Experimental Investigation of API Gravity of Gasoline in Dispensing Stations and its Effects on Gasoline Engines in Bayelsa State, Nigeria

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Abstract

In recent years, the frequent reported cases of low engine performance and increasing emission of dangerous pollutants from vehicles in Bayelsa State, Nigeria. This triggered the study which aimed at the investigation of the API gravity of gasoline in some selected dispensing stations and its effects on gasoline engines in the region. And was accomplished by the underpinned objectives: to estimate the specific gravity of the sampled gasoline and to compute the API gravities using the required correlations. Furthermore, the data collected from the experiment were computed in the given equations and outcomes obtained were analysed with spread-sheet tool in Microsoft Excel 2012. The experimental results show that the specific gravity and the API gravity in the region under the time of study are between 0.71 and 0.73, and 69 and 62, respectively. These results concluded that the presence of impurities exist in the sampled gasoline due to adulteration and poor quality of refining process. Therefore, the gasoline automobile engines in Bayelsa State of Nigeria will be affected with crankcase dilution, emission of dangerous pollutants, wash down of oil on engine cylinder liner. This paper demonstrates that the Nigerian government need to redouble efforts to put all the refineries in operations. This will impede gasoline importation, illegal refining of crude oil, adulteration of gasoline, and fuel scarcity.

Keywords: Gasoline, Adulteration, Specific Gravity, API Gravity, Engine Performance, emission, pollutants

1.0 Introduction

Gasoline is a major product of fractional distillation of petroleum (Robert, Roussel and Boulet, 1995) and comprises of over four hundred flammable and volatile liquid hydrocarbon ranging from four to twelve atoms of carbon per molecule (Dahadha and Barakat, 2013; Jude *et al.*, 2012). With the high demand for gasoline in Nigeria, and the inability of government to meet up with demands (Akpan and Nnamseh, 2014), and its attendant importation of gasoline to meet up with demand (Ismail, Tsaku and Bilikisu, 2014; Isa *et al.*, 2013), the gasoline market is from time to time flooded with adulterated products, and these products when used by vehicles, increases tailpipe emission and may eventually lead to knocking (Massawe, Kilavo and Sam, 2013; Yadar, 2005; Fonseca*et al*, 2007).According to Kulathunga and Mahanama (2013) gasoline adulteration is majorly reported in developing countries. Gawande and Kaware (2013) defined adulteration as the unauthorised or illicit addition of extraneous substances into gasoline, giving a result that is not in conformity with international set standards.In a recent research Mohammed, Yahya and Amer (2008) defined adulteration as the blending of high grade MG with other grades of solvents.

While differentiating adulteration from contamination Mohammed, Yahya and Amer (2008) averred that contamination is the deliberate addition of unacceptable materials to MG by unscrupulous people for the sole purpose of enhancing profit; owing that gasoline (petrol) has a density approximately 737.22kg /m3. Engine performance can be attributed to several factors ranging from brake specific fuel consumption, brake power, engine speed for different engine loads and brake thermal efficiency. In addition, Teixeira*et al.*(2007) affirmed that gasoline is a complex mixture, which comprises of hydrocarbons, plus little amount of sulphur and a blend of these hydrocarbons with compounds of oxygen, has direct influence on engine performance. Engine performance can also be attributed to the ratio of the air-fuel of that engine (Rahman, Mohammed and Bakar, 2009). While this research is majorly looking at the API gravities of gasoline, in a section of Nigeria, it will be proper to also note that all vehicle are designed to make use of specified gasoline as a means of combustion (Mohammed, Yahya and Amer 2008) and when the specified gasoline is not used, Mal-functioning of the engine, failure of components, and safety related problems arises (Gawande and Kaware, 2013), and this also decreases the performance and engine life and increases the emission of harmful pollutants thereby causing health problems (Muralikrishna, Kishor and Reddy, 2006).

Crankcase dilution is a major challenge facing vehicle engines as a result of adulteration, according to Ehsan, Rahman and Saadi (2010) the effect of extreme crankcase dilution is commonly existent in vehicles driven with gasoline, irrespective of model the source of the problem lies in adulteration of gasoline. According to Van de Vort, McGill and Pinchuk (2008) fuel dilution usually causes wash down of oil on engine cylinder liner, which accelerates piston, ring and cylinder wear. In addition, all internal combustion engines are designed to run on definite fuel (Ale, 2003), and will largely emit more pollutant if the specified fuel is changed (Ale, 2003). According to Gawande and Kaware (2013) and Mohan, Agrawl and Singh (2006) adulteration of gasoline gives rise to the emission of dangerous pollutants from vehicles, such as carbon monoxide (CO), hydrocarbons (HC), and oxides of nitrogen (NOx). In a similar research Muralikrishna, Kishor and Reddy (2006) opined that the level of pollutant CO and UBHC in engine exhaust increases with adulterated gasoline. Therefore, this paper is aimed at investigating the API gravity of gasoline in dispensing stations and its effects on gasoline engines in Bayelsa State, Nigeria. This was accomplished by the underpinned objectives: to estimate the specific gravity of the sampled gasoline and to compute the API gravities using the required correlations.

