STABILISING ETHANOL DIESEL MIXTURES - APRIL 1990

1.0 Introduction

The use of oxygenates, i.e. fuel additives containing oxygen have always been of interest. Compounds such as the ethers, and alcohols, particularly ethanol and methanol, fall within this classification.

Their use ability as readily combustible materials has always suggested use as a combustion aid. More recently legislation in the United States has meant that a minimum of 2.0% alcohol should be present in fuel to aid cold starts as a means of reducing carbon dioxide and hydrocarbon emissions during the period when the engine temperature is too low for efficient combustion.

With the realisation that the fossil fuel supply is limited, interest in alcohols as alternative fuels or as fuel extenders has reawakened. One common problem has been that mixtures of hydrocarbons and alcohol, although miscible, at ambient temperatures and at in wide range of proportions, suffer from sensitivity to water contamination. The water causes a separation into ethanol and hydrocarbon phases, which Is undesirable for engines designed to operate at one setting. Consequently to take into account of this condition, a homogenous fuel is important.

Most work with alcohol and diesel mixtures has employed additives to stabilize the ethanol/diesel fuel. A high content of “oxygenates” (~20%) has been achieved, though no distinction was made between the additive and alcohol content In the fuel. Some of the problems of using alcohol as diesel extender have examined in this report.

1.1 Miscibility studies

Ethanol can be obtained from renewable biological sources. It is combustible and being a liquid Is easy to handle. By comparison, diesel is primarily produced by extraction from fossil fuels and can be regarded as coming from an unrenewable source.

Mixtures of ethanol and diesel were explored as possible alternatives to pure diesel. The two areas to be examined were the ability to form a one-phase liquid and the stability of such mixtures.

Ethanol and diesel were mixed with a wide variety of surfactant agents. Included in this list was additive mkII and the components involved in its formulation. The long-term miscibility and stability of the resulting mixtures were studied.

1.2 Water/ethanol/diesel studies

In order to formulate an effective additive, it was decided that an ethanol/water mixture (20:1, 21ml) would be used with diesel (l00ml). This would represent ~1% water contamination of a 20% ethanol/diesel mixture.

1.3 Stability in air

The next test involved leaving stable solutions of diesel/ethanol/additive open to the atmosphere. The intention was to simulate poor procedural practice which might be encountered in the field, in which fuel exposed to the atmosphere might come into contact with water in the air.

1.3.1 D1925 as a stabilizing agent

Mixtures of ethanol/water/diesel using D1925 as the stabilising agent were studied.

1.3.2 Egme as a stabilizing agent

Mixtures of ethanol/water/diesel with DI and Egme as the stabilizing agents were studied. In this series of experiments, the proportion of Egme was varied.

1.3.3 Ethanol/Diesel studies - the role of TX

Mixtures of ethanol/water/diesel were stabilized by the use of an additive. In this series of experiments, the proportion of TX in the additive was varied.

1.3.4 Ethanol/Diesel studies - the role of Egme

Mixtures of ethanol/water/diesel were stabilized by the use of an additive. In this series of experiments, the proportion of Egme in the additive was varied.

2.0 Results and discussion

2.1 Miscibility studies

2.1.1 Ethanol/diesel mixtures

Ethanol was mixed with diesel in two proportions, 20% and 30%. The two mixtures produced a clear single-phase liquid which indicated that ethanol was miscible with diesel to a high degree. These simple ethanol/diesel solutions showed a tendency to breakdown into a 2-component system on standing at ambient temperature for around 60 days.

2.1.2 Addition of water

The addition of water to ethanol/diesel mixtures resulted in the separation of the two components. This is consistent with previous findings in which the major problem of using ethanol/diesel mixtures as fuel was water contamination, which resulted in component separation. Only a small amount of water (<0.06%) was required to cause the ethanol to separate from the diesel. The low quantity of water required to cause component separation offers a possible explanation as to the limited stability of simple ethanol/diesel mixtures. Water present in air could be absorbed into the mixture, resulting In component separation.

2.1.3 Additive and its components

All of the components of additive mkll; Cf, Dl, TX and egme were found to be miscible with ethanol/diesel. Dl could be added to a ethanol/diesel mixture to afford a one-phase liquid of limited stability. Similarly, Cf could be added to ethanol/diesel to afford a one-phase liquid of limited stability (approximately 2 months). The test with Egme, showed that stability of an egme/ethanol/diesel solution was about the same as For Cf, i.e. around 60 days. The use of TX as a component, was considerably less successful. TX/Ethanol/diesel solutions demonstrated a low stability and separated out Into a bilayer after only 3 days.

