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Chemistry of petroleum products: Assessment of fuel attendants' knowledge around Sapele metropolis

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Petroleum products are very flammable and can ignite at extremely low temperatures if exposed to an open flame source or not handled appropriately. Individuals who handle petroleum products in the petroleum industry and fuelling stations are known as "petrol station attendants". The study was a descriptive cross-sectional study carried out among petrol station attendants working in a filling station owned by independent petroleum marketers in Sapele metropolis of Delta state from November 2022 to January 2023. The assessment was done with an adapted instrument for data collection, a 12-item questionnaire titled "Chemistry of Petroleum Products: Assessment of Fuel Attendants Knowledge around Sapele Metropolis". Most petrol attendants within Sapele metropolis fell within the age range of 18-35 years, predominantly 22-28 years being the highest with a respondent of 16 constituting 39% representation. There were more females working within Sapele as petrol attendants with 26 females out of 41 respondents representing 63% of the total sample population. About 51.21% of respondents did science or chemistry-related courses but their skills were limited, 58.53% of petrol attendants which was the highest proportion per qualification had Senior School Certificate Examination (SSCE) qualification, and those with a higher degree (National Diploma and Bachelor of Science) had a combined total of 14 respondents (34.1%), 48.78% of respondents which was below average were given chemistry and safety training of petroleum product by their employers, about 80.48% of respondents had managed to learn either by convention or practice safety techniques and were using safety protocol when handling petroleum product. 87.80% knew nothing about chemistry quality control tests such as octane rating, flash point, pour point, and smoke point. The percentage of science oriented graduate who work as petrol attendant in Sapele metropolis is very low. Hence, the study recommends science expertise with regards to chemistry knowledge in relation to safety practices among fuel attendants.

Key words: Petrol station attendant, chemistry, petroleum products, educational qualification.

INTRODUCTION

A petrol filling station as a facility is a place where petroleum products such as Premium Motor Spirit (PMS), Liquefied Natural Gas (LNG), Dual Purpose Kerosene (DPK), Automated gasoline oil (AGO), and lubricants are

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sold (Ahmed et al., 2014; Ogundahunsi, 2014).

Petroleum products are highly inflammable (Ogundahunsi, 2014) and can ignite at very low temperatures (Ahmed et al., 2014) if exposed to an open flame source or if not properly handled. Individuals who handle petroleum products in the petroleum industry and fueling stations are known as petrol station attendants (Moke, 2019; Johnson and Umoren, 2018). Most petrol attendants are employed without basic pre-requisite science qualifications from a tertiary or post-secondary institution.

Petroleum products are organic materials gotten from the fractional distillation of crude oil (Onyinye and Nkechi, 2015). Crude oil is referred to as “black gold” and they are formed from biogenic sources as a result of complex diagenesis, silt, and sedimentation that occurred million years ago (Peters et al., 2007). Products derived from the fractional distillation of crude include but are not limited to kerosene, liquefied natural gas, petrol, diesel, lubricating oil, petroleum jelly (wax), and bitumen (Abdullah, 2012).

Chemical reactions used in the distillation and processing of petroleum products include cracking, flocculation, alkylation, isomerization, step reaction (initiation, propagation, and termination), and addition reaction (Chaudhuri, 2011).

Processes, where these chemical reactions are utilized, includes desalting, desulphurization, field separation (separation of waste, water, and gas), fractional distillation (Kolmetz, 2016). Petroleum products contain a varied mixture of aliphatic compounds (paraffin or olefins) (Kolmetz, 2016) and aromatics (Toulene, Xylene, Benzene, and Napthalenes), (Kolmetz, 2016; Onojake et al., 2012).

Most products sold in petrol stations have a combination of chemicals that contribute to their behavior and reaction and only a good knowledge of petroleum products chemistry can guarantee proper interpretation and explanation of these products to customers when the need arises. Knowledge of petroleum product parameters such as colour, octane rating, flash point, specific gravity, vapour pressure, cloud point, pour point, viscosity, boiling point, and aniline point are used both for product specification and control and particularly for the formulation of policy geared toward safety and hazard management.

