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Original Research Article

Physico-chemical analysis of water from some selected automobile repairing area in Abakaliki Southeastern Nigeria

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Abstract

This study was carried out in 2016 and 2017 to determine the effect of automobile repair wastes on water properties in Abakaliki Southeastern Nigeria. Four replicate water samples were collected at: A – was the tube well at non – automobile repair site (Control); B – was the tube well at lorry automobile repair site; C – was the tube well at motorcycle automobile repair site; D – was the tube well at car and buses automobile repair site and E – was the tube well at automobile spare parts market. The data obtained was analysed using analysis of variance based on CRD and difference between treatments means were dictated using F-LSD. Water collected were used to determine colour, conductivity, total solid, suspended solid, total dissolved solid, pH, NO_3^-, Cl^-, Ca hardness, Mg hardness, total hardness, Pb, Cd, Cu and Zn. These parameters apart from pH (which was lower) were significantly ($p<0.05$) higher in automobile repair sites than non-automobile repair site. Total solids, Pb, Cu and Zn observed in automobile sites were higher than the recommended standards whereas pH was lower than the recommended standard. Only tube well at lorry automobile repair site had Cd that was higher than the standard. Generally, the parameters studied were higher in the 2nd year of the study when compared to 1st year of the study. Therefore, this study recommends treatment of water from tube wells in automobile repair site before usage in order to prevent health problems associated with usage of such water.

Keywords: Automobile, Repair, Transfer, Treatment, Wastes

Introduction

Automobile shops are businesses such as new and used automobile dealers, service stations, fleet management facilities, municipal garages and other similar activities. These activities are responsible for producing varieties of solid and hazardous wastes that cause air and water pollution (Pataki and Crotty, 2003). Few of these wastes are used antifreeze, used oil, degreasers, parts cleaners, used oil filters, floor drains, lead-acid batteries, shop towels, underground storage tanks, oil-fired space heaters, above ground storage tanks, tires, used, refrigerants, wastewater and sludge, spray painting operations, absorbents, automobile recyclers, air bags, mercury switches used electronics, spill cleanup, used fuel filters and fluorescent bulbs, (Pataki and Crotty, 2003). These wastes have high quantities of solids particles such as zinc, lead, calcium, magnesium and barium along with smaller concentrations of sodium, copper, aluminum, chromium, iron, manganese, potassium, tin, silicon, boron, nickel, and molybdenum (Wasiu et al., 2015). Most of the particles that dissolved in water can be easily moved through the soil to contaminate ground water and surface water (Agency for Toxic Substance and Disease Registry, 1997). These contaminated groundwater and surface water drain to underground and then into marshes and lakes. Most of these substances persist in the environment for a long time. Thus, hazardous substances from automobile wastes can build up in water, alluvial deposition, plants and animals to toxic level.

In 2006, the Federal Road Safety Commission established that about seven million vehicles including motorcycles, cars, buses and trucks are on Nigerian roads, Nigeria (Zitte, 2016). This data showed an insight into the quantity of automobile wastes produced in Nigeria. Boughton and Horvath (2004) estimated that about 45% of used engine oil is being recycled worldwide whereas the remaining 55% is used to pollute the environment by the end user. This used oil, also known as used engine oil or spent lubricant, is often generated from servicing and subsequently draining from generator and automobile engines (Brinkman, 1991). The automobile or generator wastes that come in contact with surface water bind to small water and eventually sediment to the bottom of water where they residence for many years. Diran (1997) in his work on the little adsorption book pointed out that oil on surface water harshly interrupts the life-support ability of the water. The oil generated from automobile or generator wastes prevents sunlight and oxygen from entering the water which makes it hard for fish to breathe and for photosynthesis to occur in aquatic plants. This causes the death of the fishes and plants living in the water bodies. The harmful substances in spent lubricant can also destroy other organisms that sustain the rest of the food chain (Arner, 1992).

Njoku et al. (2017) in their study of water properties as influenced by abattoir wastes in Abakaliki and Ezzamgbo Southeastern Nigeria showed that for water near abattoir waste dumpsite to be fit for usage, it must be treated in order to avoid the health problems associated with such water. This necessitated the need for this study since majority of people in the study area use both water near automobile repair sites and abattoir sites for their daily activities. Therefore, the objective of this research work was to evaluate the effect of automobile repair waste on water properties in Abakaliki southeastern Nigeria.