Despite the poor stability of TX, it was suggested that perhaps the additive could be used to treat the problem of water initiated separation of ethanol/diesel mixtures. Two formulations of additive mkII were used. ADD2 - DCTE 651.01/131088 and ADD2-131068. Both formulations of Additive mkII when mixed ethanol/diesel produced solutions with limited stability. When using ADD2/131088 the stability of the resulting solution was worse than plain ethanol/diesel when stored in a sealed vessel. The other formulation of ADD mkII. i.e. ADD2-DCTEt651.01, showed a stability which was better than simple ethanol/diesel mixtures.

2.1.4 Component alternatives

The solutions showed that all the major classes of components associated with the additive MKII, i.e. alkyl ethoxylates, are all miscible with the ethanol/diesel mixture and would not cause separation of the diesel and ethanol. In this class, Gp, EmKB2, EmKB3 and Sy were tested. The results of this class of compounds was more promising. Mixtures of these ethoxylates with ethanol/diesel gave solutions which were stable in excess of 150 days (5 months). Several conclusions can be drawn from the experiments. It has been shown that ethanol and diesel may be mixed in relatively high proportions (20-30%). It has demonstrated that by using suitable additives the stability of 20% ethanol/diesel solutions could be extended. One formulation of additive mkII did demonstrate a slight improvement in stability of ethanol/ diesel, which may have implications for the patent with regards to ascribed uses for the product. The extensive stability demonstrated by the ethoxylate class suggests that research into reformulating or modifying the additive mkII might prove promising.

2.2 Ethanol/water/Diesel studies

2.2.1 EW/170789

Ethanol and water readily mix to form a homogeneous solution, so that in a volume of 21ml, 20ml of ethanol and lml of water would be present.

2.2.2 Water/ethanol/diesel

The use of an water/ethanol, i.e. EW/170789, with diesel represents a ethanol/ diesel mixture which has been severely contaminated with water (~1%).

2.2.3 Additive and its components

The components associated with additive mkII, I.e. Ct, Dl, and Egme were tested against such water contaminated mixtures. In the absence of any additive, it was found that water/ethanol/diesel mixtures were unstable with the ethanol and water separating from the diesel to afford a bilayer or two-phase system.

2.2.3.1 Dl

Dl 925 (20ml) was found to stabilize such water/ethanol/diesel mixture. The product solution was clear, one-phase and showed a stability in excess of 218 days.

22.3.2 Egme

An egme (20ml) <20%) treatment of a water/ethanol/diesel mixture produced a one-phase product of limited stability. The stability of the product mixture was in excess of 56 days but less 130 days, by which time the product mixture had broken down into a bilayer.

2.2.3.3 Cf/DI (2:3)

A mixture of Cf/D1925 (3:2, 25ml) <25%) was used as the additive and to a mixture of EW 170789 and diesel, it afforded a one-phase, clear product, which remained stable in excess of 56 days but by 130 days it had deteriorated into a bilayer.

2.2.3.4 Cf/DI/Egme

A complex mixture of Cf/DL925/Egme (2:11:5, I8ml) When added to water/ethanol/diesel afforded one-phase, clear product, which remained stable in excess of 14 days but by 50 days it had deteriorated into a bilayer.

2.2.3.5 Cf/DI/Egme/TX

Cf/TX/Egme/D1925 (1:1:5:11, 18ml) when used to stabilize a water/ethanol/diesel mixture afforded a one-phase, clear product, which was stable in excess of 14 days, but by 42 days it had deteriorated to form a bilayer.

The results of these experiments demonstrated that the components in the additive could be used to enhance stability of ethanol/diesel solution which were substantially contaminated with water. The stability of such mixtures was limited and it would appear that the most effective component for long term stability is neat DI925. However, the most effective (as measured by the minimum total volume of additive required to produce a clear, one-phase solution) additive required for short-term stability Involves a blend of components.

These results confirm previous findings that the most efficacious component in terms of long-term stability is a member of the alkyl ethoxylate class of compounds.
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2.3 Open to atmosphere stability testing

In this series of experiments the effect of leaving the samples open to the air was explored. It was reasoned that if a solution remained stable to moisture in the air it would be of practical commercial value as the treated ethanol/diesel mixture would not require special handling conditions.

