SHORT PAPER

OFF ROAD AND MARINE DIESEL FROM LIGHT GAS OIL, VACUM GAS OIL AND KEROSENE BLEND

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Abstract: Vacuum gas oil (VGO) produced by Benghazi Asphalt Factory and light gas oil (LGO) used in north Benghazi power plant were mixed in different volume ratio to produce a fuel blend. Kerosene was added in a small different volume ratio to reduce viscosity and improve cold flow LGO/VGO fuel blend property. LGO/VGO fuel blend pour point, flash point, volatility, copper corrosion properties, heat of combustion, water content, ignition quality and ash content are within the range of diesel fuel and light gas oil specifications. Viscosity and sulfur content of fuels A and C are within the range of diesel fuel classified A_2 and marine diesel specifications whilst, carbon residue is slightly higher than that of diesel fuel classified A_2 and No. 2-D specifications.

Keywords: Off Road, Marin Diesel, LGO, VGO, Kerosene, Blend.

INTRODUCTION

Vacuum gas oil (VGO) is produced by vacuum distillation of atmospheric residue whilst kerosene and light gas oil (LGO) are both a middle distillate produced by atmospheric petroleum distillation (Hobson, 1992). Kerosene is a fuel for aeroplanes and domestic application and the mean use of LGO is a fuel for diesel engines and heating oil for power plants. The viscous and high sulfur content VGO is a feedstock for hydro and catalytic cracking plants (Hobson, 1992) and heating oil to minor industrial operations as in Benghazi Asphalts Factory. The aim of this research is to prepare marine and off road diesel by mixing LGO and the available cheap VGO produced by Benghazi Asphalt Factory and kerosene in different blending volume ratio. Both fuel blends LGO/VGO and LGO/VGO/kerosene have never been mentioned in literatures.

EXPERIMENTAL

Three fuel blend samples were prepared from light gas oil, vacuum gas oil and kerosene. LGO, VGO and kerosene specifications are shown in (Table 1). The specifications were obtained from Benghazi Asphalt Factory and north Benghazi Power Plant. The first LGO/VGO fuel blend was prepared by blending in a 1L measuring cylinder a 1:0.25 volume ratio LGO and VGO. The LGO/VGO fuel blend was shaken for several minutes then left stand unshaken for several minutes, this fuel blend assigned Fuel B and C were prepared by blending LGO, VGO and kerosene in the following volume ratio 1:0.5:0.1 for fuel B, and 1:0.25:0.05 for fuel C.

Fuel A, B and C physical specifications were obtained following ASTM standard methods at Benghazi Asphalt Factory laboratory (American Society for Testing and Materials, ASTM Test Method, petroleum products, lubricants and fossil fuels analysis 1993, and American Society for Testing and Materials, Standard Specifications for Marine Fuels D 2069-1991, for Fuel Oils, D 396-1997, for Diesel Fuel Oils D 975-1997 and for Aviation Turbine Fuels D1655-1998). Total sulfur carbon residue and ash content were obtained by calculation method. LGO, VGO and kerosene samples used as received.

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Table 1. LGO, VGO and Jet kerosene specifications.

Test & Unit	Method	Result		
		LGO	VGO	Jet kerosene
Specific gravity @ 15.6 ˚C	ASTM-D 1289	0.8555	0.9389	-
API gravity	ASTM-D 1289	33.90	19.21	-
Density @ 15 ˚C kg/l	ASTM-D 1289	0.8851	0.9383	0.7902
Distillation:	ASTM-D 86			
Initial boiling point. ˚C		-	215	147.6
Recovered@280 ˚C. mL		-	3.5	-
Temperature @ 65% recovery ˚C		324.3	-	-
Temperature @ 95% recovery ˚C		369.1	-	-
Final boiling point		-	555	275.4
Flash point ˚C	ASTM-D 93	62	106	39.5
Pour point ˚C	ASTM-D 97	-12	+18	-
Cetane index	ASTM-D976	48.7	37	-
Heat of combustion (net) MJ/kg	ASTM-D 4868	46.38	45.71	43.32
Copper corrosion 3 hrs @ 100 ˚C	ASTM-D130	-	1a	-
Copper corrosion 2 hrs @ 100 ˚C	ASTM-D130	-	-	1a
Copper corrosion 3 hrs @ 50 ˚C	ASTM-D130	1a	-	-
Water by distillation V%	ASTM-D 95	-	0.05	-
Total sulfur wt%	ASTM-D 4294	0.10	1.863	0.035
Conradson carbon residue. Wt%	ASTM-D 189	<0.10	1.39	-
Viscosity @ 40 ˚C. cSt	ASTM-D 445	3.478	21.53*	-
Viscosity @ -20 ˚C. cSt	ASTM-D 445	-	-	3.24
Ash content Wt%	ASTM-D 482	<0.001	0.0088	-
Freezing point ˚C	ASTM-D 2386	-	-	-49.5
Total acidity mg KOH/g	ASTM-D 3242	-	-	0.009
Total aromatic V%	ASTM-D 6379	-	-	19.9
Water and sediment	ASTM-D-96	<0.01	-	-