2.0 Methodology

2.1 Materials

The materials used for the experimental investigation were hydrometer (Aerometer), thermometer, stirring rod, distilled water. In addition, four (4) samples of gasoline were sampled each from four different petrol pump stations.

2.2 Methods

The city was divided into four (4) clusters for the purpose of this research. From each of these clusters 200ml of gasoline were collected from a gasoline dispensing station. These samples were sampled into four different 200ml containers. The instruments used for the experiment were first cleaned up to remove particles of dust from its surface. The samples were poured into the 150ml measuring cylinder. In these four 150ml measuring cylinder, fluid level readings was taken at 100ml each. Temperatures of the samples were taken and the samples were subsequently mixed with the stirred rod. After 5 minutes the hydrometer was carefully inserted into the measuring cylinders and readings were taken appropriately from the meniscus at eye level to avoid parallax error. The readings recorded were the densities of the gasoline sampled. However, the hydrometer was calibrated with distilled water at 100ml in a 150ml measuring cylinder before conducting the experiment. The specific gravity and API gravity were computed using equations 2.1 and 2.2.

Mathematically,

$$SG_{Sample} = \frac{\rho_{Sample}}{\rho_{H_2O}} \quad \ldots 2.1$$

$$^{O}API_{Sample} = \frac{141.5}{SG_{Sample}} - 131.5 \ldots 2.2$$

Where:

$$\rho = Density, \frac{Kg}{M^3}$$

$SG = Specific Gravity$
$^{0}API = APIGravity$
$Sample = Sample\ of\ gasoline\ in\ dispensing\ stations, ml$

Abbreviations:

MG = Motor Gasoline,
API = American Petroleum Institute,
UBHC = Unburnt Hydrocarbon

2.3 Data Analysis Technique

In this research, the data collected from the experiment were computed in the given equations and outcomes obtained were analysed with spread-sheet tool in Microsoft Excel 2012.Therefore, the method of data analysis technique adopted in this research is suitable and up-to-date.

3.0 Results and Discussion

3.1 Results

After carrying out the experiment, it was observed that all the samples had different but close-ranged API values and specific gravity values. Figures 3.1, 3.2 and 3.3are graphical representations showing the results obtained from the data analysis.