2.3.1.1 Ethanol/diesel

Initially, the diesel/ethanol (5:1, 120ml) was allowed to stand at ambient temperature under a porous lid. As expected, the clear, one-phase mixture had deteriorated within 3 days Into a bilayer. Surprisingly, the mixture returned to a one-phase liquid after 19 days and remained stable in excess 123 days. However, measurement of the sample volume showed that 24ml of mixture had been removed. This would be equivalent to the removal of the ethanol from the mixture by evaporation. Consequently it remains doubtful that the return to a one-phase liquid was anything other than the observation of a one-component system, i.e. only diesel remained present.

2.3.1.2 DI stabilized Water/ethanol/diesel (sealed system)

When DI925 was used as an additive, a clear one-phase solution was obtained from a sample of water/ethanol/diesel. The stability of this solution was in excess of 123 days.

2.3.1.3 DI stabilized Water/ethanol/diesel (open system)

The product sample (131ml) was left to stand at ambient conditions and open to the air. The solution (105ml) remained stable in excess of 123 days. The final volume of the product Indicated that substantial evaporation had occurred.

2.3.1.4 Egme/DL925 (1:1)

The ethanol/diesel/additive (130ml) was left open to air and the solution remained stable in excess of 123 days. The final volume (105ml) of the solution indicated that substantial evaporation had occurred.

2.3.1.5 Egme/DL925 (1:1) stabilised water/ethanol/diesel

Although the ethanol/diesel mixture contained water (1.0) deliberately Introduced, the additive produced a clear, one-phase solution, which like previous samples showed a stability in excess of 123 days. The final volume (105ml) of the sample was the same as the control sample without added water (see 3.3.1.4) and would suggest that the evaporation which takes place was probably ethanol and any water present evaporates oft along with the ethanol.

2.3.2 Formulations of additive mkll

Several formulations of the additive components were tested.

2.3.2.1 DCTE-36122

Cf (0.25ml), TX (0.5ml), Egme (0.5ml) and a final volume of D1925 (9.0ml) were blended with ethanol/diesel to form a clear, red, one-phase liquid. The sample was stored open to the air via a porous lid. The solution (110ml) remained stable in excess of 92 days.

2.3.2.2 DCTE-21111

Cf (0.5ml), TX (0.5ml), Egme (0.5ml), and an overall volume of Dl925 (10.7ml) were used to stabilise a water/ethanol/diesel mixture. The resulting solution was a clear, red, one-phase liquid, which remained stable in excess of 92 days. The final volume (110ml) indicated thallium evaporation had also occurred.

2.3.2.3 DCTE-21112

Cf (0.5ml), TX (0.5ml), Egme (1.0ml), and an overall volume of Dl925 (10.7ml) were used to stabilise a water/ethanol/diesel mixture. The resulting solution was a clear, red, one-phase liquid, which remained stable in excess of 92 days. The final volume (110ml) indicated that evaporation had also occurred.

2.3.2.4 DCTE-16114

Cf (0.5ml), TX (0.5ml), Egme (2.0ml), and an overall volume of Dl925 (7.85ml) were used to stabilise water/ethanol/diesel mixture. The resulting solution was a clear, red, one-phase liquid, which remained stable in excess of 92 days. The final volume (108ml) indicated that evaporation had also occurred. The slightly lower final volume than DCTE - 21112 probably reflects the increased evaporation from the additive because of the increase in the proportion of the more volatile component, i.e. Egme.

2.3.2.5 DCTE-17116

Cf (0.5ml), TX (0.5ml), Egme (3.0ml), and an overall volume of D1925 (8.6ml) were used to stabilise a water/ethanol/diesel mixture. The resulting solution was a clear, red, one-phase liquid, which remained stable in excess of 92 days. The final volume (110ml) indicated that evaporation had also occurred.

2.3.2.6 DCTE-15116

Cf (0.5ml), TX (0.5ml), Egme (4.0ml), and an overall volume of Dl925 (7.7ml) were used to stabilise a water/ethanol/diesel mixture. The resulting solution was a clear, red, one-phase liquid, which remained stable in excess of 92 days. The final volume (108ml) indicated that evaporation had also occurred. The final volume showed increased evaporation, It should be noted that at' this proportion the decrease in D1925 is compensated by the increase in Egme.

2.3.2.7 DCTE-161110

Cf (0.5ml), TX (0.5ml), Egme (5.0ml), and an overall volume of Dl925 (8.0ml) were used to stabilise a water/ethanol/diesel mixture. The resulting solution was a clear, red, one-phase liquid, which remained stable in excess of 92 days.

