# Effect of phenol group antioxidant on performance & emission characteristic of diesel engine fueled with diesel-jatropha biodiesel blend-A review study

Rohitkumar H. Sonagra[1], Rushi B.Rawal[2]

[1] *PG student, Mechanical Department, GEC-Bhuj, Gujarat, India*

[2] *Assistant Professor, Mechanical Department, GEC-Bhuj, Gujarat, India*

**ABSTRACT**

*In conventional CI engine diesel is used as a fuel which provide better power, efficiency and BSFC. But it increase the CO2, CO, HC, SOX and NOx emission. Which affect the environment and human health. It causes global warming and greenhouse effect and responsible for acid rain too. Also diesel fuel is nonrenewable energy resources and increase our dependency for importing fuel on other country.*

*Due to depleting the fossil fuel and increasing effect of environment pollution from this fuel demands an eco friendly alternative which can be used in diesel engine without any major modification.*

*So this study present a detailed analysis of the green alternative of diesel fuel jatropha-Biodiesel fuel blends whose performance is optimum among the biodiesel diesel fuel and shows lower emission compare to diesel fuel but its limitation is high emission of NOx and storage stability of biodiesel blends is tried to nullify by selecting phenol group antioxidant with different proportion. so in this review we have according to studies phenol group antioxidant is most promising solution for storage stability and NOx reduction of jatropha biodiesel-diesel fuel.*

**Keyword :** - *phenol group antioxidant, jatropha biodiesel-diesel blends, Nox reduction*

## 1. Introduction

From literature study we can say that jatropha oil can not be used directly in CI engine due to its high viscosity, high molecular weight it causes the problem of filter chocking and injector chocking due to poor atomization and high molecular weight for that we have to reduce its viscosity and make it comparable to diesel fuel. This can be achieved by many ways like Pyrolysis, Micro emulsification, Dilution and Transesterification. Among these, transesterification is the most commonly used commercial process for produce biodiesel.

The fatty acid triglycerides themselves are esters of fatty acids and the chemical splitting up of the heavy molecules, giving rise to simpler esters, is known as Transesterification.

Biodiesel (fatty acid methyl ester) is produced by: FFA is catalyzed by metallic Zn in esterification (Reaction 1) and triglycerides (TGs) transesterification catalyzed by NaOH. (Reaction 2).

