

Alternative Fuels, such as Vegetable oil, Adaptability using Microemulsion Blend of Diesel and Water alongwith Stabilization by a Surfactant located at o/w Interface

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ABSTRACT

Vegetable oil based fuels such as mustard sal, palm, soy, castor seed oil based are more ecofriendly and biodegradable in comparison to the mineral oil based such as petrol & diesel due to the low toxic constituents. So their blend with microemulsion along with good surfactants will provide us a sharp edge over the old and conventional fuels. Microemulsions are generally found in two forms (1).o/w emulsion (2).w/o emulsion. It is observed that the cetane number of this system remains stabilized (45-55) and also the knocking property as well, through the tests ASTM D976 and ASTM 4737.

Some cetane standards of different oils or fuels which give us a marked advantage over other fuels.

- (1).Regular Diesel – 48
- (2).Premium Diesel – 55
- (3).Biodiesel(B100) – 55
- (4).Biodiesel blend(B20) – 50
- (5).Synthetic Diesel – 55

The best suited and benchmark cetane improvers are

- (1).2-ethyl hexyl nitrate(2-EHN) and,
- (2).Lubrizol 8090 (Under company's brand name)

The cloud point and corrosiveness remained unaffected by use of microemulsion blend alongwith surfactants.

The microemulsion blend of water and diesel increases not only the combustion of fuel but also the atomization while water keeps the microexplosions continuous encouraging the combustion and reducing the fuel consumption.

The surfactant such as polyoxyethylene (5), Sorbitan monooleate, Ethoxylated fatty alcohol, Oleic di ethanolamide(1:1), Ethoxylated amide, Polyethylene glycol monooleate act in reducing interfacial tension while surfactants such as linear alcohol, Ethoxylate, Ethylene oxide/Propylene oxide, EO/PO alkoxyate of primary alcohol, Trimethyl nonal ethoxylate, Phosphated nonyl phenol ethoxylate help in solubilization.

The main work of a good surfactant is to reduce the surface tension by its action and thus stabilization of system.

A surfactant contains polar end and non polar end. The polar end or hydrophilic end will be directed towards water while nonpolar end or hydrophobic end will be directed towards the organic end and thus removes the contaminants from the microemulsion by the micelle structure formation.

KEYWORD

Vegetable Oil, Surfactants, Microemulsion, Ecofriendly Emissions

INTRODUCTION

Diesel oil is a mineral based fuel which is used in compression ignition engine. Combustion reaction of diesel emits the CO, NO_x and particulate matter in our environment. To prevent these harmful and poisonous gases from going in to environment, a better and less polluted one alternate vegetable oil fuel or biofuel in lieu of fossil and nonrenewable diesel oil is thought of. In this continuous and nonending pursuit, the concept of microemulsion alongwith surfactants has given a new dimension by avoiding the carbon deposition in the internal parts of diesel engine as a choice of improved and better option in place of using neat diesel oil as a fuel.

Thus to improve the quality and performance of diesel engine, the emphasis will be on using microemulsion alongwith suitable surfactant. Surfactant will also stabilize the system by dissipation of energy through addition.

Microemulsions may be observed of the following type.

- (1). Blends of diesel with biodiesel.
- (2). Blends of vegetable oil with microemulsions.
- (3). Blends of vegetable oil with alcohols.

(Crooks et al., 1997, Nabi et al., 2006, Rakopoulos et al., 2006, Sarvi et al., 2009, Ochoterena et al., 2010, Pa Pagiannakis et al., 2010, Lif et al., 2010., Singh et al., 2010).

Microemulsions are formed by two immiscible liquids, like water in oil stabilized by surfactant located at w/o interface and thus removes contaminants and are called cleaners. Generally surfactants are chemical based and contain organic compounds and release organic substances as pollutants. The extent of toxicity remains low using these surfactants. Microemulsions have special

features such as high thermodynamic stability, large interfacial area, ultra low interfacial tension and optical transparency.

In microemulsion there occurs two phase, one is external phase and other is internal phase, but for a system existence the presence of both phase is essential. Now for the case of microemulsions such

two types of systems are w/o and o/w with surfactants

For o/w phase, the oil is finely dispersed in water (aqueous phase), while for w/o phase, the water droplets are finely dispersed in oil (organic phase).

Now in microemulsions of w/o, the addition of water in the organic phase of diesel oil improves the combustion process and thereafter the disintegration of several other molecules of oil. This leads to improve combustion efficiency and reduction in exhaust gas temp. which also reduce pollutant emissions. (Peekham, 2001, Wang & Fu, 2001, Abu Zaid, 2004, Park & Kwak, 2004, Armas et al., 2005, Lif & Halmberg, 2006, Bernert et al., 2009, Alamher et al., 2010).

The use of water as a part of microemulsion not only improves the emissions standards but also increase the combustion efficiency of blended fuel due to its superior volatile nature than oil. Also these type of the fuels enhances the use of renewable resources in comparison to the fossil fuels.