2.3.3 Ethanol/Diesel studies ptll TX

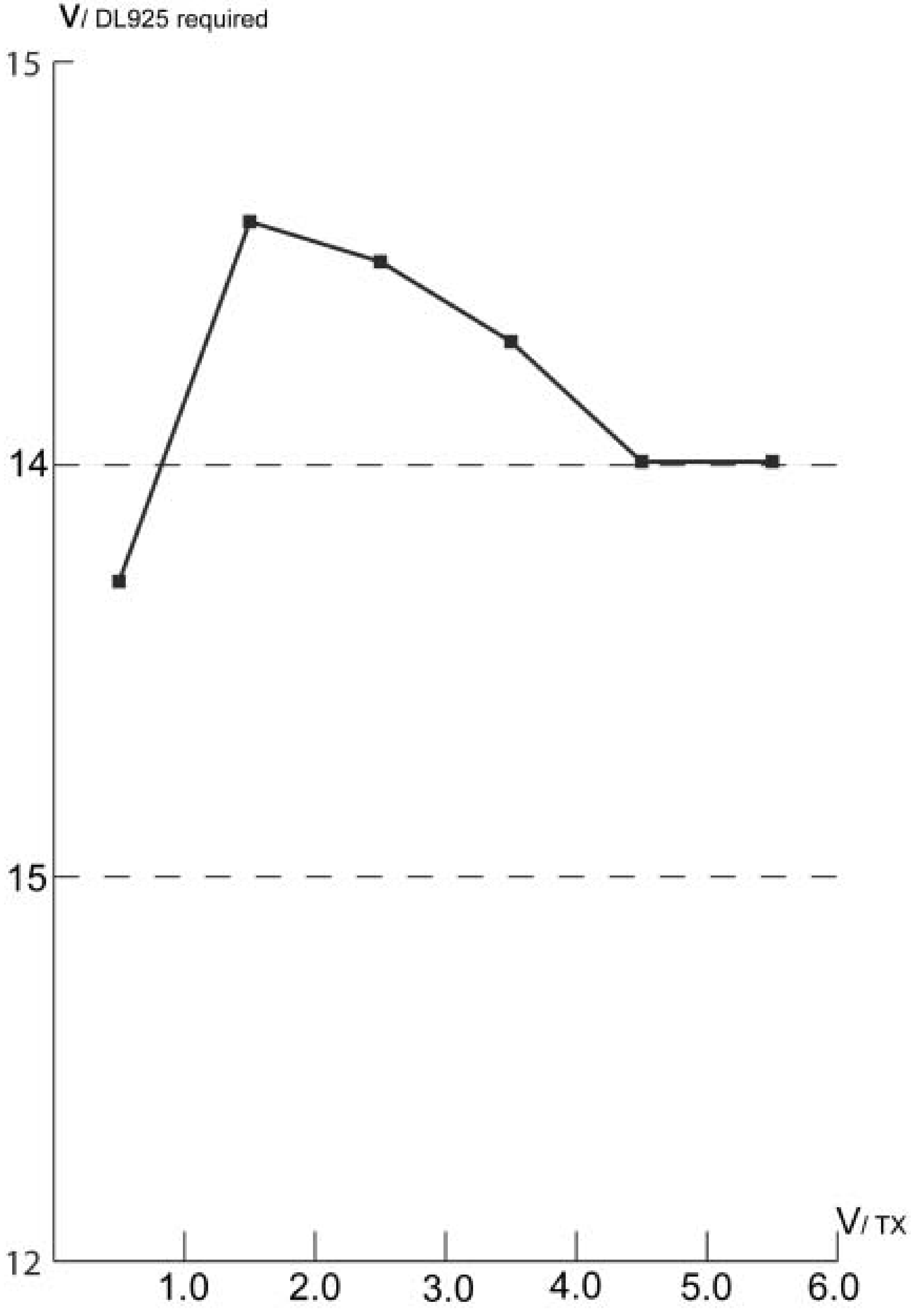
A more detailed study of the role of TX in the stabilising of ethanol/diesel mixtures was undertaken. The quantity of Egme, Cf and water were kept constant. The amount of egme was varied and mixture titrated with D1925 until clear. The results are given in the following table (Table 1).

TX	DL925	stability of final solution
0.5	13.7	+155
1.0	14.6	+155
2.0	14.5	+155
3.0	14.3	+155
4.0	14.0	+155
5.0	14.0	+155

Table 1

It can be concluded that TX is not as efficient as D1925. It is therefore recommended that formulations of additive mkII in which the TX content Is kept at a minimum would be the most efficient for stabilising ethanol/diesel mixtures against water.