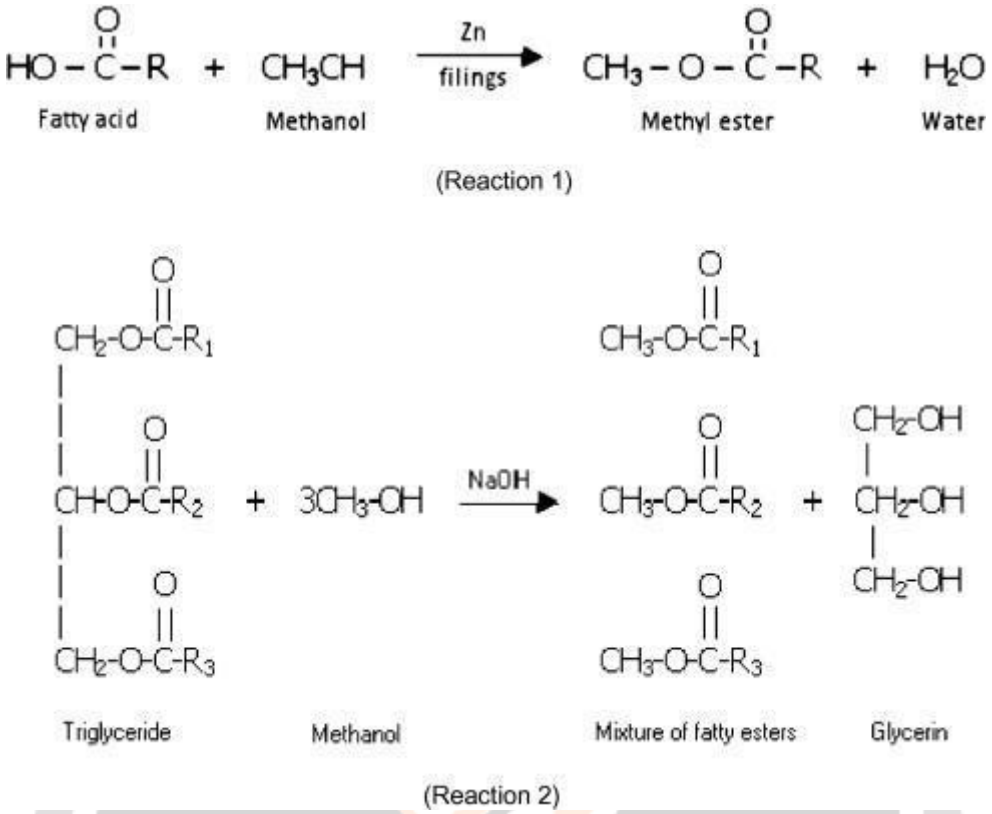


**Figure 1** Transesterification process [1]

Thus biodiesel obtained by transesterification can be use in CI engine with diesel blends due to its viscosity is comparable to diesel fuel. Biodiesel reduce the exhaust emission like HC,CO2,PM compared to diesel fuel. It contains lower sulfur content and it also improve lubricity of the engine parts. but main problem associated with use of biodiesel as a fuel is its storage stability and it increase NOx formation. NOx is formed by chain reactions involving Nitrogen and Oxygen in the air. These reactions are highly temperature dependent and engine using biodiesel are always operated with excess oxygen. And one another reason for NOx formation is due to free radical formation due to oxidation process which can be retarded by use of antioxidant which also improve storage stability of biodiesel. Antioxidant also help to reduce NOx formation with use of biodiesel blend use as a fuel in CI engine.

## 2. Literature survey

**Brajesh Kumar Mishra et al. [1]** investigate that biodiesel is ecofriendly fuel and also an alternative fuel for diesel engine. They also find the advantages of biodiesel it is green alternative and clean engine fuel and used in any diesel engine without any modification. Biodiesel is alternative fuel of diesel because it is renewable and have similar properties with diesel fuel.

Biodiesel contain 11% oxygen by weight which allows the fuel to burn more completely and reduce the emission of CO, HC and PM. these pollutants are toxic which affect the human health. Diesel fuel contain 500 PPM sulfur and Biodiesel contain less than 15 PPM. Thus by combustion of Biodiesel Sox emission is reduced.

Biodiesel improve lubricity due to high viscosity of Bio diesel fuel which causes problem of atomization and choking of injector. Viscosity is reduced by dilution of biodiesel or by transesterification process. NOx is formed by chain reaction between nitrogen and oxygen and is highly temperature dependent. Which is increased by increasing Bio diesel content in diesel biodiesel blend. Biodiesel is said to be carbon neutral as more carbon dioxide is absorbed by the biodiesel yielding plants than what is added to the atmosphere when used as fuel.

**K. Pramanik[2]** investigate that dilution of jatropha biodiesel or blending with diesel fuel bring the viscosity to the specific range.
Viscosity of 9.848 and 6.931 cSt and density of 0.862 and 0.853 g/cc were observed with 30:70 and 20:80 J/D, respectively. Which is close to the diesel fuel thus blend containing the 20-30% jatropha biodiesel can be used as engine fuel without preheating. The specific fuel consumption and the exhaust gas temperature were reduced due to decrease in viscosity of the vegetable oil.

**M. Mofijur et al.[3]** investigate about the performance and emission characteristic of jatropha biodiesel diesel blends. they found that Calorific value decreased & density increased as the amount of Jatropha biodiesel Increased in the blends.
An average reduction in B.P.is found for B10 & B20 by 4.67% and 8.86% respectively compared to B0.
The maximum torque was recorded at 1800 rpm, and it was 21.1 Nm, 20.45 Nm, and 20.12 Nm for B0, B10 and B20 respectively.
The average BSFC for B10, B20 (278.46 g/kWh, and 281.9 g/kWh) were found to be higher compared to B0 (273.5 g/kWh).
The use of B10 and B20 produced lower HC (3.84% and 10.25%) and CO (16% and 25%) emissions but slightly higher NOx (3% and 6%) emission compared to B0.