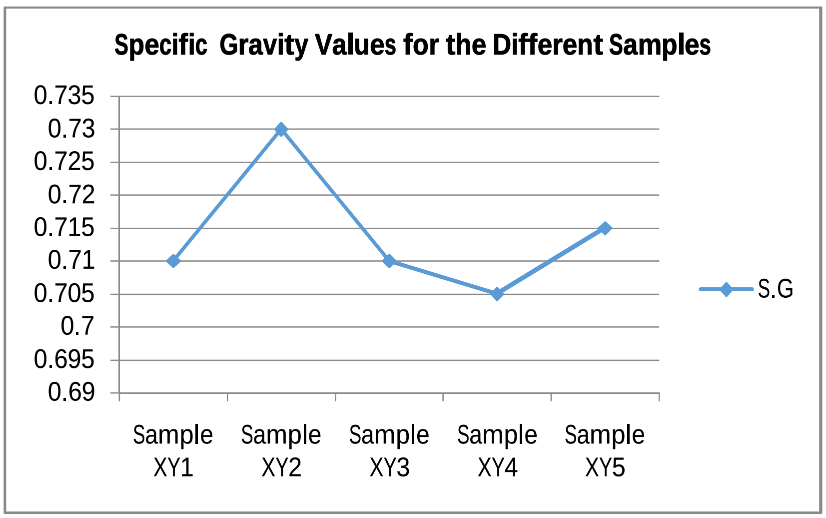

Fig. 3.1: Specific Gravities of the Sampled Gasoline in Bayelsa State, Nigeria

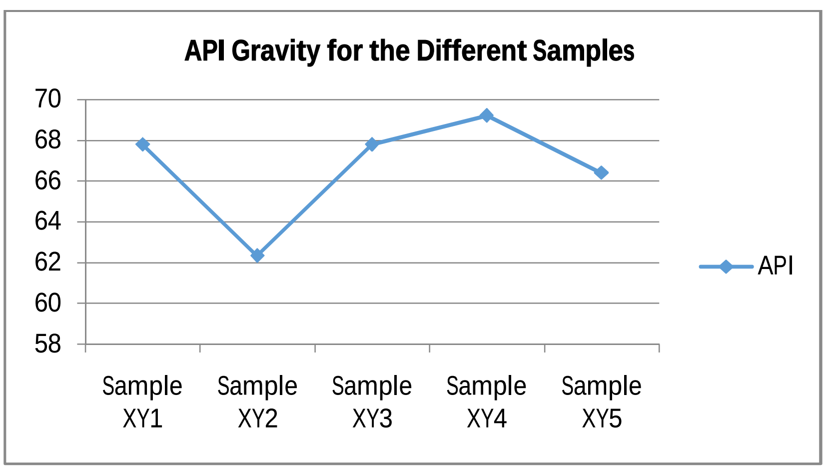

Fig. 3.2: API Gravities of the Sampled Gasoline in Bayelsa State, Nigeria

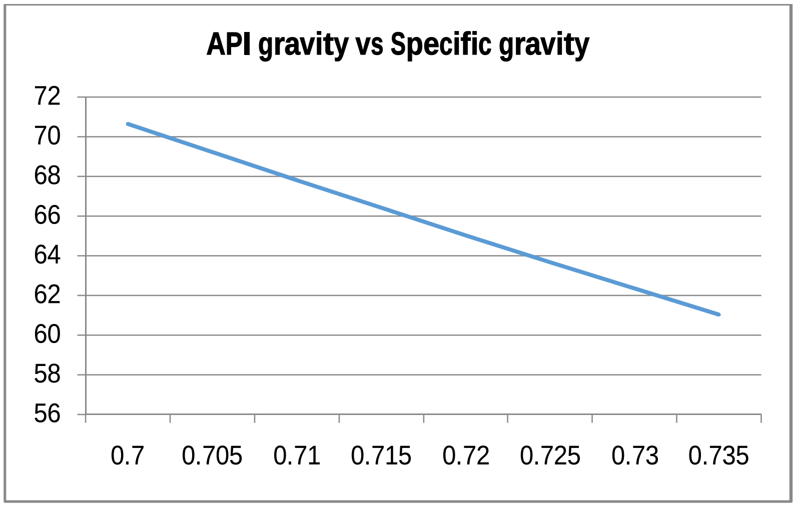

Fig. 3.3: Relationship of API Gravities and Specific Gravity of the Sampled Gasoline in Bayelsa State, Nigeria

3.2 Discussion

Figure 3.1 illustrates the specific gravities of the sampled gasoline in Bayelsa State, Nigeria. Explicitly, this shows the trend of a plot of specific gravity against the samples. Sample XY2 was observed to have the highest specific gravity. The specific gravity was estimated at0.73and thus, the sample with the lowest API gravity (62) as shown in figure 3.2, implying that this sample contains more of impurities attributed to adulteration due to consistent fuel scarcity. In addition, the higher the specific gravity of gasoline indicates that the fraction of crude oil was obtained with less rigorous refining process. In contrast, sample XY4 from figure 3.1 was observed to have the lowest specific gravity, which was evaluated as 0.71and thus, the sample with the highest API gravity (69) as shown in figure 3.2. From this graphical result, it is seen that sample XY4 contains less impurities, and went through a better refining process than the rest of the samples. The International Council on Clean Transportation (ICCT) posits that API gravity varies inversely with density i.e. the lighter the fluid, the higher its API gravity. A plot of API gravity against specific gravity in figure 3.3 affirms that, API gravity increases with a corresponding decrease in specific gravity.

4.0 Conclusion and Recommendation

4.1 Conclusion

Sequel to the aforementioned discussion, it is found that different samples of gasoline acquired from different gasoline dispensing stations have different specific gravity and API gravity values. These differences in turn were affected by a number of factors, some of which were found to be the presence of impurity due to adulteration and poor quality of refining process. Therefore, the gasoline automobile engines in Bayelsa State of Nigeria will be affected with crankcase dilution, emission of dangerous pollutants, wash down of oil on engine cylinder liner.

