QUALITY ASSESSMENT OF PETROLEUM FRACTIONS FROM ROAD SIDE VENDORS AND FILLING STATIONS IN EFFURUN, DELTA STATE

Otobrise, C.

Department of Chemistry, Delta State University, P.M.B.1, Abraka, Nigeria.
e-mail: otocharles@yahoo.com

ABSTRACT

The levels of adulteration in Petroleum fractions like petrol (PMS), kerosene (DPK) and diesel (AGO) was studied. Samples were collected from some road side vendors (black market) and filling stations within Effurun in Delta state. They were analysed for density at 15^0C, specific gravity at 60^0F, API gravity, Reid vapour pressure, kinematic viscosity, dynamic viscosity, cloud point, pour point, flash point, auto distillation and moisture content, using standard procedures of the ASTM. The results were compared with limits set by the Department of Petroleum Resources (DPR) in Nigeria. The investigation revealed the level of adulteration to be significant. The deviations of the physio-chemical properties of PMS from DPR limits ranged between 4.83-6.21% for density at 15^0C; 0.03-1.45% for specific gravity at 60^0F; -8.93- -4.72% for API gravity; 311.11-388.89% for Reid vapour pressure; -46.00- -45.00% for kinematic viscosity; -41.43- -40.00% for dynamic viscosity; 0.00- 10.00% for cloud point and <7.14% for flash point. The deviations of the same properties for DPK samples ranged between 0.98%; 0.00%; -2.84%; <-80%; -31.00- -30.00%; -28.75- -28.13%; 0.00% and 36.00-40.00%. Whereas the deviations of the same properties for AGO samples ranged between 4.76-8.17%; 1.13-4.42%; -15.63-0.15%; <-47.37%; 4.00-41.67%; 3.08-45.00%; -150.00- -100.00% and -42.22-40.00%.

Key Words: Petroleum fractions, adulteration, black market, filling stations.

INTRODUCTION

In Nigeria fuel consumers have unhindered access to petroleum products from various outlets which include; Nigerian National Petroleum Corporation (NNPC), licensed and unlicensed petroleum products filling stations, unlicensed surface tank operators (who locate surface tanks within residential areas), road side vendors (black market) and the very small mobile hawkers. These products are often adulterated with cheap products or by-products or waste hydrocarbon streams for monetary gains. For example, petrol is believed to be widely adulterated with naphtha, natural gas liquid, kerosene, waste solvents and so on (Igbafe and Ogbe, 2005).

Fuel adulteration is the introduction of foreign substances into fuel illegally or unauthorized with the result that the product does not conform to the requirements and specifications of the product (NNPC, 2008). Adulteration of automobile fuels, leads to increased tailpipe emissions of hydrocarbons, carbon-monoxide, nitrogen oxides, particulate matter and the consequent ill effects on public health (Osueke and Ofondu, 2011; Yadav *et al.,* 2005; Fonseca *et al.,* 2007). The primary cause of adulteration is greed fuelled by differential tax system on different petroleum fractions (World Bank, 2002; India CSE, 2002). With a large number of adulterants available in the market (both local and imported) and the fact that adulterated products are difficult to detect at point of sale terminals (POS), the magnitude of these adulterations has grown to alarming proportions in recent times. The objective of this research is to determine the quality and level of adulteration of some samples of petroleum fractions obtained from road side vendors (black market) and filling stations within Effurun in Delta state.

MATERIALS AND METHODS

Procurement of the Samples: Petroleum fractions (PMS, DPK, and AGO) were procured from some road side vendors and filling stations within Effurun in Delta state. The samples were preserved in clean, air-tight plastic containers and taken for analysis in the water and oil laboratory of Eleme Petrochemical Company, at Eleme in Rivers state.

Analysis: The density at 15^{0}C, specific gravity at 60^{0}F and API gravity were determined using ASTM D4052-11 method (Digital density analyser, Mettler Toledo, DA-100M); kinematic viscosity at 40^{0}C was determined using ASTM D445-06 method (Ubbeholde viscometer, Tanaka KV-4V/England DMO); cloud point was determined by the ASTM D2500-05 method; pour point was detrmined by the ASTM D97-06 method; flash point was determined by the ASTM D93-06 method; moisture content was determined by the ASTM D1744-92 method; Reid vapour pressure was determined by the ASTM D323-94 method; auto distillation was determined by the ASTM D86-05 method (Distillation apparatus, Tanaka Model AD-6). All reagents used were analytical grade.

RESULTS AND DISCUSSION

The results for the determination of some physio-chemical properties of the petroleum fractions are presented in Tables 1-2.