Graph 1
Stabilising ethanol/diesel mixtures



2.3.4 Formulation studies for Diesel/Ethanol - role of Egme

A more detailed study of the role of Egme In the stabilising of ethanol/diesel mixtures was undertaken. The quantity of TX, Cf and water were kept constant. The amount of Egme was varied and mixture titrated with Dl925 until clear:

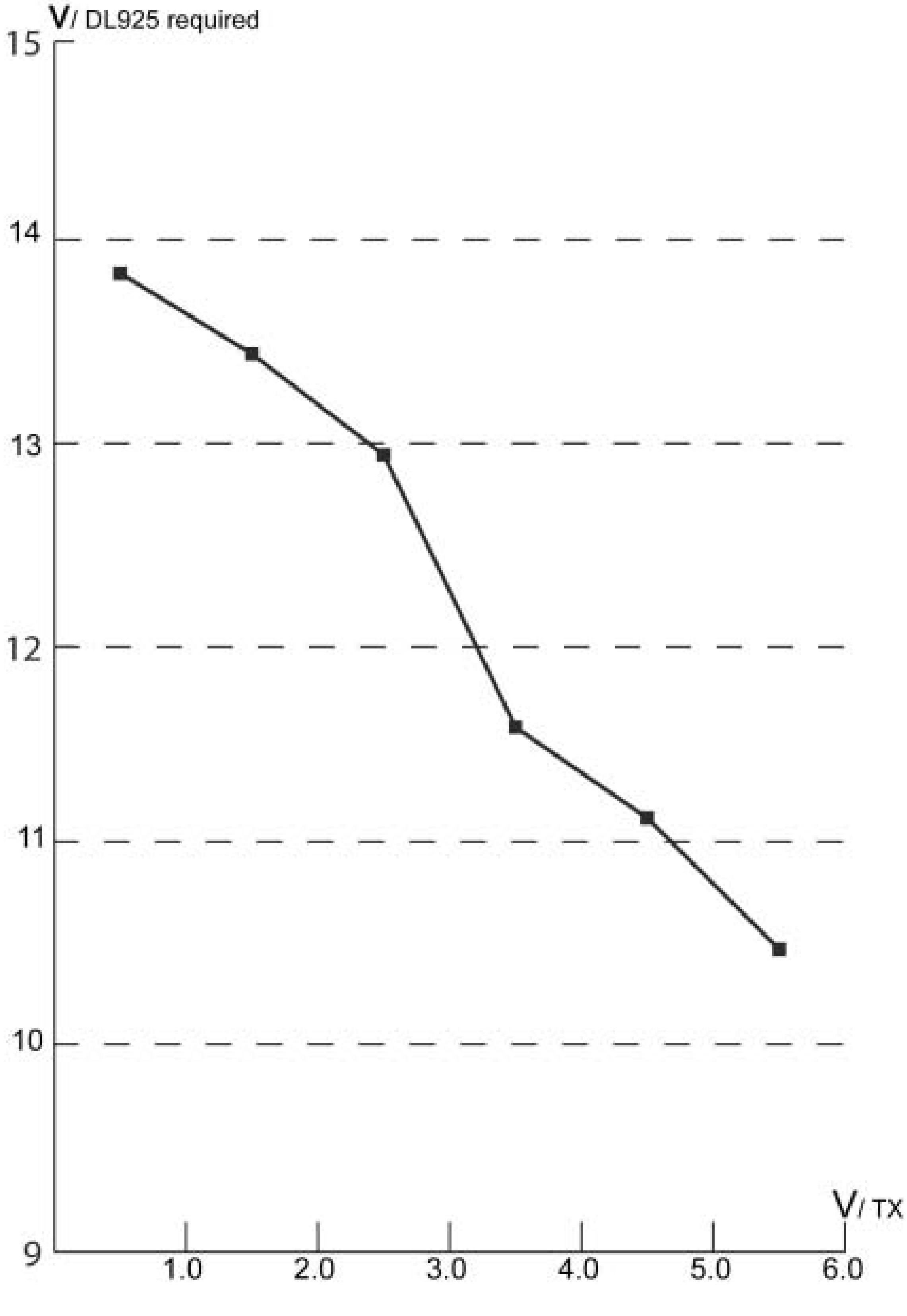
The results are given in the following table (Table 2).

