COMPARATIVE ANALYSIS OF THE QUALITY OF PETROLEUM PRODUCTS FROM DIFFERENT SOURCES IN SAPELE, DELTA STATE, NIGERIA

Abstract

Physicochemical analysis was carried out on different petroleum products (namely, gasoline, kerosene and diesel) from different petrol stations/sales outlets, to determine their quality.

The physical chemical parameters investigated were specific gravity, pour point, API gravity, viscosity, flash point, fire point and cloud point. The test was carried out using standard procedures of American society for testing and materials (ASTM).

The result shows that physical chemical parameters investigated fell short of the ASTM standard range for a good number of the petroleum products, suggestive of adulteration. Given that petroleum products are generally imported into the country, the source of adulteration could not be determined since samples were collected only at petrol stations/sales outlets.

Keywords: Petroleum products, physical chemical parameters, petrol stations, adulteration

1.0 Introduction

The Nigerian oil sector can be categorized into three main sub-sectors, namely, upstream, downstream and gas. The most problematic over the years has been the downstream sector, which is the distribution arm and connection with final consumers of refined petroleum products in the domestic economy (1)

In Nigeria however, due to the dilapidated state of our refineries, the country has to import fuel to meet up the daily consumption of different petroleum products. These products pass through different storage, handling, transportation and delivery procedures from the point of refining to the final consumers. The consequence of these procedures is the possibility of the compromise of product quality and adulteration (2)

Adulteration is the illegal addition of any foreign substance into motor Gasoline / high speed diesel. Adulteration maybe due to a long storage period. fuel quality can widely evolve and be different from its initial quality. Storage conditions, condensation, bacteria or the fuel itself can all distort its composition. Depending on the type and degree of the contamination, fuel could generate engine failure. There are different patterns of adulteration ranging from blending of lubricants into kerosene as a substitute for diesel, blending of kerosene into petrol, blending of kerosene into diesel; and blending of used lubricants into diesel. Adulterants may contain halogens, silicon, phosphorous or other metallic elements (found in recycled lubricants); these in turn are quite outside the normal gasoline composition range. They will cause increased emissions and may even cause vehicle breakdown by corroding fuel injection systems and carburetors, and by causing deposits on valves, fuel injectors, spark plugs, oxygen sensors and exhaust catalysts. Even low levels of adulterants can be very injurious and costly to the vehicle operator. For gasoline, any adulterant that changes its volatility can affect drive ability. High volatility (resulting from the addition of light hydrocarbons) in hot weather can cause vapor lock and stalling. Low volatility in cold weather can cause starting problems. (2, 3)

This research paper investigates the quality of petroleum products sold in different petrol stations/sales outlets in Sapele through the analysis of some physico-chemical properties of diesel, kerosene, and gasoline such as specific gravity, API gravity, viscosity, flash point and fire point, cloud point and pour point following ASTM procedures. The results obtained would then be compared with ASTM standards to ascertain the level of purity or adulteration of these petroleum products.

1.1 Study Area

The study area is Sapele town, Delta state, southern Nigeria. It lies along the Benin River just below the confluence of the Ethiope and Jamieson rivers, 98 miles (158 km) from the Escravos Bar and entrance to the Bight of Benin. The town also lies on the road that branches to Warri, Ughelli, and Asaba and is connected by ferry to the road to Benin City. Founded in the colonial period on land traditionally inhabited by the Urhobo (Isoko) people, Sapele has been a centre for saw-milling (obeche, abura, sapele, and mahogany) since 1925. Its plywood- and veneer-manufacturing plant is one of the largest in western Africa. Sapele is also known for the rubber plantations in the vicinity.