Material and Methods

Environment of the study

The research was done in Abakaliki Southeastern Nigeria. Abakaliki lies in latitude 06^0 14' and 06^0 30' N with longitude 08^0 0' and 08^0 15' E. The rainfall pattern is pseudo-bimodal (April to July and September to November), with a dry spell in August usually referred to as "August Break". It has annual rainfall of 1700 to 2000mm and annual mean of 1800mm. Abakaliki has minimum temperature of 27ºC and the maximum mean daily temperature of 31ºC. Humidity is high (80%) during rainy season and low (60%) during dry season. Geologically, the research site is sedimentary rock which is obtained from straight seawater retainer of the cretaceous periods and quaternary periods. Federal Department of Agriculture and Land Resources (1987) reported that Abakaliki remain within 'Asu River group' and made up of olive brown sandy shale, small particles of mudstones and sandstone. The soil is not very deep with unconsolidated parent substances within 1 m of the sand uppermost layer.

Field Method

After the preliminary survey of the study area the following tube wells (underground water bodies) were selected within Abakaliki capital territory for the study.

A – was the tube well at non – automobile repair site (Control)

B – was the tube well at lorry automobile repair site

C – was the tube well at motorcycle automobile repair site

D – was the tube well at car and buses automobile repair site

E – was the tube well at automobile spare parts market

Water Sample Collection

Cleaned and sterilized aqua-rapha bottle water was used to collect four replicate water samples in four tube wells in each site in the 2016 and 2017 years of the study.

Laboratory Analysis

Determination of physical parameters: Bhagure (2010) methods were used to determine total suspended solids, total solids and total dissolved solids. The colour of the samples was determined in terms of percentage transmittance of light as described y Hossain et al, 2001).The conductivity of the sample was determined using SANXIN SX723 conductivity meter as described by Hossain et al.(2001).

Determination of chemical parameters: The water pH was determined using pH meter and chloride was determined using argentometric titrimetric method while calcium, magnesium and total hardness were determined using estimation method described by Jung 2001).

Nitrate (NO_3^-) was determined using turbidimetric method as described by Stavrianou (2007)

Determination of heavy metals

Heavy metals (Pb, Cd, Cu and Zn) were determined by digesting the sample in a fume cupboard and reading transmittance of light using Atomic Absorption Spectrophotometer model (American Public Health Association, 1998).

Data Analysis

The data obtained from laboratory was analysed using analysis of variance (ANOVA) for CRD and the differences between means were dictated using F-LSD at P=0.05 (SAS Institute Inc., 1999) and compared with World Health Organisation standards (Alloways, 1996).

Results

Effect of Automobile Repair Wastes on Colour, Conductivity, Total Suspended Solids, Total Dissolved Solids and Total Solids

Table 1 shows the effect of automobile repair wastes on colour, conductivity, total suspended solids, total dissolved solids and total solids**.** The Table also showed significant ($p<0.05$) differences among the various tube wells studied in terms of colour, conductivity, total suspended solids, total dissolved solids and total solids**.**. Control (A) recorded the lowest colour transmittance of 3%, whereas colour transmittance in automobile sites ranged between 8 – 21% in the 1st year of the study. Also, in the 2nd year of the study, the order of increase in colour transmittance was A<E<B<C<D. The lowest conductivity values of 0.03 µScm^{-1} and 0.04 µScm^{-1} were observed in Control in 1st and 2nd years of study, respectively whereas conductivity values in the corresponding years ranged between 0.21 – 0.37 µScm^{-1} and 0.22 – 38 µScm^{-1}. Lowest total suspended solid of 29.01 mgl^{-1} was observed in control in 1st year of the study. This observed total suspended solid in control in the 1st year of the study was higher than total suspended solid in B, C, D and E by 249, 238, 272 and 229%, respectively. Similarly, in the 2nd year of the study, control recorded the lowest suspended value of 31.02 mgl^{-1} while that of automobile sites ranged between 99.23 – 107.78 mgl^{-1}. The order of increase of total dissolved solids in 1st and 2nd years of study were A<E<C<D<B and A<E<D<B<C, respectively. In the 1st and 2nd years of the study control recorded the lowest total solid of 74.02 mgl^{-1} and 77.25 mgl^{-1} while total solids in automobile sites ranged between 183.77 – 233.30 mgl^{-1} and 187.64 – 257.64 mgl^{-1} for the corresponding years.

Effect of Automobile Repair Wastes on water pH, NO_3^- and Cl^-

The effect of automobile repair wastes on water pH, NO_3^- and Cl^- is as presented in Table 2. There was significant ($p<0.05$) changes in pH, NO_3^- and Cl^- among the various tube well in the two years of the study. The highest pH of 6.79 and 6.73 was obtained in control in 1st and 2nd years of study, respectively whereas pH in automobile sites for the corresponding years ranged between 4.97 – 6.23 and 4.93 – 6.15. The order of increase in NO_3^- in 1st and 2nd year of study was E<A<D<C<B and A< E< D<C<B, respectively. In the 1st year of the study the highest Cl^- of 276.03 mgl^{-1} was observed in control. This observed Cl^- in tube well at lorry automobile repair site (B) was higher than Cl^- in A, C, D and E by 1100, 4, 1 and 66%, respectively. Also, on the 2nd year of the study B recorded the highest Cl^- value of 277.15 mgl^{-1}while Cl^- in tube wells ranged between 67.27 – 272.24 mgl^{-1} with control recording the lowest Cl^- concentration.