Table 1: Some Physio-chemical Properties of the

Parameter	Unit	PMS	DPK	AGO
Density @ 15^{0}C	g/cm^3	0.7700	0.8240	0.8870
Spec. gravity @ 60^{0}F		0.7710	0.8250	0.8880
API gravity		52.0000	40.0000	27.8000
Reid vapour pressure	KPa	37.0000	<1	<1
Kinematic viscosity	cSt	0.5500	1.3800	4.2500
Dynamic viscosity	cP	0.4200	1.1400	3.7700
Cloud point	^{0}C	-22	-10	-20.0000
Pour point	^{0}C	<-34	<-34	-27.0000
Flash point	^{0}C	<30	70.0000	54.0000
Moisture	ppm	381.0000	220.0000	90.0000

Petroleum Fractions from Road side Vendors.

Table 2: Some Physio-chemical Properties of the

Parameter	Unit	PMS	DPK	AGO
Density @ 15^{0}C	g/cm^3	0.7600	0.8240	0.8590
Spec. gravity @ 60^{0}F		0.7610	0.8250	0.8600
API gravity		54.4000	40.0000	33.0000
Reid vapour pressure	KPa	44.0000	<1	<1
Kinematic viscosity	cSt	0.5400	1.4000	3.1200
Dynamic viscosity	cP	0.4100	1.1500	2.6800
Cloud point	^{0}C	-20	-10	0.0000
Pour point	^{0}C	<-34	<-34	-10.0000
Flash point	^{0}C	<30	68.0000	52.0000
Moisture	ppm	110.0000	136.0000	114.0000

Petroleum Fractions from Filling Stations

Deviations of the physio-chemical properties of the petroleum fractions from DPR limits are shown on tables 3-5. They were calculated according to:

$$D = \frac{S - L}{L} \times 100.$$

Where S = value of the physio-chemical property of the petroleum fraction; L = value of the DPR limit of the physio-chemical property of the petroleum fraction and D = deviations (%) of the physio-chemical properties of the petroleum fractions from DPR limits.

Table 3: Deviations of Physio-chemical Properties of PMS Samples from DPR Limits

Parameter	Unit	DPR Limits	Deviations (%)	
			Road Side	Filling Station
Density @ 15^{0}C	g/cm^3	0.7250	6.21	4.83
Spec. gravity @ 60^{0}F		0.7501	0.03	1.45
API gravity		57.1000	-8.93	-4.72
Reid vapour pressure	KPa	9.0000	311.11	388.89
Kinematic viscosity	cSt	1.0000	-45.00	-46.00
Dynamic viscosity	cP	0.7000	-40.00	-41.43
Cloud point	^{0}C	-20.000	10.00	0.00
Pour point	^{0}C	-30.000	>13.30	>13.30
Flash point	^{0}C	28.0000	<7.14	<7.14
Moisture	ppm	Not available	-	-

Table 4: Deviations of Physio-chemical Properties of DPK Samples from DPR Limits

Parameter	Unit	DPR Limits	Deviations (%)	
			Road Side	Filling Station
Density @ 15^{0}C	g/cm^3	0.8160	0.98	0.98
Spec. gravity @ 60^{0}F		0.8250	0.00	0.00
API gravity		41.1700	-2.84	-2.84
Reid vapour pressure	KPa	5.0000	<-80.0	<-80.0
Kinematic viscosity	cSt	2.0000	-31.00	-30.00
Dynamic viscosity	cP	1.6000	-28.75	-28.13
Cloud point	^{0}C	-10.000	0.00	0.00
Pour point	^{0}C	-20.000	>70.00	>70.00
Flash point	^{0}C	50.0000	40.00	36.00
Moisture	ppm	Not available	-	-

Table 5: Deviations of Physio-chemical Properties of AGO Samples from DPR Limits

Parameter	Unit	DPR Limits	Deviations (%)	
			Road Side	Filling Station
Density @ 15^{0}C	g/cm^3	0.8200	8.17	4.76
Spec. gravity @ 60^{0}F		0.8504	4.42	1.13
API gravity		32.9500	-15.63	0.15
Reid vapour pressure	KPa	1.9000	<-47.37	<-47.37
Kinematic viscosity	cSt	3.0000	41.67	4.00
Dynamic viscosity	cP	2.6000	45.00	3.08
Cloud point	^{0}C	40.0000	-150.00	-100.00
Pour point	^{0}C	3.0000	-1000.00	-433.33
Flash point	^{0}C	90.0000	-40.00	-42.22
Moisture	ppm	Not available	-	-

The density at 15^{0}C for the PMS and AGO samples were above the DPR limits, while the DPK samples showed a small deviation of just 0.98%. The specific gravity at 60^{0}F corresponded with the DPR limits for DPK samples, for PMS and AGO samples, a slight deviation was observed. However the AGO sample from the road side recorded a significant deviation of 4.42% from the DPR limit. The API gravity for all the samples were below the DPR limits, except the AGO sample from the filling station. The density at 15^0C, specific gravity at 60^0F and API gravity are parameters that are indicative of the storage and handling properties of the petroleum fractions under different temperature conditions. The implication the findings of this research portend for storage and handling of the petroleum fractions in a tropical country like Nigeria is minimal.