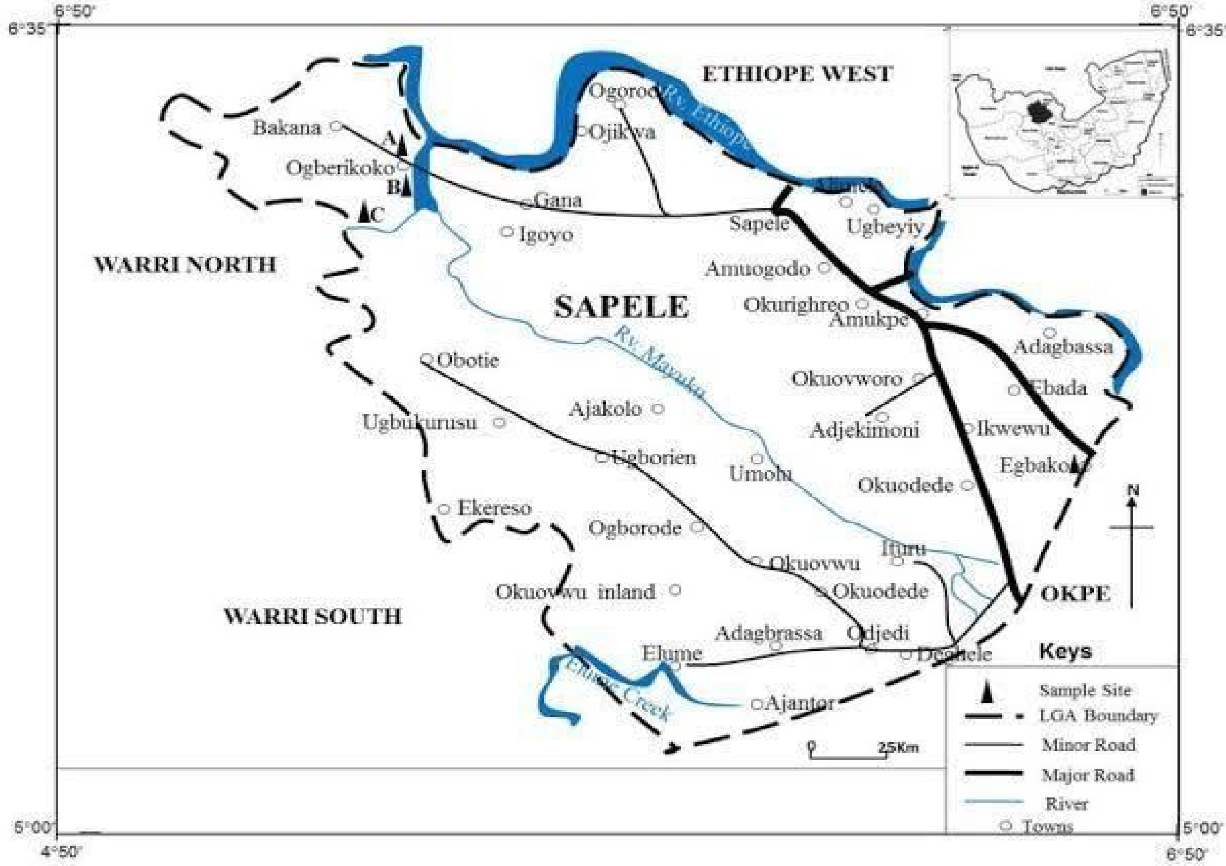

Figure 1: Map of Sapele (Encyclopedia Brittanica)

2.0 Materials and Methods

Three different petroleum products (namely, gasoline, diesel and kerosene) were collected from four different sampling points: a major petrol station, an independent/privately owned station, 'black market' and local artisanal outlets respectively. The purpose was to determine the quality of these petroleum products sold in these sales outlet.

Some physical chemical parameters such as Specific gravity, API gravity, viscosity, flashpoint, fire point, pour point, and cloud point were determined using the American society's standard process for testing and materials (ASTM). The results obtained were now compared for quality with known standards for gasoline, kerosene and diesel respectively.(4,6)

3.0 Results and Discussion

3.1 Specific gravity

3.1 The results for the specific gravity of gasoline, diesel, and kerosene collected from the different petrol stations/ sales outlet is given in Table 1 and figure 2 to 3.

Table 1: ***Results for specific gravity of gasoline, diesel and kerosene***

SOURCE	GASOLINE	DIESEL	KEROSENE
Major petroleum station(MPS)	0.738	0.817	0.776
Private owned station(POS)	0.748	0.838	0.741
Black market (BM)	0.671	0.840	0.813
Local artisanal (OB)	0.755	0.888	0.789
ASTM Standard	0.750-0.770	0.80-0.875	0.825-0.925