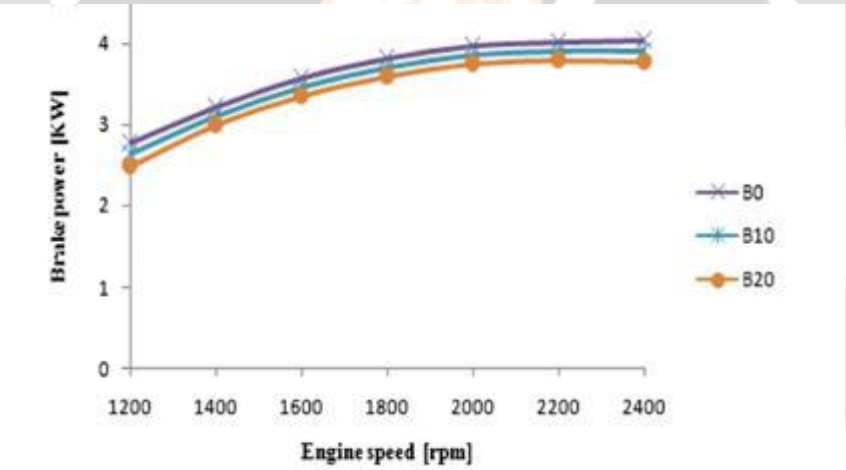


**Figure 2** : brake power-speed characteristics [3]

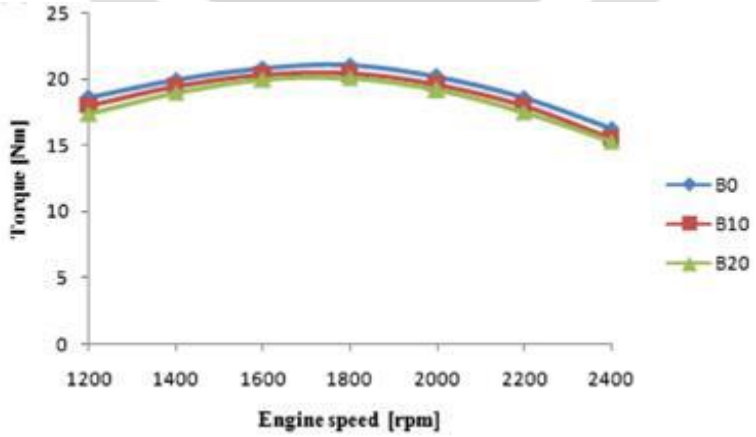


**Figure 3** : Torque-speed characteristics [3]

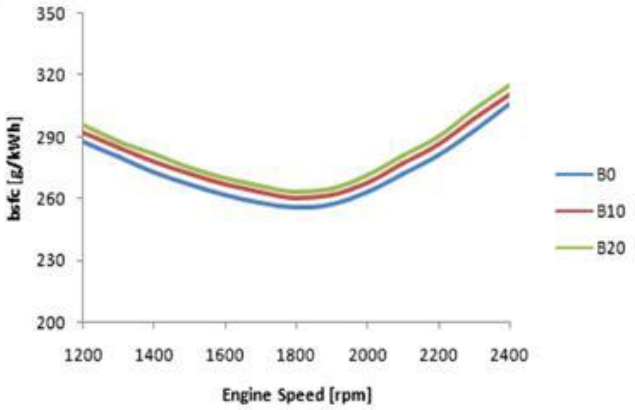


**Figure 4** : Variation of BSFC with respect to speed [3]

**Siddharth Jain et al.[4]** investigate about the oxidation and storage stability of jatropha diesel blend by using antioxidant.
Stability of biodiesel is affected by interaction with light, temperature and other factor with affect the cleanliness of the fuel. Literature showed that oxidation stability is influenced by the different natural & synthetic antioxidants.
Different types of phenol group synthetic antioxidants are tert-butylhydroquinone (TBHQ), butylated hydroxyanisole (BHA), butylated Hydroxytoluene (BHT), propyl gallate (PG), R-tocopherol and Pyrogallol (PY). PY was found as the
Most effective antioxidant to increase the oxidation stability of Jatropha Biodiesel.
It is clear that as the amount of antioxidant increased in the Jatropha biodiesel, the IP also get increased from 3.27 hrs. to 18 hrs. By increasing amount of antioxidant is jatropha fuel long term storage stability is also increase thus it possible to store biodiesel for longer period of time.

**Velmurugan.K et al.[5]** investigate about the effect of antioxidant on reducing NOx by using L ascorbic acid as antioxidant. NOx is generated in biodiesel is mainly due to oxidation of nitrogen at higher temperature and formation of free radical in front hydrocarbon flame. Antioxidant inhibits the oxidation processes by donating electron or hydrogen to the free radicals. Thus reduce the NOx emission.
Result shows that L-ascorbic acid is very effective to control NOx formation. LA300 with mango seed methyl ester, the emission is reduced by 21.33%.and HC emission is also reduced by 8.13% at full load condition. There is slightly increase in CO and BSFC is observed.

**W. O. Osawa et al. [6]** investigate the effect of different antioxidant on storage and oxidation stability of croton biodiesel. They investigate that antioxidant ability of phenolic group antioxidant depend on the number of –OH group and their occupying 1,2 and 1,4 position in the aromatic ring. They also found that –OH group provide proton which prevent the formation of free radicals hence reduce the speed of the oxidation.
PY and PG have three –OH group and each two of are on the 1,2 position of aromatic ring. while TBHQ have 2 –OH group and located on ,4 position .BHA have only one –OH group and directly bonded to the aromatic ring. Thus PY,PG and TBHQ shows the better effect of antioxidant compare to BHA and BHT.

## 3. CONCLUSIONS

1) This study shows that biodiesel is a green alternative fuel which can used with diesel engine without any modification. It also shows the lower emission of CO, CO2, SOx, PM compared to diesel fuel but it increased NOx formation due to free radical and oxidation instability is major problem regarding to the biodiesel blends which cause oxidation of fuel and harm the fuel properties.

2) High viscosity of jatropha oil is also a major issue regarding it uses as fuel but it can be reduced by dilution of jatropha oil, preparing blends of biodiesel with diesel or transesterification process.

3) Literature shows that antioxidants is used for inhibits the oxidation process which also assist in reduction of NOx formation. It increases the oxidation stability and storage stability of jatropha biodiesel-diesel fuel blend.

4) Among all the antioxidant phenol group antioxidant is excellent antioxidant for jatropha oil. In phenol group PY (Pyrogallol), PG (Propyl gallate) and TBHQ (tert-Butylhydroquinone) shows the effective performance on oxidation and storage stability compared to others. Oxidative stability improve as proportion of antioxidant increase in jatropha biodiesel diesel blend.

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