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(54) **Oil and water mixture and method of promoting combustion.**

(57) The combustion of a mixture of from one to thirty parts of water by volume in about one hundred parts of oil, e.g. heavy fuel oil, is promoted by the addition of a catalyst. The catalyst is the phenolic-EO adduct or alkyl polyethylene glycol ether of which EO is ethylene oxide. The phenolic-EO adduct is obtained from the reaction between alkyl phenol and ethylene oxide. The oil and water are mixed and the catalyst is added thereto prior to spraying the mixture into a combustion chamber.

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Oil and water mixture and method of promoting combustion

The present invention relates to the use of oil as a fuel and to methods of promoting the complete combustion of a mixture of oil and water, especially a mixture of heavy oil and water.

Heavy oil has long been burned as a fuel in many industrial applications. Heavy oil is used as a fuel in the industrial manufacture of glass and steel, and in the generation of commercial electrical power. Heavy oil also is used as a fuel for the manufacture of cooking oil and in the production of sugar, as well as in other industrial processes.

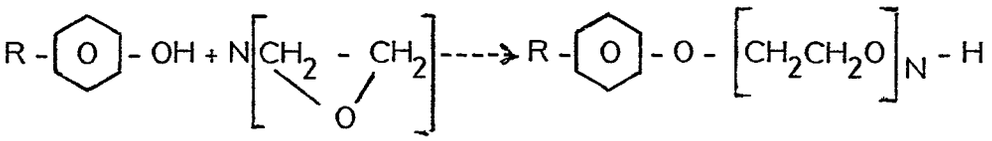
When heavy oil is sprayed into a combustion chamber for ignition as a fuel, a quantity of water is sometimes also sprayed into the combustion chamber at the same time. The purpose of burning such a mixture of fuel oil and water is to maximize the thermal output from the combustion of fuel oil and to thereby conserve on the consumption of fuel oil.

Heretofore, the use of a mixture of heavy oil and water as a fuel was performed by introducing the oil and water into a combustion chamber through separate lines. The oil and water were sprayed through separate nozzles and mixed together inside the combustion chamber at a fixed ratio. However, a number of problems exist in this prior technique. In the conventional use of a mixture of oil and water as a fuel, combustion is incomplete and fuel is not conserved as intended. Moreover, the nozzle through which the fuel oil is introduced into the combustion chamber deteriorates rapidly. When exposed to the combustion of oil and water in conventional combustion techniques the nozzle orifice becomes enlarged, and ceases to produce a mist of sufficient fineness.

Furthermore, the conventional combustion of a mixture of heavy oil and water is accompanied by the production of large amounts of harmful pollutants. Excessive quantities of soot, sulphur dioxide and oxides of nitrogen are produced.

The present invention involves both a method of increasing the extent of combustion of a mixture of oil and water and also the mixture used in that method. The invention is particularly applicable to a mixture of heavy oil and water. The invention is characterised by the use of a catalyst which serves as an emulsifying agent, enabling the production of a mixture capable of complete and efficient combustion when introduced into a combustion chamber.

The catalyst is alkyl polyethylene glycol ether, also known as phenolic-EO adduct, EO being ethylene oxide and the adduct being produced by the oxyethylation of alkyl phenol. Alkyl polyethylene glycol ether is produced according to the following formula:



The addition of alkyl polyethylene glycol ether to a mixture of oil and water causes a chemical reaction in which the atoms of the water separate and mix integrally with the molecules of the oil without separation. Mixing of the oil and water, and introduction of the catalyst are performed prior to introduction of the mixture into the fuel combustion chamber. In contrast, according to prior art techniques, it has been necessary to introduce the oil and water separately through separate flow lines and nozzles into the fuel combustion chamber.

According to one embodiment of the invention, a quantity of water, preferably from about one to about thirty parts of water by volume, is mixed with about one hundred parts by volume of oil. While the invention is not restricted to the use of heavy oil, the greatest beneficial results are achieved when heavy oil is used. For purposes of this specification, heavy oil may be considered to be fuel oil of grades number 4, 5 and 6. These grades comply with the several specifications adopted as a commercial

standard by the United States Bureau of Standards. An analysis of each of the several grades of fuel oil appears at pages 3-5 of the book, "Steam: Its Generation and Use", published by the Babcock & Wilcox Company, New York, 1960. The invention is applicable to fuel oil of all grades.