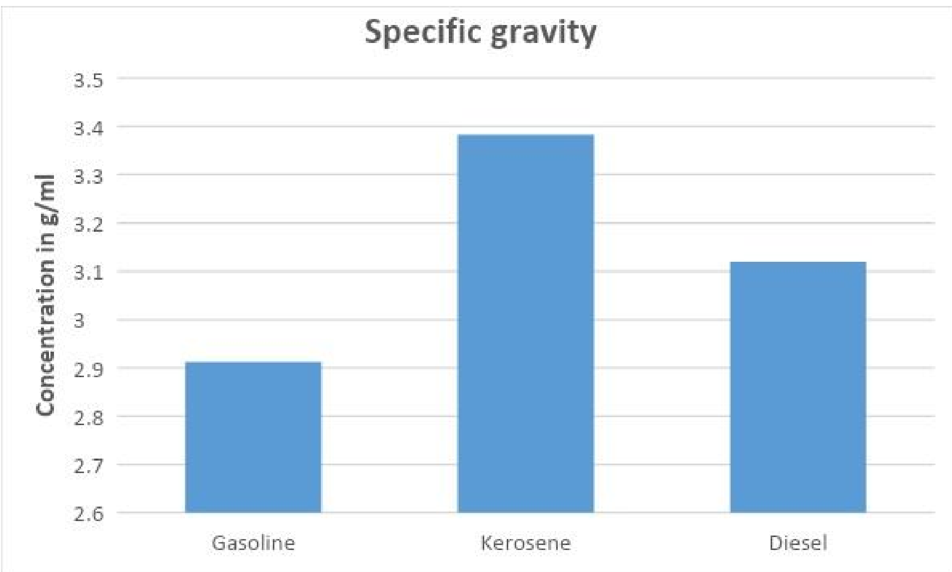

Figure 2 **specific gravity of gasoline, kerosene and diesel**

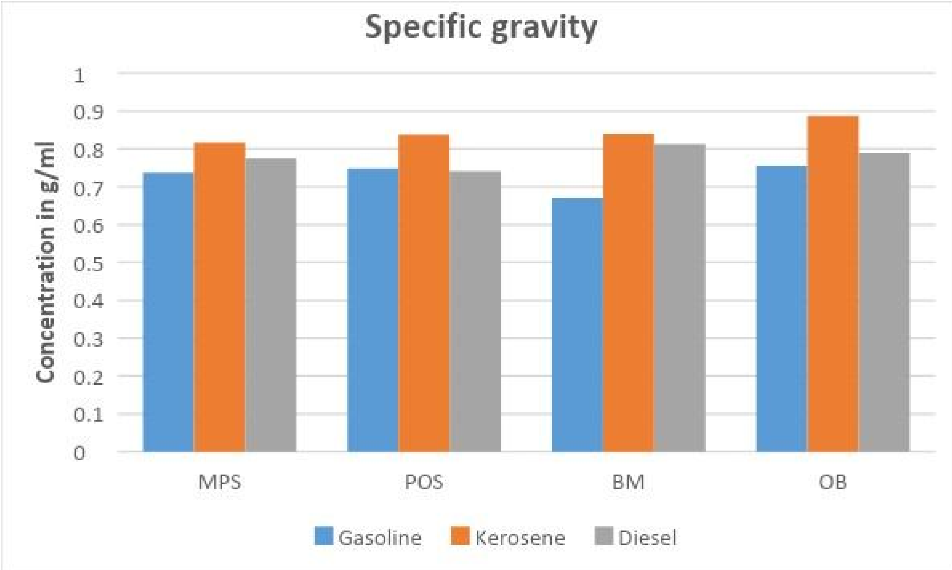

Figure 3 **specific gravity of gasoline, kerosene and diesel from petrol stations/sales outlets**

Specific gravity is defined as the ratio of a substance's density (mass per unit volume) to the density of a reference material. The specific gravity for all gasoline fell below the ASTM standard, except the one from local artisanal, with values within the ASTM standard range. However, for diesel fuel, specific gravity was generally within the ASTM standard, with slightly higher value for the diesel obtained through local artisan operation. Specific gravity for all kerosene products are generally below the ASTM standard. (4,6)

3.2 API Gravity

The API gravity for gasoline, kerosene and diesel obtained from different petrol stations /sales outlet has been given in table 2 and figure 4 to 5.

Table 2: ***Results for API gravity***

SOURCE	GASOLINE	DIESEL	KEROSENE
Major petroleum station(MPS)	**60.23**	**41.53**	**50.85**
Private owned station(POS)	**48.07**	**33.80**	**59.46**
Black market(BM)	**79.13**	**76.96**	**42.92**
Local artisanal(OB)	**55.92**	**25.90**	**47.84**

