Enhancement in viscosity of diesel by adding vegetable oil

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ABSTRACT: *Some time due to improper blending of different refinery distillate stream and variation in distillation range as well as cause of using different crude we are getting resulting diesel having various range of viscosity. When viscosity falling below specification value it is necessary to enhance this value for proper use of this diesel in engine. Enhancement of this viscosity was done by using some vegetable oil in this paper. Soya bin methyl ester and yellow grease methyl ester are two vegetable oil studied among this soya bin methyl ester is most efficient vegetable oil to raise the viscosity of diesel.*

KEYWORDS: *Viscosity, distillate, stream, SME (soya bin methyl ester), YGME (Yellow grease methyl ester.)*

I. INTRODUCTION

The primary role of engine oil is the lubrication of moving engine parts and reducing friction and wear of metal surfaces which provides the good engine performance and its long life. In order to provide a defined quality of engine oils during production and for final products to meet the product specifications we need to know the physical chemical characteristics of engine oils. Certain physical-chemical characteristics which are significant for the quality of engine oils are achieved by adding additives to base oils. The most frequent additives are for: Improving of viscosity index-improvers
 Reducing pour point-depressants
 Maintaining engine cleanness-detergents and dispersants
 Preventing oxidation-antioxidants
 Preventing corrosion-corrosion inhibitors

The most important engine oils characteristic is the viscosity defined as a measure of inner friction which works as a resistance to the change of molecule positions in fluid flows when they are under the impact of shear force, or in other words, it is the resistance of fluid particles to shear. When fluids flow, there are friction forces between their particles and also between fluid particles and the adjoining surface, caused by the resistance of fluid to particle shear and also of surface roughness. The viscosity is a changeable category and it depends on the change of temperature and pressure. A higher temperature reduces the viscosity and makes a fluid thinner. The viscosity index is an empirical number which shows how the viscosity of some oils changes by increasing or reducing the temperature. High viscosity index shows relatively small tendency of viscosity to change upon influence of certain temperature, as oppose of low viscosity index which shows greater viscosity change with temperature. The calculation is based on viscosity values determined by ASTM D 445 method at 40 and 100 °C.

II. MATERIALS AND METHODS

Petroleum diesel of refinery grade purchased directly from city petrol pump and different additive added to this diesel were purchased from Shree Padma Bio Fuels is Soya Methyl Ester which is derived from Esterrification of Soya oil with Methanol and yellow grease were make available from Biomass Energy Conversion Center of the Iowa Energy Center in Nevada, Iowa. The methods used in this work are the ASTM standard methods.

III. EXPERIMENTAL

Diesel fuel is composed of a variety of blending components of different hydrocarbon types. Refiners use blending components to balance the viscosity specifications that produce the optimum diesel fuel for specific applications and operating environments.

Petroleum-derived diesel is composed of about 75% saturated hydrocarbons (primarily paraffin including n, iso, and cycloparaffins), and 25% aromatic hydrocarbons (including naphthalene and alkyl benzenes). The average chemical formula for common diesel fuel is C12H23, ranging approximately from C10H20 to C15H28. Some of the blending components are straight-run streams that come directly from the crude oil in the primary distillation process. Other blending components are hydrocracker streams produced from heavy gas oils, thermally cracked distillates typically produced from the delayed coking of refinery residual streams, and light-cycle oils produced from fluid catalytic cracker (FCC) units. Depending on the sulfur content of the crude oil, the straight-run and processed streams may require desulfurization before addition into the final diesel-fuel blend. refinery stream that contribute for saturated hydrocarbon is LGO,HGO,VD,LK,HK,STRAIGHT RUN HEAVY NAPHTHA, while stream that contribute for aromatic are cracked stream like LCO,HEAVY GASOLINE and AGO. Viscosity of diesel is increases with increasing molecular weight of diesel as well as increasing naphthenic and paraffinic compound in diesel. Among all stream that use for diesel HGO having highest concentration of naphthenic and paraffinic compounds as well higher molecular weight. Considering this basic concept generally refiner are used to increase blending ratio of HGO hence we get desired value of viscosity of final blended diesel product but this concept is not always advisable because of cost of HGO as well as direct contribution of HGO on other key parameter of diesel.