Egme	DL925
0.5	13.85
1.0	13.45
2.0	12.95
3.0	11.60
4.0	11.15
5.0	10.50

Table 2

The effect of Egme was found to be less than the corresponding amount of D1925. It can also be concluded in this case that formulations where Egme is at a minimum would be more efficient at stabilizing ethanol/diesel mixtures from water-induced component separation.

Graph 2
Stabilising ethanol/diesel mixtures



3.0 Experimental

3.2.1 EW/170789

A solution of ethanol/water (20:1) was prepared.

3.2.2 Neat Water/ethanol/diesel

EW/170789 (21.0ml) was mixed with diesel (100ml) to afford a pale red opaque/ translucent emulsion, which soon formed a bilayer.

3.2.3 Additive and its components

3.2.3.1 D1925

EW/170789 (21.Oml) was mixed with diesel (100ml) and D1925 (20ml) and afforded a clear red solution, which remained stable in excess of 218 days.

3.2.3.2 Egme

EW/170789 (21.Oml) was mixed with diesel (100ml) and Egme (10ml). A further addition of egme (10ml) gave a clear red solution, which remained stable in excess of 56 days but deteriorated by 130 days.

3.2.3.3 Cf/Dl (2:3)

EW/170789 (21.Oml) was mixed with diesel (100ml) and Cf (10ml). Cf (5ml) and Dl925 (10ml) were added and gave a clear red solution, which remained stable in excess of 56 days. However by 130 days the solution had deteriorated into a bilayer.

3.2.3.4 Cf/Dl/Egme

Cf (2ml), Dl (5ml) and Egme 5ml) were mixed together and gave a clear yellow solution. EW/170789 (21.Oml) was added to the mixture and gave a paler solution. Diesel (100ml) was added and the mixture titrated with D1925 (6.0ml) until clear. The solution was stable in excess of 14 days but by 50 days it had deteriorated to form a bilayer.

3.2.3.5 Cf/Dl/Egme/TX

EW/170789 (21.Oml) was mixed with Cf (1ml), TX(1ml), Egme 5ml) and Dl (5ml) to give a pale yellow, clear solution. Diesel (l00ml) was added and the mixture titrated with Dl925 (6.0ml) until clear. The solution was stable in excess of 14 days but by 42 days it had deteriorated to form a bilayer.

3.3 1% Water contaminated ethanol/diesel mixtures

In these samples an water was deliberately added to represent a, severe contamination (1%), which is much higher water content than might have been expected to have come from moisture in the air.

3.3.1.1 20% Ethanol/diesel

Diesel (100ml) was blended with ethanol (20ml) and gave a clear one-phase liquid. The sample was covered with a porous lid (i.e. filter paper) and left to stand at ambient temperature. The solution deteriorated to form a bilayer after 3 days, which returned to a one-phase liquid after 19 days After 55 days, a clear, orange, one-phase solution was still present. The solution (96ml) remained stable after 123 days.

3.3.1.2 Dl925 stabilized Water/ethanol/diesel (sealed system)

Diesel (l00ml) was blended with ethanol (20ml) and gave a clear one-phase liquid. Water (1.0) was added and titrated with DL925 (4.8ml) and gave a one-phase liquid. A further quantity of DL925 (5.2ml) was added and gave a clear liquid. The sample was then stored in a sealed system. The solution (135ml) remained stable in excess of 123 days.

3.3.1.3 Dl925 stabilized Water/ethanol/diesel (open system)

Diesel (100ml) was blended with ethanol (20ml) and gave a clear one-phase liquid. Water (1.0) was added and titrated with DL925 (4.8ml) and gave a one-phase liquid. A further quantity of DL925 (5.2ml) was added and gave a clear liquid. The sample was covered with a porous lid (i.e. filter paper) and left to stand at ambient temperature. The solution (105ml) remained stable in excess of 123 days.

3.3.1.4 Egme/DL925 (1:1)

Diesel (100ml) was blended with ethanol (20ml) and gave a clear one-phase liquid. Egme (5ml) and DL928 (5ml) were added and gave a one-phase Liquid. The sample was covered with a porous lid (i.e. filter paper) and left to stand at ambient temperature. The solution (105ml) remained stable in excess of 123 days.

3.3.1.5 Egme/DL925 (1:1) stabilised water/ethanol/diesel

Diesel (l00ml) was blended with ethanol (20ml) and gave a clear one-phase liquid. Water (1.0ml) was added and the emulsion returned into solution by the addition of DL928 (5ml). Egme (5ml) was added to the clear liquid and the sample was covered with a porous lid (i.e. filter paper) and left to stand at ambient temperature. The solution (105ml) remained stable in excess of 123 days.