The amount of water which is mixed with the oil depends upon the type and quality of the oil used as a part of the mixture. The oil and water are stirred together in a mixer for between one and five minutes. The time of stirring also depends upon the quality of the oil utilized. After the oil and water have been stirred together, the catalyst, alkyl polyethylene glycol ether, is added at a ratio of between about 0.1 and about 0.6 parts by volume. Stirring in the mixer is continued for between about one and about five minutes once the catalyst has been added. This time of stirring also depends upon the type and the quality of the oil. Once the catalyst has been stirred into the oil and water mixture, the mixture is fed through a single fuel supply line and sprayed through a single nozzle into a fuel combustion chamber. The mixture is ignited and combustion proceeds far more completely than occurs in conventional oil and water mixtures.

The alkyl polyethylene glycol ether operates as a catalyst according to the principle of the invention. That is, the alkyl polyethylene glycol ether separates the atoms of the water a distance of about one micron and creates an emulsion of the water and the oil without separation. While mixing, the water and oil are held at a temperature of between about 20 degrees and 60 degrees Celsius.

The oil and water mixture of the invention burns far more completely than oil and water mixed in the same proportions without the catalyst of the invention. As a result, the amount of fuel oil consumed to produce a specific amount of heat in industrial applications is reduced by between about one and thirty percent. This saving is achieved because the oil which is consumed is oxidized far more completely than has been the case with oil and water mixtures.

Furthermore, because combustion is far more complete, the amount of harmful pollutants produced is dramatically reduced. The soot content in the products of combustion is reduced by about 80 percent. There is also an

80 percent reduction in oxides in nitrogen (NO_x) and in sulphur dioxide (SO_2). Furthermore, the combustion of the oil and water mixture in the presence of the catalyst of the invention produces far less damage to the nozzle into the combustion chamber as compared with the prior techniques for burning a mixture of heavy oil and water. The mixture of the invention reduces the cost of maintenance and extends the useful lives of boilers and furnaces.

The amount of catalyst within the range of between about 0.1 and about 0.6 parts by volume depends upon the quality of the oil utilized. The catalyst serves as an emulsifying agent which brings about the appropriate reactions in the surface chemistry of the oil and water mixture to form a stable emulsion with particle diameters of about one micron. Although from between about one to about thirty parts of water may be mixed with the oil and emulsified in the oil by the catalyst, the greatest conservation in fuel oil is achieved when between about twenty and about thirty parts of water are mixed with about one hundred parts of heavy oil. The savings in fuel with such a mixture is between about twenty and thirty percent.

While mixing for only a few minutes is sufficient to produce the necessary emulsion according to the invention, it is not necessary to burn the oil and water mixture immediately. On the contrary, the phenolic-EO adduct emulsifies the oil and water in a stable manner so that the oil and water are emulsified permanently and will not separate during storage.

The catalytic emulsifying agent is the phenolic-EO adduct produced by the reaction between ethylene oxide and an alkyl phenol. Nonylphenol is typically the predominant base material in commercially available alkyl phenol, although octylphenol and dodecylphenol are sometimes also present. Alkyl polyethylene glycol ether is a polyoxyethylene alkylphenol. The base materials and the manufacture of polyoxyethylene alkylphenols are described at Chapter 3 entitled "Polyoxyethylene Alkylphenols" by C.R. Enyeart in the book, Nonionic Surfactants, Ed. Martin J. Schick, Vol. 2, London 1967.

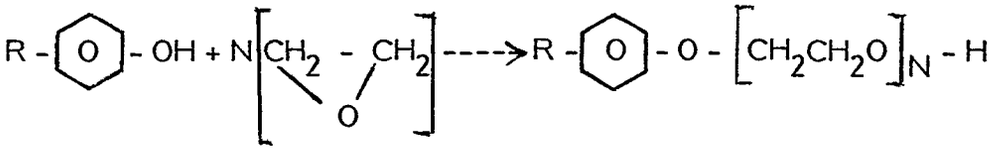
Polyoxyethylene alkylphenols have been widely used in the field of textile processing where their wetting and detergent properties are quite

important. They are also useful in the processing of synthetic fibres because of their antistatic, emulsifying and lubricating properties. However, the major consumption of polyoxyethylene alkylphenols is in domestic and commercial detergents. Water soluble alkylphenol derivatives are also used in metal processing where rust and scale are removed in the finishing of steel. They are also used in agricultural applications in the manufacture of emulsifiable concentrates of insecticides and herbicides. The higher adducts containing twenty to one hundred moles of ethylene oxide are used in the emulsion polymerization of vinyl acetate and acrylates. Emulsion type floor polishes are prepared from both natural and synthetic waxes with the higher adducts.