ASTM Standard	**52.28-57.16**	**30.21-45.38**	**21.47-40.01**

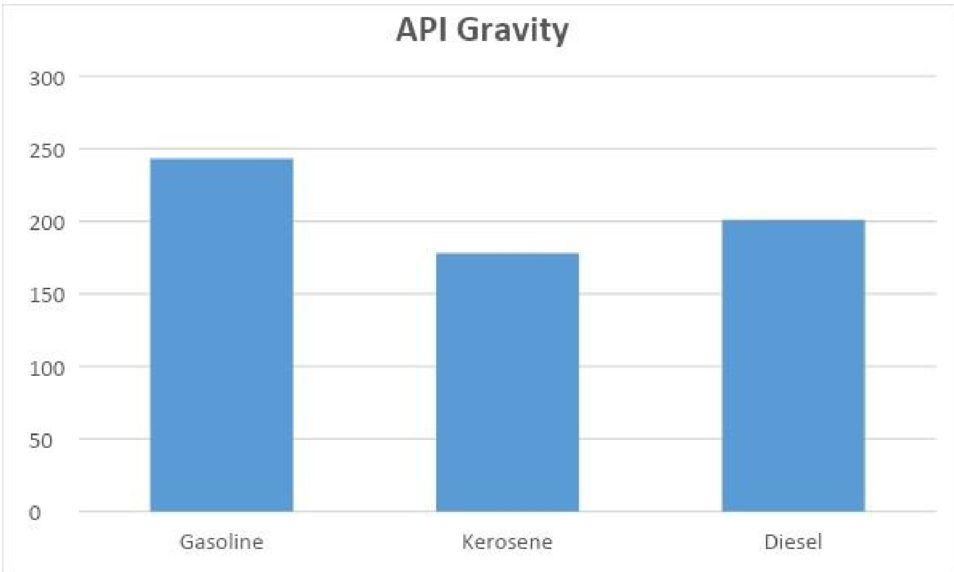

Figure 4 API gravity for gasoline, kerosene and diesel

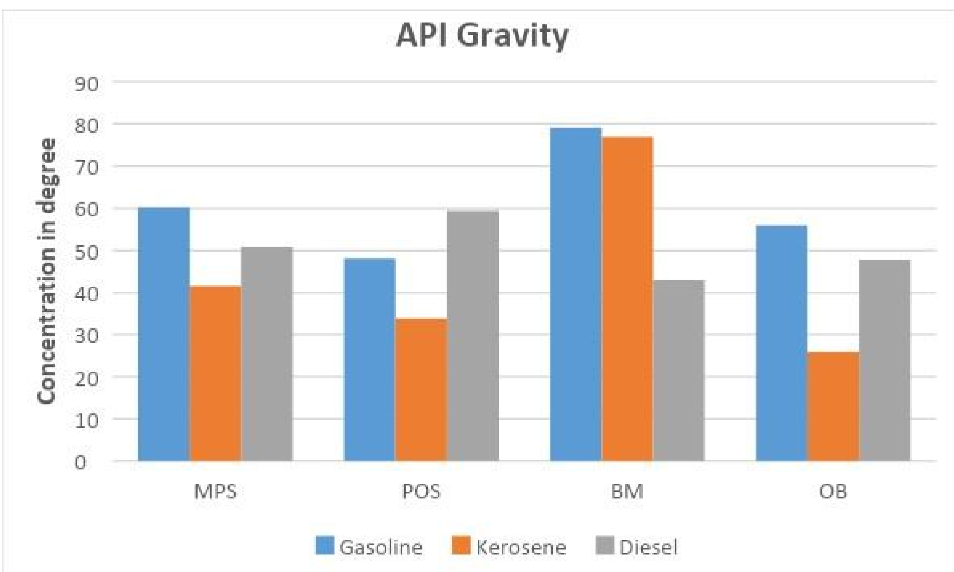

Figure 5 API gravity of gasoline, kerosene and diesel from different petrol stations/sales outlets.

The API gravity, or American Petroleum Institute gravity, is used to determine how heavy or light a petroleum liquid is, in comparison to water: if the API gravity is greater than 10, the petroleum liquid is lighter and floats on water; if the API gravity is less than 10, the petroleum liquid is heavier and sinks.

For this study however, the API gravity of gasoline for the major petrol station and black market sales outlet was found to be higher than the ASTM standard, the privately owned petrol station had value below the ASTM standard, while the gasoline from the local artisan process was within the ASTM standard range.(6)

For diesel fuel, the black market sample had API gravity far above the ASTM standard, while the local artisan product was found to be below standard. The major and private petrol stations had values within the ASTM standard. For kerosene samples, the observed API gravity for all sampling points was generally above the ASTM standard.(4)

3.3 Viscosity

The viscosity of gasoline, diesel, and kerosene is presented in Table 3 and figure 6 to 7.