Table No. 01 Base diesel blending stream proportion and distillation property

Volume percentage	**28%**	**15%**	**12%**	**2%**	**21%**	**20%**	**0.8%**	**1.2%**	**TOTL= 100%**
Stream	LGO	HGO	VD	LK CDU	HK CDU	LCO	HEAVY GASOLINE FCCU	AGO VBU	RAW DIESEL
IBP	207	268	254	160	189	166	137	175	156
5%	245	294	281	171	215	191	143	195	171
10%	260	312	287	173	222	199	145	202	179
30%	282	332	311	178	236	227	150	229	207
50%	296	345	329	186.0	244	255	156	259	240
70%	312	350	347	198	251	290	164	291	279
85%	328	377	364	210	257	320	172	314	314
90%	336	389	373	216	260	331	177	323	330
95%	348	393	390	225	265	342	183	336	352
FBP	360	399	397	232	269	346	195	342	361
VISCOSITY@ 40^0C	3.934	9.668	6.798	1.551	2.0235	2.665		2.330	1.946

To overcome this problem we have choose to use two different type of bio oil that can enhance viscosity of diesel without measure deviation in other key parameter of diesel .The yellow grease methyl ester (YGME) and the soybean oil methyl ester (SME) were tested as pure fuels and as 20% blends with as such diesel fuel. Diesel fuel was purchased from a local commercial supplier. The SME purchased from Shree Padma Bio Fuels and YGME purchased were prepared in the pilot plant located at the Biomass Energy Conversion Center of the Iowa Energy Center in Nevada, Iowa. Effect of SME blending on viscosity and other parameter is as shown below presented in tables 2

Table No. 02 Properties of diesel fuel and various blends of SME

Property	Diesel 0%	SME 20%	SME 40%	SME 60%	SME 80%	SME 100%
Sulphur fraction in the fuel	0.025	0.00105	0.00208	0.00308	0.00405	0.005
Cetane number	48	48.69	49.37	50.03	50.67	51.3
Fuel density (kg/m3)	830	841	852	863	874	883
Kynemetic viscosity (Cst)	1.946	3.971	4.319	4.635	4.943	5.285

Similarly effect of Yellow grease methyl ester blending on viscosity and other parameter is as shown below presented in tables 3

Table No. 03 Properties of diesel fuel and various blends of YGME

Property	Diesel 0%	YGME 20%	YGME 40%	YGME 60%	YGME 80%	YGME 100%
Sulphur fraction in the fuel	0.025	0.00145	0.00278	0.00388	0.00465	0.002
Cetane number	48	49.85	50.37	51.53	52.17	57.3
Fuel density (kg/m3)	830	841	852	863	874	876
Kinematic viscosity (Cst)	1.946	2.471	2.985	3.585	4.046	4.000

From above two experiments it is merely seen that both the additive having tendency to raise the viscosity of base diesel in addition to this there is no other adverse effect on other key parameter of base diesel.

One more experiment were carry out by adding 1:1 ratio of SME :YGME to diesel in 20% volume the result obtained of this experiment and complete test report of pure SME and YGME are as bellowing shown in Table No. 04

Table No. 04 Fuel Properties of petroleum diesel, yellow grease methyl ester, Soy methyl ester, and B20

Fuel Property	**Test Method**	**Diesel Fuel**	**YGME**	**SME**	**B20 (80%petroleum diesel+10%SME+10%YGME)**
Flash Pt. (oC)	ASTM D93	59	130	160	74
Heating value (BTU/lb.)	ASTM D240	18110	15781	15873	17828
Kinematic Viscosity (cSt @ 40oC)	ASTM D445	1.946	4.0	5.285	2.981
Ash (mass %)	ASTM D482	0	0	0	0
Cetane Number	ASTM D613	48.0	57.3	51.3	49.8
Fuel density (kg/m3)	ASTM D1298	830	876	0.883	0.858
Aromatics (vol. %)	ASTM D1319	27.6	0	0	0
Sulfur (mass %)	ASTM D2622, ASTM D 4294	0.025	0.002	0.005	0.023
Water & Sediment (vol. %)	ASTM D2709	0	0	0	0
HFRR Lubricity (@ 60oC, WSD um)	ASTM D6079	448	376	377	375
Distillation Analysis	ASTM D86				
oF IBP		156	613.8	626.5	358.4
oF 10% Recovered		179	629.7	634.2	432.2
oF 50% Recovered		240	636.6	638.5	534.4
oF 90% Recovered		330	656.9	652.9	638.1
oF Final Boiling Point		361	661.5	651.9	667.6
Vol.% Recovered		97.7	96.2	94.5	98.0
Vol. % Residue		1.6	2.1	5.2	1.3
Vol. % Loss		1.0	1.7	0.3	0.7

IV. RESULTS AND DISCUSSION

Yellow grease methyl ester and soya methyl ester both having ability to enhance viscosity of diesel but out of this both soya methyl ester is most efficient to raise viscosity because of its own higher viscosity value compare to yellow grease methyl ester. Soya Methyl ester having higher value of sulfur and lower value of cetane number compare to yellow grease methyl ester hence it gives reducing effect on other key parameter of diesel with respect to yellow grease methyl ester. Although before using it as additive further study of fuel emission in engine required.

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