Fernandes et al. (2006) submitted a request for a patent of using microemulsions of diesel oil with vegetable oil referring that the blend worked better by the addition of water in microemulsion. Use of surfactant enhanced the stabilization efficiency. The w/o microemulsion fuel imparted good thermal stability and thus their physico-chemical properties

have been found in accordance with the original diesel oil as fuel in Brazil(ANP,2006). They concluded that the new blend of microemulsion can be used in diesel engine for increasing engine performance and fuel quality alongwith,maintaining that very criteria of toxicity as per environment specifications.

Lim and Wang(2004),working on two phase(w/o) and three phase(o/w/o) system, showed the possible results that best suited for microemulsions.

They concluded that three phase(o/w/o) emulsions were found to be better in comparison to two phase(o/w).They added that three phase microemulsion(o/w/o) produced more gas exhaust in comparison to the two phase.Also with the help of used water that remained a part of microemulsion and in definite proportion the amount of smoke has been seen low.

One of the scientists(Selim & Elfeky)(2001) showed

through their experiments that use of water, for single cylinder pre combustion chamber diesel engine(Heimen 111),remained a good idea behind proving the applicability of microemulsion blend in comparison to pure diesel and that was conspicuous by a difference in temp. drop.

These signs also prove that use of microemulsion alongwith water content can have not only good results over the efficiency of diesel engine butalso for the increased life and working condition of metallic parts and thus ignore the necessity of using a complex cooling system.

The percentage of surfactant in the blend was evaluated up to the maximum amount of water that could be added to this system for maintaining highly stabilized conditions.The most coveted and praiseworthy work with this study was the analysis and the statistical data that has been collected by fuel consumption,emissions of gas and hydrocarbon.

DISCUSSION

There are wide variety of alternative fuels in practice or at various stages of introduction today.Apart from emulsions such as o/w and w/o,the present topic also highlights and reviews those alternative fuels which were not included and summarized such as the emulsions containing hydrogen,natural gas,biogas,di methyl ether(DME),alcohols(methanol and ethanol),L.P.G.,vegetable oils and fatty acids methyl esters and blends of these with gasoline or diesel.Bio based fuel is a generic term that can be applied for all other alternative fuels or can be derived through it as an important renewable raw material.

The Kyoto protocol of 1997 and European parliament directive 2003/30/EC,gave emphasis on the use of alternative renewable fuel based on microemulsions and now a days they are called biobased such as biodiesel and ethanol.

In this way and the same context it is also true that nonrenewable sources of fuels are depleting and

exhausted day by day therefore one's nation priority will be based primarily upon the search for such type of fuels which can remain indigenous one and can be proved more economical if necessitated.To be a part of this fleet and colourful decorum several big players,in the form of oil companies are stepping up their feets so as to find out the appropriate and most convincing solution in the long run of finding the alternative renewable fuels resources alongwith different blends ranging from edible vegetable oil to nonedible vegetable oil.But there exists a difficulty in choosing the specific blend type based on vegetable oil using renewable resources that would have been shown the engine model specific one and class such as 2-stroke and 4-stroke.This problem on revision basis has been solved by using pre combustion chamber for the class of that engine specific.Now big companies are taking interest in R&D activities and field tests of such type of formulations of

microemulsions and keeping their options open for paving their path in this direction.

Several legislation are pushing the issue both in Europe and United States. Both the legislations are giving emphasis on the adoption of Euro4 and Euro5 standards which strictly follow the ecofriendlyness of fuels. These specifications also automatically take in to consideration the use of Light duty vehicle and Heavy duty vehicle while preserving the enforcement of the directives in this regard.

For the use of alternative fuels the European commission's Green Paper "Towards a European strategy for the security of energy supply" of 2001 sets a target for the transport sector at 20% by 2020. To further strengthen the transition to alternative fuels the directive 2003/30/EC of the European parliament on "The promotion of the use of biofuels or other renewable fuels for transport" sets indicative targets on renewable fuels at 2% and 5.75% for 2005 and 2010 respectively.

In the United States, the environmental protection agency (E.P.A.) regulates the emission. The so called Tier 2, valid during 2002-2009, regulates the emissions from cars and light duty vehicles. For heavy duty vehicles the emission regulation of 2004 limits NMHC's (non methane hydrocarbons) and NOx further. The California Air Resource Board (CARB) adopted the world's most stringent low emission vehicle programme in 1990 and federal emission level.

The European Heavy Vehicle Emission Legislation

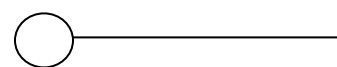
Standard	HC(g/kw)	CO(g/kw)	NOx(g/kw)	PM(g/kw)
Euro3 (2000)	.66	2.1	5.0	.1
Euro4 (2005)	.46	1.5	3.5	.02

The main aim of developing these type of microemulsions remain unfulfilled until the mechanism behind formation of microemulsion does not come in existence. In microemulsions, the dispersed phase occurs in the form of very small droplets whether it is water or oil. It is stabilized by

Euro5 (2008)	.46	1.5	2.0	.02
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HC, CO, NOx and PM stand for hydrocarbons, carbon Monoxide, nitrogen oxide and particulate matters. Neste oil has developed a specific diesel oil, called NExBTL, based on triglycerides of any origin. It is claimed to have superior properties compared to FAME (Fatty acid methyl ester). The other important fuels are methanol, D.M.E. and Fischer-Tropsch diesel.