Table 3: ***Result for the viscosity of gasoline, kerosene and diesel.***

SOURCE	**GASOLINE**	**KEROSENE**	**DIESEL**
Major petroleum station(MPS)	**1.49**	**1.887**	**4.523**
Private owned station(POS)	**1.11**	**1.219**	**4.556**
Black market (BM)	**3.08**	**3.21**	**4.369**
Local Artisanal(OB)	**0.757**	**3.419**	**10.95**
ASTM standard	**0.5-0.84**	**1.0-1.9**	**1.5-3.5**

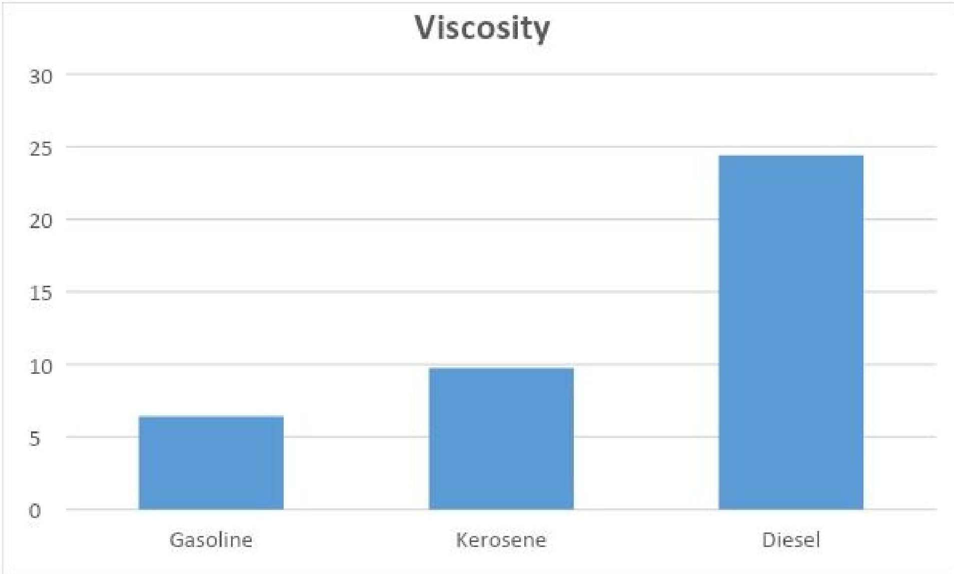

Figure 6: Viscosity of gasoline, kerosene and diesel

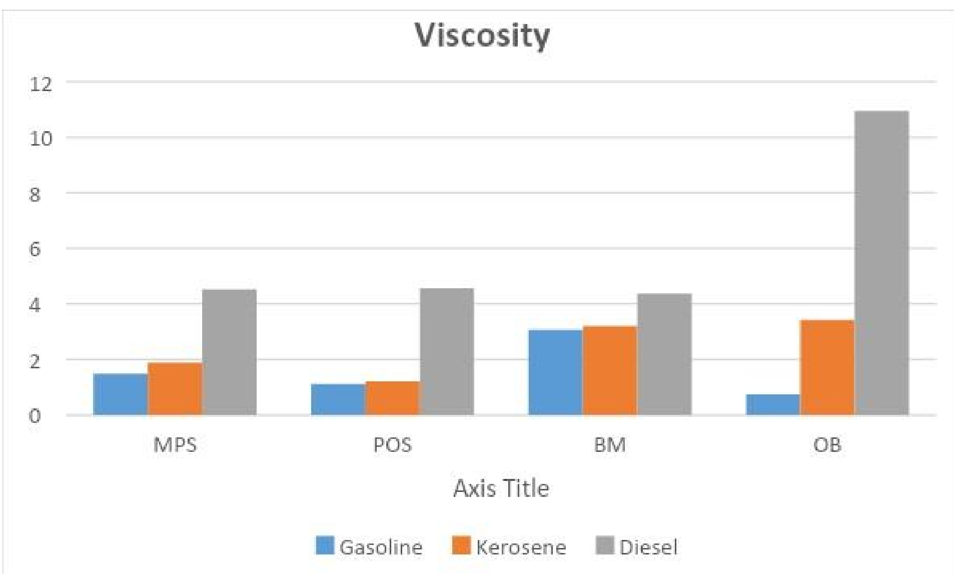

Figure 7 Viscosity of gasoline, kerosene and diesel from different petrol stations/sales outlets

The viscosity of gasoline from all petrol stations/sales outlets was found to be above the ASTM standard, except the local artisan product which fell within the standard range. While the major and private petrol stations had viscosity values falling within the ASTM range for kerosene, the black market and the local artisanal products were far above the standard. However, for diesel products, the viscosity recorded were generally above the ASTM standard range. (5,6)

3.4 Flash point and Fire Point

The results for flash point and fire point for kerosene and diesel obtained from different petrol stations/sales outlets has been presented in table 4 and 5, figure 8 to 3.11.