Studies such as those of Okafoagu et al. (2017), Afolabi (2011), and Johnson and Umoren (2018) all showed that educational qualification for petrol attendants in most petrol stations was usually secondary school level as only Moke (2019) reported a majority of attendants having up to tertiary level education. A study by zippa.com showed that 48% of petrol station attendants in the U.K. had high school diplomas while only about 18% had bachelor’s degrees (https://www.zippia.com/gas-station-attendant-jobs/education/). The result of Moke (2019) could be attributed to the location to which the research was done as it is a university town in Delta state.

Most secondary schools teach basic chemistry only. A good knowledge of the chemistry of petroleum products can only be obtained from the faculties of science and engineering of universities or at best science schools of education in mono-technic and polytechnics.

There is almost no literature bothering on the level of educational knowledge of science or chemistry among petrol station attendants, this trend has greatly added to the high hazard index and poor safety handling techniques among petrol attendants.

The issue of safety in petrol stations both for attendant and customers cannot be over-emphasized, accidents due to fire hazard leads to property loss (i.e. vehicles and automobiles) or in worst case scenario, lives and properties (Afolabi, 2011; Okafoagu et al., 2017; Ahmed et al., 2012). There has been documented incidence of fire disasters in recent times in petrol stations in some parts of Delta State, Nigeria. One of the remote causes of this recorded fire incidence is the poor handling technique and safety procedure adopted by petrol attendants (Ahmed et al., 2011; 2012), further investigation in most cases reveals that these petrol attendants do not know much about the science or chemistry behind petroleum products and in most cases they were not given adequate training prior employment and resumption of duty. This study is aimed at investigating the educational qualification, science orientation alongside the knowledge of chemistry possessed by petrol station attendant in Sapele metropolis and her adjourning districts and how this knowledge comes to play in safety procedures adopted for daily routine and operational practices.

A significant amount of research has been done on the explosion risk at gas stations, and Pula et al. (2006) found that among the loss-producing incidents, fires and explosions are the most frequently reported accidents. Petrol and other motor fuels at room temperature are potentially pollutants and hazardous. When combined with air in certain proportions can lead to fire and explosion. These pollutants if discharged into the environment can have negative health consequences on people and the environment. Illegal petroleum storage, transportation options, poor maintenance, carelessness, mechanical fault and other factors can spark fire explosion. Hence, it is advisable that lots of precautions should be adhered to when dealing with petrol in order to stop or minimize the rates of the occurrence of petrol accidents.

New petrol stations been generated these days are generated within residential areas which gives room for more secondary school certificate holders to be employed irrespective of their knowledge in Sciences or in the chemistry of petroleum products. If an accident occurs, it will not only affect the employees and the customer present at the fuel station, it will also affect the people who resides closed to the petro station. According

Table 1. Age characteristics of petrol attendants.

S/N	Age range (years)	Number of respondents	Percentage of respondents
1	< 18	1	2.43
2	18 - 22	13	31.70
3	22 - 28	16	39.02
4	28 - 35	11	26.82

Source: Authors Compilation (2022).

to Ma and Huang (2019), some fuel stations are situated close to residential areas, raising the risk of tragic human loss in the event of an explosion due to the high population density in residential areas. Hence, greater care and surveillance are needed when refueling subterranean fuel storage tanks as well as when fueling automobiles in order to reduce or prevent accidents at gas stations both inside and outside of residential areas.

Occurrences of unsafe acts and unsafe condition (UAUC) at fuel stations are quite common (Ahmed et al., 2011). A robust accident prevention program might lower the number of gasoline station incidents and even save lives (Modjo et al., 2022).

Adekitan et al. (2008) and Nnokwe et al. (2020) suggested the use of Gas Leakage Detection System. This is when a user's mobile device will receive an emergency alert message from the Gas Leakage Detection System when an emergency occurs. The system detects leaked gas using MQ-6 gas sensor whose calibrated outputs are used to trigger an alarm and display gas levels on a liquid crystal display (LCD) for ambient gas concentrations above 100 PPM (Nnokwe et al., 2020; Subri et al., 2021; Islam et al., 2022). The development of a gas leakage detection system should be developed, embraced and aired through radio stations for general awareness (Earlyanti and Wijayanto, 2020).

