Metal contamination of diesel fuel and the resultant formation of carboxylate salts is believed to be a significant cause of injector sticking. The formation of lacquers is yet another major cause of injector sticking.

One approach to combatting IDIDs and injector sticking resulting from carboxylate salts is to try to eliminate the source of metal contamination and/or carboxylic acids or to try to ensure that particularly problematic carboxylic acids are eliminated. This has not been entirely successful and there is a need for additives to provide control of IDIDs.

Deposit control additives are often included in fuel to combat deposits in the injector nozzle or at the injector tip. These may be referred to herein as “external injector deposits”. Additives are also used to control deposits on vehicle fuel filters. However additives which have been found to be useful to control “external deposits” and fuel filter deposits are not always effective at controlling IDIDs. A challenge for the additive formulator is to provide more effective detergents.

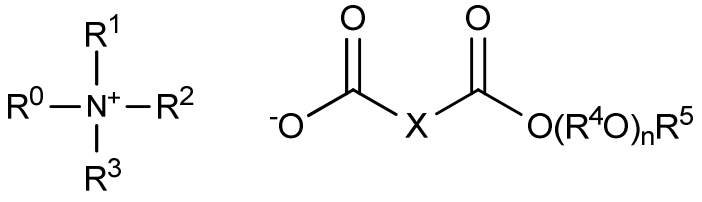
It is an aim of the present invention to provide methods and uses which improve the performance of a diesel engine, especially a diesel engine having a high pressure fuel system. This may be achieved for example by preventing or reducing the formation of IDIDs and/or by reducing or removing existing IDIDs. The invention provides methods and uses which control “external injector deposits” and/or fuel filter deposits.

Reducing or preventing the formation of deposits may be regarded as providing “keep clean” performance. Reducing or removing existing deposits may be regarded as providing “clean up” performance. It is an aim of the present invention to provide “keep clean” and/or “clean up” performance.

Many different types of compounds are known in the art for use as detergent additives in fuel oil compositions, for the control of deposits in engines.

SUMMARY

In one aspect, there is provided a quaternary ammonium compound of formula (I):

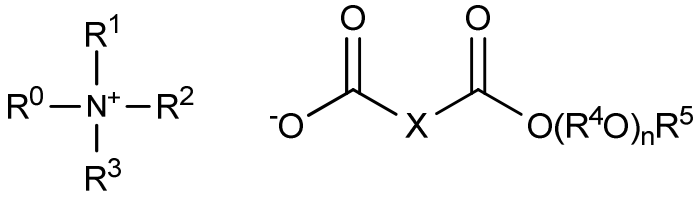


(I)

wherein R^0, R^1, R^2 and R^3 is each independently an optionally substituted hydrocarbyl group, X is a linking group, R^4 is an optionally substituted alkylene group, R^5 is hydrogen or an optionally substituted alkyl, alkenyl or aryl group, and n is 0 or a positive integer, provided that n is not 0 when R^5 is hydrogen.

In another aspect, there is provided a method of preparing a quaternary ammonium salt, the method comprising reacting (a) a tertiary amine of formula $R^1R^2R^3N$ with (b) an acid-derived alkylating agent in the presence of (c) a compound of formula $HOOCXCOO\text{-}(R^4O)_n\text{-}R^5$, wherein R^4 is an optionally substituted alkylene group, R^5 is hydrogen or an optionally substituted alkyl, alkenyl or aryl group, and n is 0 or a positive integer, provided that n is not 0 when R^5 is hydrogen.

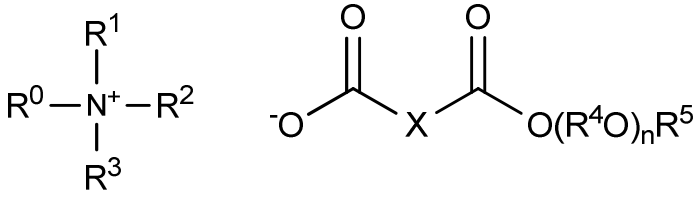
In yet another aspect of the present disclosure, there is provided a composition comprising a quaternary ammonium compound of formula (I):



(I)

wherein R^0, R^1, R^2 and R^3 is each independently an optionally substituted hydrocarbyl group, X is a linking group, R^4 is an optionally substituted alkylene group, R^5 is hydrogen or an optionally substituted alkyl, alkenyl or aryl group, and n is 0 or a positive integer, provided that n is not 0 when R^5 is hydrogen.

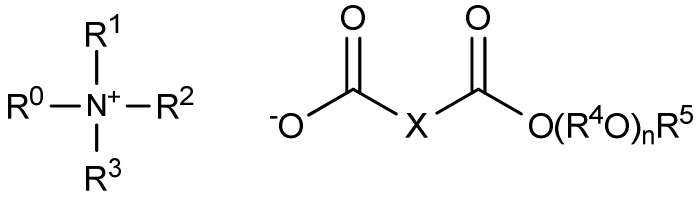
In another aspect, there is provided a use of a ammonium compound of formula (I):



(I)

wherein R^0, R^1, R^2 and R^3 is each individually an optionally substituted alkyl, alkenyl or aryl group, X is a linking group, R^4 is an optionally substituted alkylene group, R^5 is hydrogen or an optionally substituted alkyl, alkenyl or aryl group, and n is 0 or a positive integer, provided that n is not 0 when R^5 is hydrogen as an additive in a fuel or lubricant composition.

In a further aspect, there is provided a method of improving the performance of an engine, the method comprising combusting in the engine a fuel composition comprising as an additive a quaternary ammonium compound of formula (I):



(I)

wherein R^0, R^1, R^2 and R^3 is each independently an optionally substituted hydrocarbyl group, X is a linking group, R^4 is an optionally substituted alkylene group, R^5 is hydrogen or an optionally substituted alkyl, alkenyl or aryl group, and n is 0 or a positive integer, provided that n is not 0 when R^5 is hydrogen.

In another aspect, there is provided a use of an ester additive as defined herein to reduce the treat rate of one or more further additives selected from lubricity improvers, corrosion inhibitors and cold flow improvers whilst maintaining performance.

DETAILED DESCRIPTION

The present invention relates to novel quaternary ammonium compounds having an ester counterion that is the partial ester of a polycarboxylic acid that are useful as detergents.

According to a first aspect of the present invention there is provided a quaternary ammonium compound of formula (I):