Table 4: Results of Flash point of kerosene and diesel for different petrol stations/sales outlets

SOURCE	**KEROSENE**	**DIESEL**
Major petroleum station(MPS)	22°C	57°C
Private owned station(POS)	18°C	50°C
Black market(MB)	14°C	62°C
Local artisanal (OB)	21°C	65°C
ASTM Standards	38-72°C	>52-96°C

Table 5 : Results of fire point of kerosene and diesel for different petrol stations/sales outlets

SOURCE	**KEROSENE**	**DIESEL**
Major petroleum station(MPS)	**26°C**	**61°C**
Private owned station(POS)	**20°C**	**55°C**
Black market(BM)	**20°C**	**65°C**
Local artisanal(OB)	**24°C**	**68°C**
ASTM Standard	**>42°C**	**>60°C**

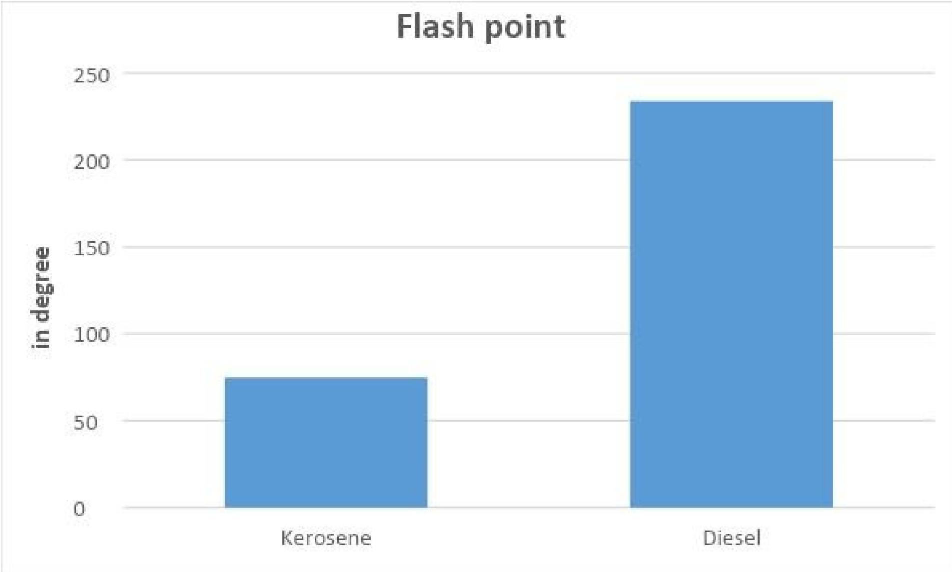

Figure 8 : Flash point of kerosene and diesel

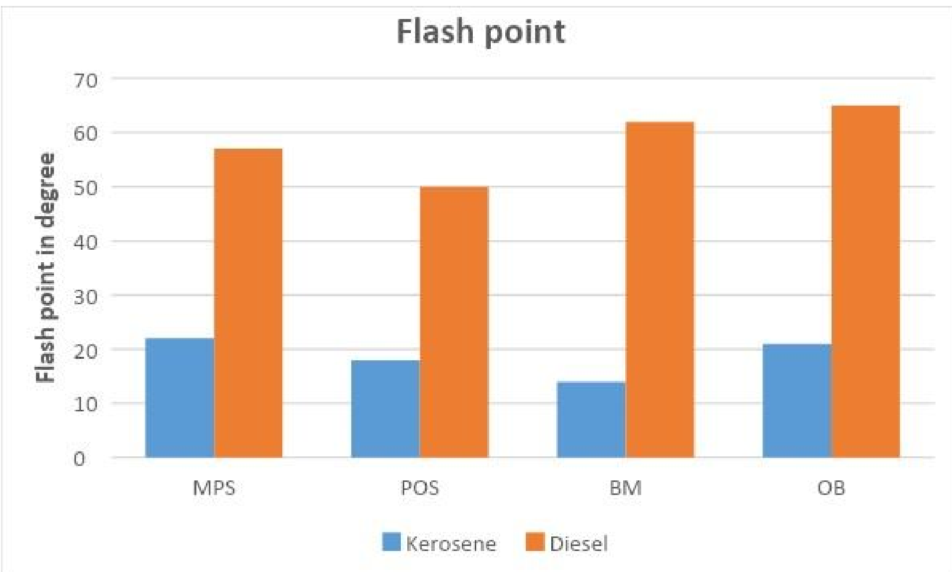

Figure 9: Flash points of kerosene and diesel from different petrol stations/sales outlets