Previous studies on safety had examined and provided numerous resources to help decrease accidents and injuries, but these accidents will still occur if these resources are not effectively used and practiced daily. Hence, staff training, fire risk assessment (Mmom et al., 2022), vapour recovery systems, emergency response, alarm systems, and escape route are preconditions that should be met by a filling station business owner (Han et al., 2005). All the employees at petrol stations should follow the working instructions and understood the hazards associated with the job and take the job after taking all the precautionary measures (Ahmed et al., 2010; Yunus, 2019; Wadembere and Apaco, 2020).

The study was a descriptive cross-sectional study carried out among petrol station attendants working in a filling station in Sapele metropolis of Delta State. Permission was obtained from the owner of the filling stations and informed consent was obtained from the attendants before the data collection instrument was applied.

METHODOLOGY

Description

A total of 41 petrol station attendants from 12 selected filling stations owned by independent petroleum marketers in Sapele metropolis, Sapele Delta State, Nigeria were included in the study (Table 1). Data collection took place between November 2022 and January 2023. Sapele is an Okpe speaking town in Delta State, with coordinate of 5.8751°N, 5.6931°E. As at the year 2015, the estimated population of Sapele was about 232,020. Most people within Sapele are traders, artisans and business persons, with a handful of civil servants of different strata. The assessment utilized a modified questionnaire titled "Chemistry of Petroleum Products: Assessment of Fuel Attendants' Knowledge in Sapele Metropolis" to collect primary quantitative data, including customer demographics, educational background, years of service as an attendant, working hours, marital status, and religion. The questionnaire consisted of two sections: Section A, which captured socio-demographic information, and Section B, which focused on the respondents' knowledge of petroleum product chemistry, testing methods, awareness of hazards, and safety and preventive measures according to those of Afolabi (2011). All the questionnaires administered to the 41 petrol station attendants were retrieved and analyzed.

Percentage of respondents

The percentage of respondent was calculated using the equation below:

$$\text{Percentage of Respondents (\%)} = \frac{\text{Number of Respondents}}{\text{Total number of respondents}} \text{ X } 100$$

Statistical analysis

The results were analyzed using one way analysis of variance (ANOVA) to compare the various group averages.

RESULTS AND DISCUSSION

Socio-demography

Most petrol attendants within Sapele metropolis fell within the age range of 18-35 years, predominantly 22-28 years being the highest with a respondent of 16 constituting 39% representation. This range represents the working and active service years of most attendants; it also fell

Table 2. Sex characteristics of petrol attendants.

S/N	Sex	Number of respondents	Percentage of respondents
1	Male	15	36.58
2	Female	26	63.41

Source: Authors compilation (2022).

Table 3. Educational qualification of petrol attendants.

S/N	Educational qualification	Number of respondents	Percentage) of Respondents
1	No qualification	3	7.31
2	First school leaving certificate	-	-
3	Secondary school certificate exam	24	58.53
4	National diploma	11	26.82
5	Higher national diploma	-	-
6	Bachelor of science	3	7.31
7	Other higher qualification	-	-

Source: Authors compilation (2022).

Table 4. Years of service as attendant of petrol attendants.

S/N	Years of service as attendant	Number of respondents	Percentage of respondents
1	0-6 months	14	34.1
2	1 year	10	24.3
3	1-2 years	2	4.87
4	2-4 years	7	17.07
5	4 years and above	5	12.19

Source: Authors Compilation (2022).

within the range of those reported by Johnson and Umoren (2018), 21-25 years (42.8%) (Table 1).

There were more females working within Sapele as petrol attendants with 26 females out of 41 respondents representing 63% of the total sample population. Gender specifications were closer to those of Moke (2019) who had more female attendants (60%) (Table 2). Generally, most researchers have established that there are more female attendants than males within south-south Nigeria (Johnson and Umoren, 2018; Moke, 2019), as opposed to those reported for the North (95% males) (Okafoagu et al., 2017) and the West (72%) (Afolabi, 2011), this disparity could be due to cultural perception of these areas on the job roles for females and males.

