution was then

added and mixed in kerosene to prepare a fuel modifier No.3 containing 3 ppm of ferric chloride.

[Example 6]

5 g of ferrous chloride (FeCl_2) anhydride was dissolved in 100 ml of a mixture of isopropyl alcohol and water (75:25 weight ratio) and the resulting solution was then added and mixed in kerosene to prepare a fuel modifier No.4 containing 3 ppm of ferrous chloride.

[Efficiency Test]

Said fuel modifiers No.1, No.2, No.3 and No.4 were respectively added to 1000 ml of gasoline, adding amount of each fuel modifiers being 0.5 ml and driving test using FORD EXPLORER was carried out by using each gasoline modified by each fuel modifier. The results are shown in Table 1.

Table 1

Fuel Modifier	No Additive	No.1	No.2	No.3	No.4
Fuel consumption efficiency km/l (10mode test)	9	10.4	10.4	10.0	10.2

Referring to Table 1, it is recognized that fuel consumption efficiency is improved to more than 15%.

The results of the analysis of components contained in the exhaust gas during driving test are shown in Table 2.

Table 2

	HC	CO	CO ₂	NOX	CH ₄	N-CH ₄
Fuel Modifier No.1	0.019	0.312	499	0.068	0.011	0.008
Fuel Modifier No.2	0.018	0.310	498	0.065	0.010	0.008
Fuel Modifier No.3	0.020	0.315	499	0.070	0.012	0.010
Fuel Modifier No.4	0.020	0.314	499	0.068	0.011	0.009
No Additive	0.042	0.493	501	0.122	0.018	0.025

(Numbers are g/ml)

Referring to Table 2, it is recognized that HC and N-CH₄ contents reduce to lower than 50%, CO and CH₄ contents reduce to about 60%, and CO₂ is also recognized to reduce a little. Further, comparing said fuel modifiers No.1 to No.4, it is recognized that ferric-ferrous iron salt has a highest efficiency and then ferrous iron salt and then ferric iron salt in sequence.

CLAIMS

1. (Canceled)
2. (Canceled)
3. (Canceled)
4. (Canceled)
5. (Amended) A fuel modifier prepared by adding and mixing an alcohol solution of a ferric-ferrous iron salt in a solvent having compatibility with fuel.
6. (Canceled)
7. (Canceled)
8. (Canceled)
9. A fuel modifier in accordance with Claim 5, wherein said solvent is a petroleum solvent.