Other industries consuming substantial amounts of these adducts include petroleum: for drilling and crude oil emulsion breaking: paper: for pitch control in pulp, felt cleaning and re-wetting of paper towels; cosmetics: as emulsifiers; leather; fat-liquoring; as dust control agents in the coal, mineral, and ceramic industries; and as wetting and foaming adjuncts in fire fighting. Quantities of polyoxyethylene alkylphenols are also consumed as intermediates in the production of sulphates, phosphates and disinfectant iodophors. However, polyoxyethylene alkylphenols have not, prior to the present invention, been used as emulsifying agents in oil and water mixtures to promote the extent of combustion of such mixtures.

EXAMPLE

The catalyst employed in the invention is obtained from the reaction between alkyl phenol and ethylene oxide in the formula:



The catalyst is alkyl polyethylene glycol ether, popularly known as the phenolic-EO adduct of which EO is ethylene oxide.

About twenty-five parts of water are stirred together with about one hundred parts of number 6 fuel oil in a mixer for about four minutes. About 0.5 parts by volume of alkyl polyethylene glycol ether are thereupon added

to the oil and water mixture and stirring is continued for about four minutes. The mixture is then forced through a fuel line and through a nozzle as a spray into a fuel oil combustion chamber. The mixture is then ignited and burned. The heat of combustion may be employed in any number of industrial applications, examples of which have previously been set forth herein.

The features disclosed in the foregoing description and/or in the following claims may, both separately and in any combination thereof, be material for realising the invention in diverse forms thereof.

CLAIMS

1. A method of increasing the completeness of combustion of a mixture of fuel oil and water, characterised by adding thereto alkyl polyethylene glycol ether.

2. A method according to claim 1, further characterised by adding from 0.1 to 0.6 parts by volume of said alkyl polyethylene glycol ether to a mixture of from one to thirty parts of water by volume in about one hundred parts of fuel oil by volume.

3. A method according to claim 1 or 2, in which said fuel oil is a heavy fuel oil of at least a number 4 grade.

4. A method according to claim 3, further characterised by stirring said water and fuel oil together for at least one minute at a temperature in the range 20 to 60 degrees Celsius before adding said alkyl polyethylene glycol ether thereto.

5. A method according to claim 4, further characterised by stirring said water and fuel oil together for between one and five minutes prior to adding said parts of alkyl polyethylene glycol ether.

6. A method according to any one of claims 1 to 5, characterised by spraying said mixture of water, oil and alkyl polyethylene glycol ether into a combustion chamber.

7. A method according to claim 6, further characterised by stirring said water, fuel oil and said alkyl polyethylene glycol ether together for at least one minute before spraying said mixture into a combustion chamber.

8. A method according to claim 7, further characterised by stirring said water, fuel oil and alkyl polyethylene glycol ether together for between one and five minutes prior to spraying said mixture into a combustion chamber.

9. A fuel mixture comprising about one hundred parts of fuel oil by volume, from about one to about thirty parts of water by volume, and from about 0.1 to about 0.6 parts of alkyl polyethylene glycol ether by volume.

10. A fuel mixture according to claim 9, in which said fuel oil is a heavy fuel oil of at least a number 4 grade.

11. A fuel mixture according to claim 9 or 10, comprising from twenty to thirty parts of water by volume.

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EUROPEAN SEARCH REPORT

0147506
Application number

EP 84 10 4942

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int Cl 4)
X,Y	DE-A-2 520 971 (KONRAD-SPEDITION) * Claim 1 * ---	1,2,6, 9,11	C 10 L 1/32
Y	US-A-3 527 581 (D.BROWNAWELL et al.) * Claim 1, column 3, lines 54-58, 71-75 * -----	1,2,6, 9,11	

TECHNICAL FIELDS SEARCHED (Int. Cl.4)

C 10 L

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	20-02-1985	DE HERDT O.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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P : intermediate document

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