Effect of Automobile Repair Wastes on Water Ca, Mg and Total Hardness

The effect of automobile repair wastes on water Ca, Mg and total hardness is as shown on Table 3. Table 3 also showed significant ($p<0.05$) differences in the various tube wells studied with respect to Ca, Mg and total hardness in the two years of the study. The order of increase in Ca hardness in both years of the study was A<E<C <B<D. In the 1st year of the study, the lowest Mg hardness of 31.54 mgl^{-1}was observed in control while Mg hardness in automobile sites ranged between 66.42 – 98.61 mgl^{-1}. Total hardness was lowest (76.77 mgl^{-1}) in control (A) in the 1st year of the study. This recorded total hardness in A was lower than total hardness in B, C, D and E by 153, 132, 175 and 86%, respectively. Similarly, in the 2nd year of the study, A recorded the lowest total hardness concentration of 78.44 mgl^{-1}. This observed total

hardness in A was lower than total hardness in B, C, D and E by 152, 129, 176 and 90%, respectively.

Effect of Automobile Repair Wastes on Water Heavy Metals (Pb, Cd, Cu and Zn)

Table 4 shows the effect of automobile repair wastes on water Pb, Cd, Cu and Zn to be significant ($p<0.05$) difference among the various tube wells studied in the 1st and 2nd years of the study. The order of increase in Pb in the 1st and 2nd years of the study was A<E<B< D< C. Control (A) and tube well at automobile spare parts market (E) recorded zero concentration of Cd in both 1st and 2nd years of the study whereas Cd in B, C and D ranged between 0.002 – 0.004 and 0.001 – 0.003 in the corresponding years with B recording the highest Cd concentration in both the two years of the study. The order of increase in Cu concentration in 1st and 2nd years of the study was A<E<B<D<C and A<E<D<C<B, respectively. Control had the lowest Zn concentration of 1.34 mgl^{-1} in the 1st year of the study. This observed Zn concentration in control in the 1st year of the study was lower than Zn concentration in B, C, D and E by 246, 184, 182 and 64%, respectively. Likewise in the 2nd year of the study control recorded lowest Zn concentration of 1.35 mgl^{-1} whereas Zn concentration in automobile sites ranged between 2.31 – 3.91 mgl^{-1} with tube well at lorry automobile repair site recording the highest Zn concentration.

Table – 1: Effect of automobile of repair wastes on water colour (% transmittance), conductivity (µScm^{-1}), total suspended solids (mgl^{-1}), total dissolved solids (mgl^{-1}) and total solids (mgl^{-1})

Tube well	Colour		Conductivity		Total suspended solids		Total dissolved solids		Total solids	
	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
A	3	4	0.03	0.04	29.01	31.02	45.01	46.23	74.02	77.25
B	13	15	0.36	0.34	101.14	123.14	132.16	133.57	233.30	256.71
C	17	16	0.36	0.38	98.14	101.41	99.63	156.23	197.77	257.64
D	21	24	0.37	0.35	107.78	104.23	100.23	123.22	208.01	227.45
E	8	9	0.21	0.22	95.54	99.23	88.23	88.41	183.77	187.64
F-LSD ($p<0.05$)	1.02	2.03	0.09	0.06	12.34	15.12	16.78	10.21	9.51	13.81
Standard	50		500		500		500		150	

Note: 1st = 2016 and 2nd = 2017

Table - 2: Effect of automobile repair wastes on water pH, NO_3^- andCl^-

Tube well	pH		NO_3^-(mgl^{-1})		Cl^-(mgl^{-1})	
	1st	2nd	1st	2nd	1st	2nd
A	6.79	6.73	2.45	2.31	23.01	67.27
B	5.76	5.77	4.38	4.31	276.03	277.15
C	5.63	5.91	4.21	4.24	265.21	268.33
D	4.97	4.93	3.97	3.23	273 76	272.24
E	6.23	6.15	2.15	2.37	165.97	177.81
F-LSD ($p<0.05$)	0.98	0.23	0.03	0.07	9.23	10.39
Standard	6.5 – 8.5		10		250	

Table – 3: Effect of automobile repair wastes on water Ca, Mg and total hardness (mgl^{-1})