Secondary school certificate holders had the highest number of respondents with 24 out of 41 respondents (58.53%), those with a higher degree (Higher national diploma and Bachelor of Science) had a combined total of 14 respondents (11 National diploma holders and 3 University degree holders which sums up to 34.13%, those without any form of educational qualification constituted the smallest number with 3 respondent representing 7.31%, most attendants within Sapele metropolis had at least a secondary school educational qualification which enabled them to work in a petrol station (Table 3). Researchers in Nigeria have reported a higher percentage of Senior school certificate examination holders who work in fuel stations (Afolabi, 2011) (98%) and (Johnson and Umoren, 2018) (83.7%), only Moke (2019) reported having higher degree holders with as high as 82.9% while Senior school certificate examination holders holding as low as 8.6%, this could be attributed to the location to which the research was done as it is a university town in Delta state (Table 3).

A preponderance of attendants had spent barely two years in the petroleum industry as those who had spent less than two years summed up 26 with a combined percentage of 63.41% (0-6 months (34.1%), 1 year (24.3%), 1-2 years (4.87%). Respondents who had spent between 2-4 years fell at 17.07% with the smallest representation being those who had spent more than four years with 12.19% (Table 4), this diminishing trend of

Table 5. Daily working hours of petrol attendants.

S/N	Daily working hours	Number of respondents	Percentage of respondents
1	< 4 h	1	2.43
2	4-8 h	6	14.63
3	>8	34	82.92

Source: Authors Compilation (2022).

Table 6. Marital status of petrol attendants.

S/N	Marital status	Number of respondents	Percentage of respondents
1	Single	33	80.48
2	Married	7	17.07
3	Divorced	1	2.43

Source: Authors Compilation (2022).

Table 7. Religion characteristics of petrol attendants.

S/N	Religion	Number of respondents	Percentage of respondents
1	Christianity	40	97.56
2	Islam	1	2.43
3	Animist (African traditional worship)	-	-

Source: Authors Compilation (2022).

Table 8. Safety and preventive measures.

Safety and preventive measures	Number of respondents	Percentage of respondents
Yes	33	80.48
No	6	14.63
Abstain	2	4.87

Source: Authors Compilation (2022).

petrol attendant years of service goes in peri-persu with the age of attendant, as most petrol attendant age between 28-35 years tend to leave the industry for a better prospect as the physical nature and demand of the job begins to take its toll on them (Table 4).

Petrol stations generally operate an 8h shift for petrol attendants following the standard procedure as laid down by the department of petroleum resources, 82.92% which represent 34 respondents, said they worked above 8 h, while 14.63% (6 respondents) worked between 4-8 h, only 2.43% (1 respondent) worked below 4 h (Table 5).

80.48% of petrol attendants were single, while 17.07% were married with only 2.43% were divorced individuals (Table 6). The Christian religion with 40 respondents representing 97.56% was the highest per religion; the Islamic religion had 2.43% representing only one respondent. Sapele is a town in south-south Nigeria, deep in the heart of the Niger Delta. Christianity and western civilization had long taken root, this account for the overwhelming percentage of Christians (Table 7).

Assessment of chemistry knowledge of petroleum product

The level of educational qualification is a determining index of many factors and operations in the petroleum industry. Most attendants within Sapele had a SSCE as their highest qualification at 58.53% (24 respondents). 43.90% which represents 18 respondents (Table 8) either attended or finished higher institution, this result fell within the range of those who had higher degree qualifications at 34.14% (14 respondents) the difference of 9% (4 respondents) could be assumed to be those

Table 9. Assessment of Science knowledge amongst petrol attendants.

Assessment of sciences knowledge	Number of respondents	Percentage of respondents
With science knowledge	24	58.53
Without science knowledge	16	39.02
Abstain	1	2.43

Source: Authors Compilation (2022).

