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Exhaust emission characteristics of diesel and biodiesel

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ABSTRACT

The performances of diesel contrasted with that of biodiesel, such as HC and CO and NO_x and fume and particles discharge, are studied on. The contents of HC, CO, NO_x and flue gas are measured by Japan 163 Gas Chromatograph, USA 48 CO Analyser, Japan MEXA-7200H and FBY-201 flue gas analyzer, respectively. The experimental results shows HC discharge of biodiesel B20 decreases with the increase of rate of revolution; NO_x discharge of biodiesel B5 and biodiesel B20 increase with the increase of torque; NO_x discharge increases with the increase of adding biodiesel at the same torque; Flue gas discharge of biodiesel B5 and biodiesel B20 firstly increase and then decrease with the increase of torque; Particle discharge decreases with the increase of the amount of biodiesel.

Keywords: Biodiesel; Diesel; HC and CO; Discharge Performance; Pollutants

1. INTRODUCTION

Biodiesel is the alkyl esters of long chain fatty acids and a transportation fuel that has gradually grown in popularity over the past decade. With the decreasing reserves of fossil fuels, it is now more important than ever to find transportation fuels that can serve as alternatives to crude oil-based fuels such as gasoline and diesel fuel. Common sources for biodiesel's feedstock include soybean oil [1], algal oil, higuereta oil [2], canola oil, vegetable oils [3], palm oil, corn oil [4], rapeseed oil [5], Brassica carinata oil [6], trap grease [7], yellow horn oil [8]. Lately there has been growing controversy about the use of potential food sources for the production of fuel. In attempt to address these concerns, researchers have turned their focus from the popular feedstock and are currently investigating the use of alternative feedstock such as beef fat from beef plant.

The objective of this work was to study on the discharge performance of biodiesel and diesel, such as HC and CO and NO_x and flue gas and particles. And the experimental results of biodiesel are compared with that of diesel. The experimental results can prove that biodiesel has more competitive in price and environmental protection with diesel fuel.

2. EXPERIMENT

Feedstock

Diesel was obtained from Fushun Petrochemical Company. Biodiesel was produced from palm oil with Assistant of $CaO\text{-}La_2O_3$. Properties of diesel and biodiesel are shown in **Table 1** and **Table 2**, respectively.

3. RESULTS AND DISCUSSION

3.1 CO and HC Discharge

Experimental results of CO discharge at the different rate of revolution (1000 r/min, 1500 r/min and 2000 r/min)

Table 1. Properties of diesel.

Project	Diesel
Oxidation stability mg 100 mL^{-1}	0.1
Acidity mg KOH 100 mL^{-1}	4.97
10% remain coke %	0.01
Copper corrosion	1
Kinematic viscosity (20˚C) $mm^2 \cdot s^{-1}$	3.541
Freezing point ˚C	–37
Flash point ˚C	54
Cetane number	57

Table 2. Properties of biodiesel.

Project	Biodiesel
Density (20˚C) $kg \cdot m^{-3}$	894.7
Flash point ˚C	121
Sulfur content %	0.0004
Copper corrosion	1
Cetane number	50.1

are listed in **Table 3**. CO discharge of blank diesel has no change with the increase of rate of revolution. CO discharge of biodiesel B5 decreases with the increase of rate of revolution. But CO discharge of biodiesel B20 increases with the increase of rate of revolution. CO discharge decreases with the increase of adding biodiesel at the same rate of revolution.

The cylinder's temperature and the content of oxygen in the cylinder have a main effect on the burning degree of fuel. The content of CO shows if the burning degree of fuel is good or bad. When fuel is burnt, the content of oxygen determines to produce the amount of CO due to the high cylinder's temperature. Diesel doesn't almost consist of oxygen element, while biodiesel includes a little bit of oxygen element, so diesel requires more oxygen and discharges more CO than that of biodiesel.

Experimental results of HC discharge at the different rate of revolution are listed in **Table 4**. HC discharge of blank diesel and biodiesel B20 decreases with the increase of rate of revolution. But HC discharge of blank diesel firstly increase and then decreases with the increase of rate of revolution and has a maximum 5. HC discharge increases with the increase of adding biodiesel at the same rate of revolution.