*viscosity at 50˚C

RESULTS AND DISCUSSION

The three prepared fuel blends Fuel A, B and C specifications are tabularized in (Table 2). Flammability or flash point which is an indication of fuel handling and storage safety requirements, flash point test result demonstrated the safety handling and storage safety of the three prepared fuel blends A, B and C. Pour point a cold flow property of the three prepared fuels are low and below zero degree celsius appropriating Libyan climate even in winter season. Volatility test or distillation and recovery @ 280˚C tests results. This property is related to the objectives of controlling start ability, evaporative emissions, and cold start/warm-up performance emissions. Cetane index which is a measure of the ignition quality of diesel fuel, net heat of combustion, water content, ash content and copper strip corrosion test results. Values of the three fuel blends A, B and C are within the range of diesel fuel and LGO specifications (Hobson, 1992). Viscosity and sulfur content of both fuel A and C are within the range of marine diesel and diesel

Table 2. Fuel A, B and C specifications.

Test & Unit	Method	Result		
		A	B	C
Specific gravity @ 15.6 ˚C	ASTM-D 1289	0.8734	0.8800	0.8715
API gravity	ASTM-D 1289	30.5	29	31
Density @ 15 ˚C kg/l	ASTM-D 1289	0.8729	0.8795	0.8710
Distillation:	ASTM-D 86			
Initial boiling point ˚C		234	172	183
Recovered@280˚C mL		30	32	34
Flash point ˚C	ASTM-D 93	70	68	64
Pour point ˚C	ASTM-D 97	-3	-6	-9
Cetane index	ASTM-D 976	46	44	47
Heat of combustion (net) MJ/kg	ASTM-D 4868	46.22	46.14	46.23
Copper corrosion 3 hrs @ 100 ˚C	ASTM-D 130	1a	1a	1a
Ash content Wt%		0.0027	0.0035	0.0026
Water by distillation V%	ASTM-D 95	traces	Traces	traces
Total sulfur wt%		0.480	0.680	0.462
Conradson carbon residue Wt%		0.380	0.525	0.364
Viscosity @ 40 ˚C cSt	ASTM-D 445	5.6	6.60	5.3

fuel classified A_2 and No. 4-D specifications for off-road automotive engines and stationary engine application (Hobson, 1992; Technical Review diesel fuels Chevron Products Company, 2011). Fuel A and C conradson carbon residue test results are a rather higher than that of both on-road diesel fuel classified ultra low sulfur No. 2-D and off-road diesel fuel classified A_2 specifications (Hobson 1992 and Technical Review diesel fuels Chevron Products Company 2011). The results are within the range of burner fuels classified E to H of BS 2869 specifications which may be used for medium and low speed large diesel engines as used in power generating installation and within the range of marine diesel fuel specifications (Hobson 1992 and Technical Review diesel fuels Chevron Products Company, 2011). Whilst fuel B viscosity which affects fuel spray atomization and fuel system lubrication, conradson carbon residue that shows only long term effect by coking tendency formation of fuel and may relate to engine deposits. Sulfur content which shows an immediate effect and long term effects by increasing particulate emissions, cylinder wear and deposits these three specifications are all within the range of off-road diesel fuel classified No. 4-D and marine diesel specifications (Hobson, 1992; Technical Review diesel fuels Chevron Products Company, 2011). During preparation, handling and laboratory testing of the three prepared fuel blends no precipitated sediment was observed or occurred.

CONCLUSION

From the physical specifications as well the calculated chemical properties of fuel A and C (Table 2); these two fuel blends can be used safely to increase power plants LGO storage feedstock for electrical energy generation. The three prepared fuel blends A, B and C are classified as ultra high quality off-road and marine diesel fuels and can handled and storage safely.

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