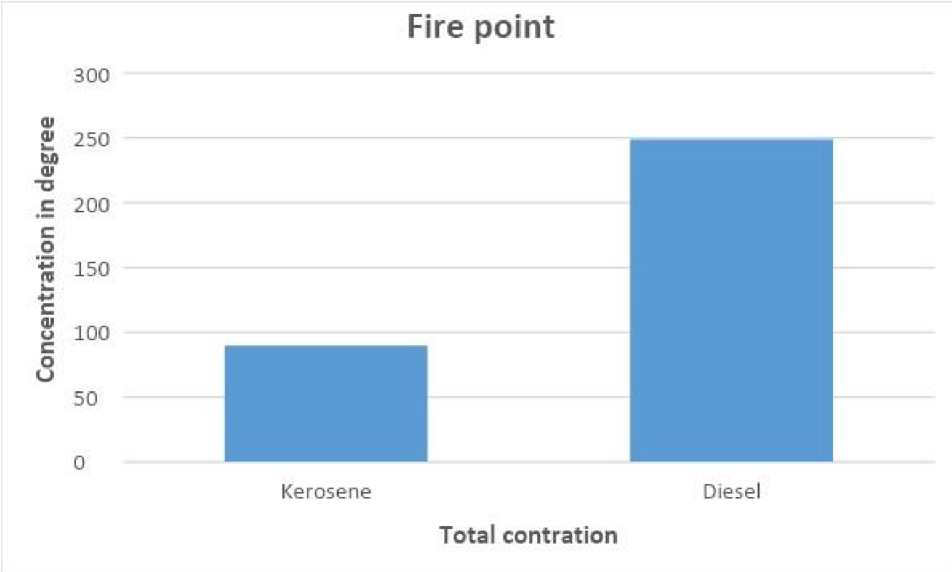

Figure 10: Fire point of kerosene and diesel

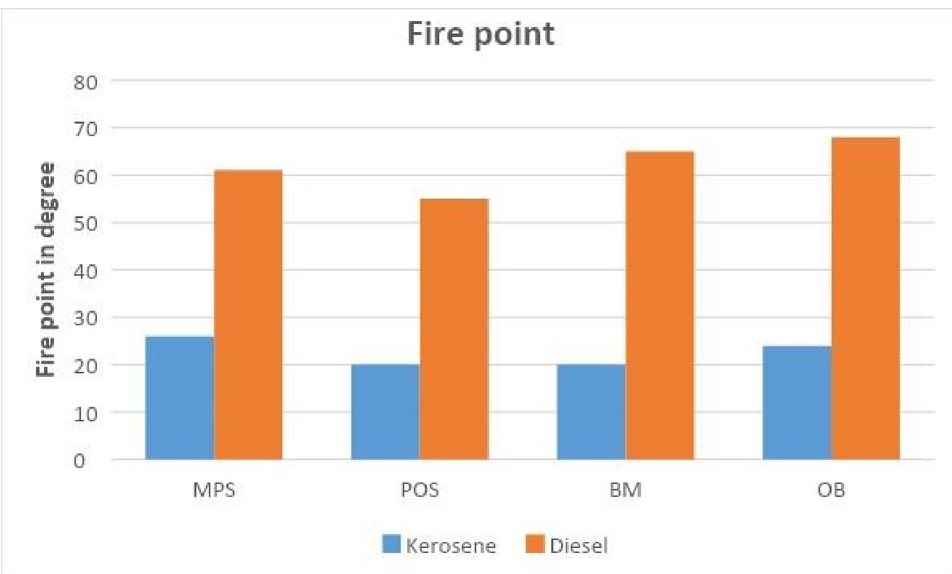

Figure 11: Fire point of kerosene and diesel from different petrol stations/sales outlets

Flash point is the temperature at which the volatiles liquid rising off the surface, and the heated oil will ignite with a flash, on passing a flame over the surface. Before gasoline became important, kerosene was the main petroleum product (used mainly as fuel for lamps and stoves), and there was a tendency on the part of petroleum distillers to leave as much as possible of the commercially worthless gasoline in the kerosene in order to sell more product. (4,5).

Following the findings in table 4, the flash point samples value obtained from major petroleum, private owned, black market and local artisanal for kerosene falls below the ASTM standard.

However, diesel samples from major petroleum station, private owned, black market and the local artisan product are within the ASTM standard range.

The fire point for kerosene for all petrol stations/sales outlets generally fall below the ASTM standard also. For diesel fuel, all samples had values within the ASTM standard, except private petrol station which had a value below the standard.(4,5)

3.5 Cloud point and Pour point

The results of the pour point and cloud point of diesel from different petrol stations/sales outlets is presented in table 6 and figure 12 to 13.