Surfactant exists at interface and thus stabilizes the polar or hydrophilic or APL end also the nonpolar or hydrophobic or NAPL end of the microemulsion system.



(Polar End) (Nonpolar End)
Head Tail

Surfactant Molecule Structure

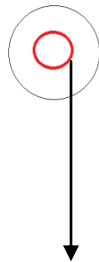
SOME SURFACTANTS STRUCTURES

Oil Soluble Part	Water Soluble Part
Hydrophobic End	(1).-COONa+
Long Hydrocarbon Chain (Organic Group)	(2).-SO ₄ Na+
	(3).-SO ₃ Na+
	(4).-OH

the use of surfactants having diameters from 50 to 500 Å and along the boundary, surfactants are located, which ensures to give the maximum output from the diesel oil by imparting it less weight or removing impurities from blends.

The mechanism can also be understood by keeping the fact that oil blends or microemulsions are maintained at Å units or 10^{-10} units which is a micro state and at this micro state the surface of emulsion remains in unstabilized phase due to the presence of contaminants and surfactants remove these contaminants and favours the emissions standards.

The main purpose of having surfactants at emulsion interface is to maintain the stabilization at both end,polar and nonpolar end



MICROFILM OF SURFACTANT

MICROEMULSION STRUCTURE

RED PART -----→Emulsion Interface

NAPL's or hydrophobic end have low solubilities and thus have high interfacial tension with aqueous or APL end in the microemulsions. These two attributes of microemulsions are responsible alongwith a surfactant to give it a stabilized state with maximum generacy.

Now with the help of surfactant the nonagitated state at NAPL end will be made agitated in a direction towards maximum solubility.On the other hand,APL ,polar or hydrophilic end of microemulsion which remains agitated will be brought up to a state where the surfactant will lower its tension.

Thus both ends of microemulsion will encountered with both the attributable character by surfactants and thus the system will be coming in a stable state alongwith remediation and thus removal of contaminants at micro level.

In both the additions,by surfactant,formation of micelle molecule will be seen(Wilson & Clarke).In the formation of micelle at APL end,the tail part of the surfactant molecule will act as a hydrophobic end with face towards the interior of micelle where the contact of water can not be experienced while at NAPL end,head part of the surfactant molecule will act as a hydrophilic end with face outward in water.

The formation of micelle at both ends of microemulsion will facilitate the movements of contaminants or nonpolar compounds towards interior of micelle and thus will be encouraging the remediation by surfactants and this phenonmenon will be showing the solubility of nonpolar compounds or contaminants.

Therefore choice of surfactant should be done in such a way so that at one place it will prove excellent in terms of solubility of contaminants and excellent reducer for interfacial tension at another.(Fountain

CONCLUSION

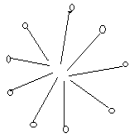
On the basis of this study and the detailed explanation for the work undergone through this review paper shows that the use of microemulsion in blend form not only increases the engine efficiency but also increases the atomization of diesel fuels for smooth running.

It has also been seen through study that water in diesel oil emulsion shows a reduction in pollution level alongwith ecofriendliness.

Reduction in the emission of toxic gases such as CO_2 , NO_2 and particulate matter(PM).Emission of NO_x has come down up to 30% and similarly 60% reduction in P.M. using microemulsion of 15% water in diesel.The water quantity which will be used for the preparation of microemulsion,affect the combustion mainly on two accounts,the first one will be the lowering of temp. in combustion chamber resulting in lower level of NO_x and second one the microexplosion in the fuel blend due to the

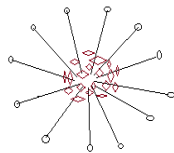
presence of water molecule and thus good volatile nature in comparison to diesel oil. The limits for water in w/o emulsion have been studied starting et,al).

from 5% to 45%.



(1)

Micelle



(2)

Micelle with non polar molecule

The use of surfactant will also be bringing the interfacial tension at a very low level along with excellent solubility conditions.

Apart from some general points, more specific points in the form of conclusions has been drawn which proves the use of water along with surfactants in preparation of microemulsion.

- (1). Combustion of fuel improved much better by the use of o/w and w/o microemulsion.
- (2). Compared with neat diesel, CO emissions were increased for the microemulsion system and with this difference engine power increased.
- (3). Total unburnt hydrocarbon content(HC) has not been seen in appropriate ratio with increasing engine power and water content.
- (4). NO_x emission increased with increasing engine power and decreased with the increasing water content in the microemulsion fuels. Increased NO_x emission can be seen in view of using

surfactant while reduction of temp. inside the combustion chamber.

- (5). A reduction in black smoke emission was observed for microemulsion as compared with diesel. Use of surfactant imparted the requisite stability to microemulsion for better combustion by removing the contaminants and thus a great deal of reduction can be seen in the amount of black smoke.
- (6). Internal combustion engine will work more efficiently and with more power output due to the presence of water (1). As a part of microemulsion (2). As a part of good liquid lubricant.

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