Tube well	Ca Hardness		Mg Hardness		Total Hardness	
	1st	2nd	1st	2nd	1st	2nd
A	45.23	46.31	31.54	32.13	76.77	78.44
B	108.15	110.78	86.38	87.23	194.53	198.01
C	99.76	100.15	78.14	79.56	177.90	179.71
D	112.34	114.98	98.61	101.23	210.95	216.21
E	76.08	78.13	66.42	71.15	142.50	149.28
F-LSD ($p<0.05$)	9.23	8.45	4.17	7.31	15.01	10.46
Standard	200		250		500	

Table – 4: Effect of automobile repair wastes on water Pb, Cd, Cu and Zn (mgl^{-1})

Tube well	Pb		Cd		Cu		Zn	
	1st	2nd	1st	2nd	1st	2nd	1st	2nd
A	0.002	0.003	0.000	0.000	0.12	0.09	1.34	1.35
B	0.021	0.020	0.004	0.003	2.23	2.67	3.46	3.91
C	0.041	0.048	0.002	0.001	2.38	2.41	3.81	3.51
D	0.038	0.037	0.003	0.002	2.28	2.29	3.78	3.45
E	0.007	0.006	0.000	0.000	1.31	1.30	2.20	2.31
F-LSD ($p<0.05$)	0.003	0.002	0.001	0.003	0.011	0.023	0.56	0.13

Discussion

The higher colour transmittance, conductivity total suspended solids, dissolved solids and total solids in tube wells in automobile repair sites than control may be attributed to higher debris and particulate matter in tube wells sited in automobile sites than in tube well in non-automobile site. Most of the debris, particulate matter, fuel combustion products and lubricating oil are transfer to underground water as a result of improper disposal. Wasiu et al. (2015) in their study of adverse effects of used engine oil (common waste pollutant) on reproduction of male sprague dawley rats concluded that used engine oil should be prevented from leaking, spilling or improperly discarded as through medium it may enter storm water runoff and eventually affect the environmental health receiving water bodies. Some of the metals dissolve in water and move through the soil easily and can be found in ground water and surface water (Agency for Toxic Substance and Disease Registry 1997).

Lower pH in tube wells in automobile sites than tube well in control site mighty be as a result of contamination of underground water by acidic automobile wastes. Similarly, atmospheric emissions such as CO_2 and SO_2 from automobile sites which was wash down to underground water in form of acidic rain might be responsible for the higher acidity and lower pH in automobile sites than non-automobile site which is in line with (Pataki and Crotty 2003). On other hand, NO_3^- was higher in automobile site than control which is attributed from blockage of sunlight and oxygen from entering the water which makes it difficult for fish to breathe and for photosynthesis to take place in aquatic plants. Thereby, killing the plants and fishes in the water body which causes eutrophication and more production of nitrate in the water concerned (Arner 1992). Also, Cl^- was higher in automobile sites than control. The concentration of Cl^- in tube wells at lorry automobile repair site; motorcycle automobile repair site and car and bus automobile repair site were higher the standard (Alloways1996). The higher Cl^- in these tube wells mighty be as a result of relatively large amounts of hydrocarbons in the automobile wastes such as highly toxic polycyclic aromatic hydrocarbons (PAH) which were transferred to the underground water from the automobile sites.

Automobiles repair sites recorded higher Ca, Mg and total hardness than non-automobile sites. The higher concentrations of Ca, Mg and total hardness in tube wells in automobile sites than tube well in non-automobile site may be as a result of indiscriminate disposing of automobile wastes in soils which then transferred these hardness to tube wells in automobile sites thereby increasing the hardness of water. Zitte et al. (2016) showed that metals may be retained in soils in the form of oxides, hydroxides, carbonates, exchangeable cations, and/or bound to organic matter in the soil which is gradually release to underground water thereby causing hardness of water.

Tube wells in automobile sites recorded higher concentration of heavy metals (Pb, Cd, Cu and Zn**)** than tube well in non-automobile site. The increase in heavy metals in tube wells in automobile site mighty have come from automobile waste from automobile sites. According to Agency for Toxic Substance and Disease Registry (1997), automobile wastes apart from containing aromatic hydrocarbons, sulfide, particulate matter etc also contains metals such as aluminum, chromium, copper, iron, lead, manganese, nickel, silicon, and tin, that come from engine and body parts as they wear down or repaired. Also, Zitte et al. (2016) in their study of used-oil generation and its disposal along East-West Road, Port Harcourt Nigeria showed that used motor oil contain a number of additional components from engine wears, this includes iron, steel, copper, lead, zinc, barium, cadmium, sulfur, water, and ash.

Conclusion

The study showed that water from tube wells in automobile sites is unfit for usage. It is also necessary to treat such water before used in order to avoid health problems related with the usage of such water. Generally, the parameters studied were higher in the second year of the study than the first year. This means that the water from these tube wells becomes more poisonous with time. Therefore, drinking of such water without treatment is been discouraged in order to be healthy.

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