Table 6: ***Results for Pour point and Cloud point of Diesel from different petrol stations/sales outlets***

SOURCE	Pour point	Cloud point
Major petroleum station(MPS)	-7.4°C	2.6°C
Private owned station(POS)	-7.4°C	2.7°C
Black market(BM)	-6.1°C	4.9°C
Local artisanal(OB)	-6.6°C	4.8°C
ASTM standards	>-7	<4.4

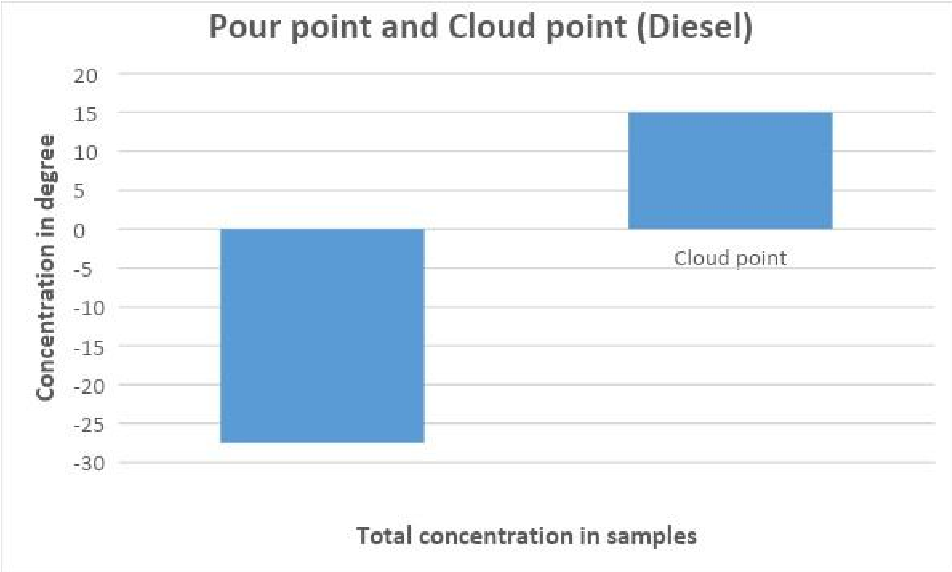

Figure 12 ***Pour point and pour point for diesel***

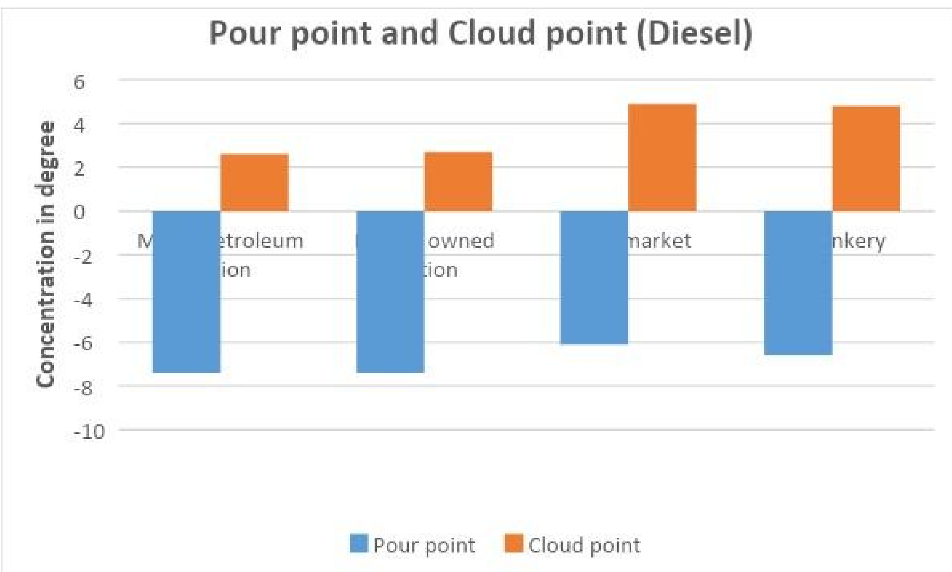

Figure 13: Pour point and cloud point for diesel from different petrol stations/sales outlets

The pour point of a liquid is the lowest temperature at which it becomes semi solid. This is where the liquid loses its flow characteristics. The higher the pour point the more the paraffin content. Lower pour point material is more desirable. Generally, light material will have a lower pour point. In (Table 6 and figure 13), only the black market and local artisanal products had values within the ASTM standard. For cloud point, all the diesel products had values within the ASTM standard range, with slight variations for black market and local artisanal products observed. (4,5)

4.0 Conclusion

This research paper has shown that the petroleum products analyzed from the major, individual petroleum station, to the black market and local artisanal products from the area under study have been adulterated with a few exceptions. The research paper did not investigate the source of adulteration, this is because most petroleum products are imported into the country and adulteration could have occurred overseas.

To monitor fuel adulteration however, oil companies and government can deploy mobile laboratories to conduct surprise and routine inspections of retail location. To discourage fuel adulteration, punitive measures need to be put in place on the sale of adulterated fuel.

5.0 References

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