The cloud point of the AGO samples was significantly below the DPR limits. The PMS and DPK samples had cloud points corresponding with DPR limits, except the PMS sample procured from the black market, which had 10.00% deviation from the DPR limit in its cloud point. This may be attributable to the kind of container and environment the product was stored in at the point of sale.

The Reid vapour pressure which is a measure of the volatility of gasoline was significantly above the DPR limit for all the PMS samples. The flash point of all the PMS and DPK samples were also above the DPR limit, thereby making the PMS samples risky for internal combustion engines. However, the DPK samples may not be too much of a risk for domestic purposes.

The kinematic and dynamic viscosities of the PMS and DPK samples were significantly below the DPR limits. A different trend was observed for the AGO samples, while the sample procured from road side vendors showed a significant deviation from the DPR limits; the samples from the filling stations had a maximum of 4.00% deviation from the DPR limits.

CONCLUSION

The findings of this research revealed that the level of adulteration of the petroleum fractions procured from road side vendors was small. The products specifications for some of the parameters tested for were met by the samples. However, significant deviations from the DPR limits was observed in parameters like Reid vapour pressure for PMS, DPK and AGO samples, flash point for DPK and AGO samples; and the kinematic and dynamic viscosities of all the samples, except the AGO samples procured from the filling stations.

ACKNOWLEDGEMENT

The author acknowledges the efforts of Freida Agholor, Awele Enem, Kanayo Chidi and Keoyenasoa Ogonegbu; all of the department of Chemistry, DELSU, Abraka towards the actualization of this research.

REFERENCES

Igbafe, A.I. and Ogbe, M.P. (2005) Ambient Air Monitoring for Carbonmonoxide from Engine Emission in Benin City, Nigeria, *African Journal of Science and Technology* **1(2):** 208-212.

NNPC (2008) Warri Refining and Petrochemical Company Limited, Technical Report **4**:74-76.

Osueke, C.O and Ofondu, I.O. (2011) Fuel Adulteration in Nigeria and its Consequences, *International Journal of Mechatronics & Engineering* **11(4):** 34-37.

Yadav, S.R., Murthy, K.V., Mishra, D. and Baral, B. (2005). Estimation of Petrol and Diesel Adulteration with Kerosene and Assessment of Usefulnessnof Selected Automobiles Fuel Quality Test Parameters, *International Journal of Environment, Science & Technology* **1 (4):** 253-255.

Fonseca, M.M., Yoshida, M.I., Fortes, I.C.P. and Pasa, V.M.D. (2007) Thermo Gravimetric Study of Kerosene-Doped Gasoline, *Journal of Thermal Analysis and Calorimetry* **87 (2):** 499-503.

World Bank Publication (2002) Catching Gasoline and Diesel Adulteration, South Asian Urban Air Quality Management Briefing Note No. 7.

India CSE Report (2002) Independent Inspection of Fuel Quality at Fuel Dispensing Stations, Oil Tanks and Tank Lorries, Prepared by Centre for Science and Environment and made available at http://www.cseindia.org.html/cmp/air/fnladul.pdf.

ASTM D4052-96 (2011) Standard Test Method for Density, Relative Density and API Gravity of Liquids by Digital Density Meter, http://www.astm.org/standards/d4052.htm.

ASTM D445-06 (2011) Standard Test for Kinematic Viscosity of Transparent and Opaque Liquids, http://www.astm.org/database.cart/history.

ASTM D2500-05 (2011) Standard Test Method for Cloud Point of Petroleum Products, http://www.astm.org/database.cart/history.

ASTM D97-06 (2011) Standard Test Method for Pour Point of Petroleum Products, http://www.astm.org/database.cart/history.

ASTM D93-06 (2012) Standard Test Method for Flash Point by Pensky-Martens Closed Cup Tester, http://www.astm.org/database.cart/history.

ASTM D1744-92 (2012) Standard Test Method for Determination of Water in Liquid Petroleum Products by Karl-Fischer Reagent, http://www.astm.org/standards/d1744:htm.

ASTM D323-94 (2011) Standard Test Method for Vapour Pressure of Petroleum Products (Reid Method), http://www.astm.org/database.cart/history.

ASTM D86-05 (2011) Standard Test Method for Distillation of Petroleum Products at Atmospheric Pressure, http://www.astm.org/database.cart/history.