Table 10. Assessment of chemistry knowledge of petroleum product amongst petrol attendants.

Assessment of chemistry knowledge	Number of respondents	Percentage of respondents
With chemistry knowledge	21	51.21
Without chemistry knowledge	18	43.90
Abstain	2	4.87

Source: Authors Compilation (2022).

Table 11. Knowledge on how petroleum products are refined.

Refining process of petroleum products	Number of respondents	Percentage of respondents
Yes	12	29.26
No	27	65.85
Abstain	2	4.87

Source: Authors compilation (2022).

who attended but did not complete their higher school degree, this result was much lower than those reported by Moke (2019) which stood at 82.9%. Most petrol attendants studied sciences in school both high school and Degree level with 24 respondents (58.53%) studying sciences and 16 respondents (39.02) studying in other fields (Table 9), of this number of 24 respondents who studied sciences 21 respondents (51.21%) studied chemistry or chemistry-related course in school (Table 10). This implied that just over half of the total respondents had any form of chemistry education, let alone a good knowledge of petroleum chemistry, 43.90% (18 respondents) did not study any course related to chemistry (Table 10).

48.78% (20 respondents) said they were given safety and chemistry training on petroleum products, this number fell below average as those who said they were not given any safety training fell at 46.34%(19 respondents), this figure shows a lack of interest industry players devote to safety training and handling techniques (Udonwa et al., 2009). Moke (2019) in his studies establishes a correlation between higher degree graduate and increased safety awareness and practice among petrol attendants.

Petrol station owners and independent marketers devote less effort to technocratic development and safety methodology amongst attendants, as more attention and emphasis are placed on the marketing, customer service and sales efficiency of petrol attendants. The result of safety awareness of petrol attendant was much lower than those of Afolabi (2011) and Daniel et al. (2022); most respondent agreed that they applied safety rules, about 33 respondents (80.48) were in the affirmative of been aware of safety precautions, but their range of skills were limited (Table 8). This result was higher than those reported by Okafoagu et al. (2017) 50.9%, for most petrol attendants around Sokoto state, Nigeria. Petrol attendants who grasp a good knowledge of chemistry would be conscious of the flammability and volatility of petroleum product and therefore seek the needed training to handle such volatile product (API, 2021; Ahmed et al., 2014) while at the same time contending with the demand of sales, handling and safety technique before, during and after dispensing of such product.

Petroleum product has a broad chemistry of how they are refined, but the most basic of this method is ″fractional distillation″ which applies cracking technique (Ashraf, 2012), 29.26% (12 respondents) knew how crude oil was refined while 65.85% (27 respondents) said they had no idea of how petroleum products were refined (Table 11). 33 respondent (80.48%) knew the generic and physical identification of the petroleum products such

Table 12. Awareness of the acronym used to describe the petrol products.

Premium motor spirit (PMS), Automated gasoline oil (AGO), Dual purpose kerosene (DPK) and Liquefied petroleum gas (LPG)	Number of respondents	Percentage of respondents
Yes	33	80.48
No	8	19.51

Source: Authors Compilation (2022).

Table 13. Chemistry of petroleum quality control tests.

Testing methods	Number of respondents	Percentage of respondents
Yes	2	4.87
No	36	87.80
Abstain	3	7.31

Source: Authors Compilation (2022).

as Premium motor spirit (PMS), Automated gasoline oil (AGO), Dual purpose kerosene (DPK) and Liquefied petroleum gas (LPG), 19.51% (8 respondents) did not know the meaning of the acronym used to describe the product they sold (Table 12).

A look through some of the tests carried out for quality and standard of PMS, such as flash point to ascertain ignition temperature, pour point to ascertain fluid dynamics, and octane rating to ascertain the anti-knock ability of petroleum (Nadkarni, 2000) showed that only 4.87% of respondent knew anything about such test procedure. 87.80% which is an overwhelming number said they knew nothing about the chemistry behind these quality tests such as octane rating, flash point, pour point, and smoke point, these procedures are adopted to control the final quality and appearance of products during fractional distillation and cracking (Table 13).