3.3.2 Formulations of additive

3.3.2.1 DCTE-36122

Cf (0.25ml), TX (O.5ml) and ethanol (20ml) were blended together. Egme (0.5ml) and diesel (100.0) were added. To the hazy solution DL925 (5ml) was added. The mixture was stirred to form a clear, red, one-phase liquid. A further addition of DL (1.0ml) was made. The sample was stored open to the atmosphere via a porous lid. A further addition of DL928 (3.Oml) was required for a clear diesel solution. An excess of DL925 (1.0ml) was added. After 50 days, a clear, orange, one-phase solution was still present. The solution (110ml) remained stable in excess of 92 days.

3.3.2.2 DCTE-21111

Cf (0.5ml), TX (0.5ml) and ethanol (20ml) were blended together. Egme (0.5ml), water (1.0ml) and diesel (100.0) were added. DL925 (5ml) was added to form a clear, red, one-phase liquid. On standing the Solution became hazy and a further addition of DL925 (1.0ml) to clear the haze and the sample was stored open to the atmosphere via a porous lid. A further addition of DL928 (3.7ml) was required for a clear diesel solution. An excess of DL925 (1.0ml) was added. The solution remained clear, orange and one-phase in excess of 92 days. The final volume (110ml) of the solution was measured.

3.3.2.3 DCTE-21112

Cf (0.5ml), TX (0.5ml), Egme (1.0ml) and ethanol (20ml) were blended together and diesel (100.0) added and gave a clear solution. Water (1.0ml) was added to give a suspension of droplets. DL925 (5.Oml) was added and gave a clear solution. The sample was stored open to the atmosphere via a porous lid. A further addition of DL928 (4.3ml) was required for a clear diesel solution. An excess of DL925 (1.0ml) was added. The solution (110ml) remained stable after 92 days

3.3.2.4 DCTE-16114

Cf (0.5ml), TX (0.5ml), ethanol (20ml) and Egme (2.Oml) were blended together and diesel (100.0) added and gave a clear solution. Water (1.0ml) was added which gave a suspension of droplets. DL925 (4.0ml) was added and gave a clear solution. The sample was stored open to the atmosphere via a porous lid. A further addition of DL928 (4.6ml) was required for a clear, orange, one-phase solution. The solution (108ml) remained stable in excess of 92 days.

3,3.2.5 DCTE-17116

Cf (0.5ml), TX (0.5ml) ethanol (20ml) and Egme (3.0ml) were blended together and diesel (100.0ml) added and gave a clear solution. Water (1.0ml) was added which gave a suspension of droplets. DL925 (3.Oml) was added and gave a clear solution. The sample was stored open to the atmosphere via a porous lid. A further addition of DL928 (4.6ml) was required for a clear solution. An excess of DL925 (1.0ml) was added. The clear, orange, one-phase solution (100.0ml) remained stable in excess of 92 days.

3.3.2.6 DCTE-15118

Cf (0.5ml), TX (0.5ml), ethanol (20ml) and Egme (4.0ml) were blended together and diesel (100.0ml) added and gave a clear solution. Water (1.0ml) was added which afforded a suspension of droplets. DL925 (2.Oml) was added and gave a clear solution. The sample was stored open to the atmosphere via a porous lid. A further addition of DL925 (4.7ml) was required for a clear diesel solution. An excess of DL925 (1.0ml) was added. The solution (108.0ml) remained stable after 92 days.

3.3.2.7 DCTE - 161110

Cf (0.5ml), TX (0.5ml), ethanol (20ml) and Egme (5.Oml) were blended together and diesel (100.0ml) added and gave a clear solution. Water (1.0ml) was added which gave a suspension of droplets. DL925 (1.2ml) was added and gave a clear solution. The sample was stored open to the atmosphere via a porous lid. A further addition of DL928 (4.8ml) was required for a clear diesel solution. An excess of DL925 (1.0ml) was added. The solution (108.0ml) remained stable after 92 days.

3.3.3 Ethanol/Diesel studies pt 2 role of TX

3.3.3.1 0.5% TX

Cf (1.0ml), Egme (1.0ml), ethanol (20ml) and TX (0.5ml) were blended together and diesel (100.0ml) added, which afforded a clear solution. Water (1.0ml) was added and titrated with DL925 (13.7ml) until a stable, clear solution was obtained. The sample was stored open to the atmosphere via a porous lid. The solution (116ml) remained stable in excess of 155 days.