Compound fuels (B5 and B20) have very low HC discharge because biodiesel has low content of aromatics and a little bit of oxygen element and high cetane number, so HC discharge is very low.

3.2. NO_x Discharge

Experimental results of NO_x discharge at 1000 r/min are shown in T**able 5**. NO_x discharge of blank diesel and biodiesel B5 and biodiesel B20 increase with the increase of torque. NO_x Discharge increases with the increase of adding biodiesel at the same torque. When biodiesel is added into diesel, it means more oxygen element is added into diesel, so NOx discharge gradually increases.

3.3. Flue Gas Discharge

Experimental results of flue gas discharge at 1000 r/min are shown in **Table 6**. Flue gas discharge of blank diesel and biodiesel DB5 and biodiesel DB20 firstly increase and then decrease with the increase of torque and have maximum. Flue gas discharge decreases with the increase of amount of biodiesel at the same torque. Flue gas decreases because C/H of biodiesel is lower than that of diesel and density of biodiesel is more than that of diesel.

3.4. Particle Discharge

Experimental results of particle discharge at 1000 r/min are shown in **Table 7**. Particle discharge obviously decreases with the increase of adding biodiesel. Particle discharge of B5 and B20 decrease 8.2% and 13.3%, respectively. Fuel is burnt to discharge particle due to high temperature and no oxygen and crack reaction. Compound fuels (B5 and B20) have low content of aromatics to produce less particle and high cetane number to decrease the burning period and the burning retention, so it prevents more particle producing.

T**able 3.** Results of CO discharge.

Rate of revolution r/min	1000	1500	2000
Torque Nm	300	300	300
	CO discharge %		
Blank diesel (B0)	0.01	0.01	0.01
Biodiesel (B5)	0.01	0.01	0.008
Biodiesel (B20)	0.006	0.007	0.008

Table 4. Results of HC discharge.

Rate of revolution r/min	1000	1500	2000
Torque Nm	300	300	300
	HC discharge ugg^{-1}		
Blank diesel (B0)	18	14	12
Biodiesel (B5)	6	7	4
Biodiesel (B20)	9	8	7

Table 5. Effect of different torque on NO_x discharge (ugg^{-1}) at 1000 r/min.

	100 Nm	150 Nm	200 Nm	250Nm
Blank diesel (B0)	875	1345	2051	2178
Biodiesel (B5)	891	1357	2067	2207
Biodiesel (B20)	886	1506	2178	2298

Table 6. Effect of different torque on flue gas discharge (%) at 1000 r/min.

	100 Nm	150 Nm	200 Nm	250 Nm
Blank diesel (B0)	0.78	1.18	1.08	1.04
Biodiesel (B5)	0.77	1.10	0.98	0.94
Biodiesel (B20)	0.60	0.82	0.48	0.40

Table 7. Particles discharge.

Project	Results
Rate of revolution r/min	1000
Torque Nm	300
Dilution PM/mgh^{-1}	
Blank diesel (B0)	6.67
Biodiesel (B5)	6.12
Biodiesel (B20)	5.78

4. CONLUSION

Biodiesel discharge performance, such as HC and CO and NO_x and flue gas and particles discharge, is researched. The experimental results are as follow:

1) Adding biodiesel is benefit to decrease pollutants in the environment.

2) CO discharge decreases with the increase of adding biodiesel at the same rate of revolution and HC discharge increases with the increase of adding biodiesel at the same rate of revolution.

3) NO_x discharge of blank diesel and biodiesel B5 and biodiesel B20 increase with the increase of torque. NO_x Discharge increases with the increase of adding biodiesel at the same torque.

4) Flue gas discharge of blank diesel and biodiesel B5 and biodiesel B20 firstly increase and then decrease with the increase of torque and have maximum. Flue gas Discharge decreases with the increase of amount of biodiesel at the same torque.

5) Particle discharge decreases with the increase of adding biodiesel.

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