Automated gasoline oil has a sticky feel and burns much more slowly under pressure inside a Carnot engine, a function of how well and how long A.G.O burns is determined by the amount of organic hydrocarbon methylene (CH2) per volume of the product, test such as “specific gravity” are used for determination in grams of hydrocarbon contained per volume of A.G.O, “viscosity” describes how sticky or the fluid dynamic behavior of A.G.O, while “aniline point” describes the level of saturation of an A.G.O product (C-C bonding) (Nadkarni, 2000), 78.04% (32 respondent) did not know anything about these test and their usefulness in the production of quality A.G.O, just about 4.87% (2 respondent) knew about these test and their use. 29.26% said they knew how petroleum product were refined but only 17.01% (7 respondents) knew in-depth the various chemical procedure used for refining of petroleum products, procedure such as desalting, desulphurization, alkylation, isomerism, vis-breaking, and catalytic cracking (Abdulahi, 2012; Chaudhuri, 2011) are advance technique used for production of quality petroleum product. 78.04% (32 respondents) responded negatively that they did not know about any of the chemical procedures mentioned above. Some attendants might have an idea of how petroleum products are refined, but on average, half the number of petroleum attendants is not science-oriented and roughly that same number had just a high school diploma education (Table 8), complex chemical procedures for petroleum distillation could only be obtained from the higher institution, particularly science faculties of universities.

Production and refining of petroleum fall under the downstream sector in Nigeria. The Nigerian government has regulatory agencies that oversee the daily running and monitoring of the production, transportation, and dispensing of petroleum products (Resolution Law Firm, 2020; Onyinye and Nkechi, 2015). The Nigerian National petroleum company limited operates as the flagship government agency that regulates the oil industry (Ken and Ernest, 2015; Resolution Law Firm, 2020), there are subsidiaries under the NNPCL that regulates different sector of importance in the petroleum sector (Resolution Law Firm, 2020). The Department of petroleum resources, regulates most parts of the up and downstream sector, mostly those of depots (tank farms and storage facilities) and dispensing stations (Liquefied petroleum gas and petrol station) (DPR, 2021; Onyinye and Nkechi, 2015). Petroleum Price Marketing Company (PPMC) regulates the price of crude oil exported from Nigeria and the price of different petroleum products imported into Nigeria (PPMC, 2019), it does this in relation to demand and supply and international market force and dynamics. Weight and Measure Department, are a monitoring agency of the government that ensures that the right amount of product is dispensed to customers in exchange, to put it simply, they ensure customers are not short-changed by petrol station owners and they get what they paid for, they ensure station owners operate proper and standard approved calibration

Table 14. Knowledge about some agencies responsible for the regulation of petroleum in Nigeria?

Knowledge about some agencies	Number of respondents	Percentage of respondents
Yes	24	58.53
No	13	31.70
Abstain	4	9.75

Source: Authors compilation (2022).

(Onyinye and Nkechi, 2015).

58.53% of attendants knew of the existence of the NNPCL, 31.70% did not know about them, 46.34% knew about agencies such as DPR, weight and measure, PPMC, and equal number 46.34% (19 respondents) did not know of the existence of these subsidiaries as such half of attendant population did not know or had not experienced the supervisory presence of these agencies (Table 14), this shows that these agencies are not paying much attention to technology, technocratic and expertise operation, and developmental operation in terms of chemistry development of petrol station attendants.

Conclusion

In conclusion, this study highlights the significant shortage of science-oriented graduates working as petrol attendants in the Sapele metropolis. The importance of science expertise, particularly in chemistry knowledge related to safety practices, cannot be underestimated, especially in fueling stations.

Recommendations

A gas leakage detection system capable of sending emergency alerts to users' mobile devices should be developed and promoted through radio stations to enhance safety in emergency situations. To ensure safety at petrol stations, it is important to employ competent managers and operators, who are proactive in implementing safety practices, address electrical faults and potential ignition sources, provide functional fire extinguishers and firefighting equipment, conduct daily safety reminders for employees, and prominently display signs and symbols indicating potential dangers within the station premises.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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