3.3.3.2 1.0% TX

Cf (0.5ml), Egme (1.0ml), ethanol (20ml) and TX (1.0ml) were blended together

and diesel (100.0ml) added, which afforded a clear solution. Water (1.0ml) was added and DL925 (14.6ml) until a stable, clear solution was obtained. The sample was stored open to the atmosphere via a porous lid. The solution (115ml) remained stable in excess of 155 days.

3.3.3.3 2.0% TX

Cf (1.0ml), Egme (1.0ml), ethanol (20ml) and TX (2.Oml) were blended together and diesel (100.0ml) added, which afforded a clear solution. Water (1.0ml) was added and DL925 (14.5ml) until a stable, clear solution was obtained. The sample was stored open to the atmosphere via a porous lid. The solution (116ml) remained stable in excess of 155 days.

3,3.3.4 3,0% TX

Cf (1.0ml), Egme (1.0ml), ethanol (20ml) and TX (3.Oml) were blended together and diesel (100.0ml) added, which afforded a clear solution. Water (1.0ml) was added and DL925 (14.3ml) until a stable, clear solution was obtained. The sample was stored open to the atmosphere via a porous lid. The solution (117ml) remained stable in excess of 155 days.

3.3.3.5 4.0% TX

Cf (1.0ml), Egme (1.0ml), ethanol (20ml) and TX (4.0ml) were blended together and diesel (100.0ml) added, which afforded a clear solution. Water (1.0ml) was added and DL925 (14.0ml) until a stable, clear solution was obtained. The sample was stored open to the atmosphere via a porous lid. The solution (118ml) remained stable for 155 days.

3.3.3.6 5.0% TX

Cf (1.0ml), Egme (1.0ml), ethanol (20ml) and TX (5.Oml) were blended together and diesel (100.0ml) added, which afforded a clear solution. Water (1.0ml) was added and DL925 (14.0ml) until a stable, clear solution was obtained. The sample was stored open to the atmosphere via a porous lid. The solution (118ml) remained stable after 155 days.

3.4 Formulation studies for ethanol/diesel - role of Egme

3.4.1 0.5% Egme

Cf (2.0ml) TX (1.0ml), Egme (0.5ml) and ethanol (20.0ml) were blended together and diesel (100.0ml) added. With gentle warming a clear solution was obtained. Water (1.0ml) was added and the mixture titrated with DL925 (13.05ml) until clear. A further addition of DL925 (0.8ml) was required to produce a stable solution.

3.4.2 1.0% Egme

Cf (2.0ml), TX (1.0ml), Egme (1.0ml) and ethanol (20.0ml) were blended together and diesel (100.0ml) added to afford a clear solution was obtained. Water (1.0ml) was added and the mixture titrated with DL925 (12.7ml) until clear. A further addition of DL925 (0.75ml) was required to produce a stable solution.

3.4.3 2.0% Egme

Cf (2.0ml), TX (1.0ml), Egme (2.Oml) and ethanol (20.0ml) were blended together and diesel (100.0ml) added to afford a clear solution was obtained. Water (1.0ml) was added and the mixture titrated with DL925 (12.2ml) until clear. A further addition of DL925 (0.75ml) was required to produce a stable solution.

3.4.4 3.0% Egme

Cf (2.0ml) TX (1.0ml), Egme (3.Oml) and ethanol (20.0ml) were blended together and diesel (100.0ml) added to afford a clear solution was obtained. Water (1.0ml) was added and the mixture titrated with DL925 (10.8ml) until clear. A further addition of DL925 (0.8ml) was required to produce a stable solution.

3.4.5 4.0% Egme

Cf (2.0ml), TX (1.0ml), Egme (4.0ml) and ethanol (20.0ml) were blended together and diesel (100.0ml) added to afford a clear solution was obtained. Water (1.0ml) was added and the mixture titrated with DL925 (10.1ml) until clear. A further addition of DL925 (1.05ml) was required to produce a stable solution.

3.4.6 5.0% Egme

Cf (2.0ml), TX (1.0ml), Egme (5.Oml) and ethanol (20.0ml) were blended together and diesel (100.0ml) added to afford a clear solution was obtained. Water (1.0ml) was added and the mixture titrated with DL925 (9.7ml) until clear. A further addition of DL925 (0.8ml) was required to produce a stable solution.