4.2 Recommendation

The New Nigerian government should redouble efforts to put all the refineries in operations. This will stop gasoline importation and fuel scarcity which encourages adulteration of gasoline. In addition, if the refineries are operational, it will discourage oil theft for illegal refining of crude oil which will adversely affect the life span of gasoline automobile engines in Bayelsa State of Nigeria.

5.0 References

Akpan, S.S. and Nnamseh, M. (2014). Managing risk of petrol scarcity in Nigeria: A test of the efficacy of strategic management approaches. Global Journal of Human-Social Science: E Economics, Vol. 14, Issue 5, version 1.

Ale, B.B. (2003).Fuel Adulteration and Tailpipe Emission. Journal of Institute of Engineering, Vol. 3(1), pg.12-16.

Dahadha, A.A. and Barakat, S.A. (2013).Determination of kerosene in gasoline using fractional distillation technique. Der Chemica Sinica,Vol. 4(3), Pp. 170-175.

Ehsan,M., Rahman, M.M. and Saadi, M.H. (2010).Effect of Fuel Adulteration on Engine Crankcase Dilution. Journal of Mechanical Engineering, Vol. ME 41, No.

Fonseca, M.M., Y. M., fortes, I.C.P. and Pasa, V.M.D. (2007).Thermo gravimetric study of kerosene-Doped gasoline.J. Therm. Anal. Calorim. 87(2), Pp. 499-503.

Gawande,A.P. and Kaware, J.P. (2013).Fuel Adulteration Consequences in India: A Review. Scientific Reviews and Chemical Communications, Vol. 3(3), Pp. 161-171

Isa, A.H., Hamisu S., Lamin, H.S., Ya'u, M.Z. and Olayande, J.S The perspective of Nigeria's projected demand for petroleum products Journal of Petroleum and Gas Engineering, Vol. 4(7), Pp. 184-187

Ismail, O. S, Hezekiah, T. and Bilikisu, M. Y. (2014).The Impact of Gasoline Subsidy Removal on the Transportation Sector in Nigeria. American Journal of Energy Research, vol. 2, No. 3 Pp. 60-66.

Jude, C.I., Kalu E.A., Anthony, I.O. and Christopher, U. (2012).Extraction, Characterization and Determination of Ethanol Fuel Composite Qualities of Saccharumofficinarum, Pennisetumpurpureum and Costus afer" Asian Journal of Plant Science and Research, Vol. 2(5) Pp. 643-649.

Kulathunga, D.R., and Mahanama, K.R.R. (2013): Fingerprinting diesel and petrol fuels for adulteration in Sri Lanka. Journal of National Science Foundation, Vol. 41 (4), Pp. 287-292.

Massawe, E.A., Kilavo, H., and Sam, A. (2013).Fuel adulteration in Tanzania and its consequences: An overview. Research Journal in Engineering and Applied Sciences, vol. 2, No 4, Pp. 281-284.

Mohammed, A.A., Yahya, S.A. and Amer, M. (2008).Determination of motor gasoline adulteration using FTIR spectroscopy and multivariate calibration. Talanta, Vol. 76, Pp. 1105-1112.

Mohan D., Agrawl A. and Singh R. (2006).Standardization for Automotive Exhaust Pollution: some Issues in Indian Perspective. J. Instrumenta'n Engg., Vol. 86, pg. 39-43.

Muralikrishna, M.V., Kishor, K., and Reddy, C.R., (2006).Studies on Exhaust Emissions of Catalytic Coated Spark Ignition Engine with Adulterated Gasoline. Journal of Environmental Science and Engineering, Vol. 48(2), Pp. 97-102

Robert, R., Roussel, J. and Boulet, R. (1995).characterization of crude oils and petroleum fractions. Journal of petroleum refining. 1:39-84, Pp. 453-469.

Teixeira, S.G, Souza, J.C, Hilda, C.D, Pontes, L.A.M, Vianna, R.F, Sobrinho, E.V. and Guimaraes, P.R.B. (2007). The influence of Cu, Fe, Ni, Pb and Zn on gum formation in the Brazilian automotive gasoline. Journal of Fuel Processing Technology, Vol. 88, Pp. 73-76.

Van de Voort, F.R., McGil, l I.R. and Pinchuk, D. (2008).In line continuous monitoring of Fuel dilution in Motor Oils by Fourier Transformation Infrared (FTIR) Spectroscopy. Conference Proceeding

Yadar, S. R. (2005).Estimation of petrol and diesel adulteration with kerosene and assessment of usefulness of selected automobile fuel quality test parameters". International Journal of Environmental Science and Technology, Vol 1, No. 4, Pp. 253-255.