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Total Petroleum Hydrocarbon concentration in Surface water from Taylor Creek, Rivers State, Nigeria

Edori E.S., Kpee F.

Department of Chemistry, Faculty of Natural and Applied Sciences, Ignatius Ajuru University of Education, Rumuolumeni, PMB 5047 Port Harcourt, Rivers State.
Correspondence: enizeedori@yahoo.com

Abstract As a result of environments pollution due to total petroleum hydrocarbon in the aquatic environment this research work was conducted from sampling station were selected from the study area to ascertain the level of hydrocarbon pollution in the Taylor creek. Dichloromethane was used in the extraction of the sample and then being analysed by gas chromatography-flame ionization detector (GC-FID). The results obtained in the various month ranged from 9.8411986 - 40.03405 ml/L for the total petroleum hydrocarbons and a mean range of 2.46029965 - 10.0085125ml/L and in the stations, total petroleum hydrocarbon ranged from 23.34247mg/l to 32.268289mg/l and mean value of 5.8356175 - 8.06707225 ml/L. The average value of total petroleum hydrocarbon in the surface water samples of the creek is less than or equal to the standard value by DPR of 10 ml/L. The pollution though moderate and low, still pose threat to humans and aquatic organisms and therefore effort should be made by relevant authorities to entails this menace.

Keywords Petroleum hydrocarbons, pollution, surface water, effluents, human activities

Introduction

The life of humans and other creatures have been put under danger and attack due to the unchecked lifestyle of man. The indispensability of water to life is under threat due to the high level of contamination of most water bodies (rivers, lakes, wells, etc.) of the Niger Delta Area of Nigeria. Pollution and contamination of the rivers of the Niger Delta region of Southern Nigeria has rendered most of them unfit for drinking and other domestic, agricultural and industrial uses. Due to the activities of man, water which is essential for human life and development has been subjected to degradation. The use of water for industrial and agricultural activities is now of a serious concern to humans. This arose as a result of pollution.

One of the greatest sources of water pollution and contamination in the Niger Delta Region of South-South Nigeria is from the activities of oil prospecting, exploration, exploitation and eventual production. This has brought about noticeable increase in environmental degradation and contamination [1-2]. Contamination, degradation and eventual pollution of the surface water of host communities of the multinational oil companies in the Niger Delta region have been reported in several studies [3-7], in order to ascertain the level of contamination and pollution.

Petroleum is known as the most dominant source of power in the world today. In order to maintain the socio-economic development of any nation, its use and application need to be checkmated. Total Petroleum hydrocarbon is one of the major organic pollutants, which may be caused by underground storage tank leakages, accidental spill and disposal, wilful disposal, sabotage [8]. The important and very significant roles played by petroleum in our modern life includes; transportation, manufacturing, source of heating and also raw material for industries [9]. Crude oil that spill, also contains total petroleum hydrocarbons which are highly inflammable. Some components of total

petroleum hydrocarbonvaporize easily, while others are thick, dark or maybe solids. Total petroleum hydrocarbon also contain benzene, toluene, xylene, hexane and polycyclic aromatic hydrocarbons which are extremely toxic and are of great concern to man [10-13].

It may also contain volatile organic compounds (VOCS), semi volatile organic compounds (SVOCS) and metals which also have their toxicity information [13-16]. The presence of these chemicals in the rivers or any water body poses a threat to the marine organisms [17]. Large quantity of these pollutants that are toxic to the environment enter into the rivers and creeks through gas flaring, water runoff during rain, automobile discharges, emission of vehicles due to incomplete combustion, automobile wastes, oil spills, industrial and municipal discharges etc [16, 18-19].

The contamination and pollution of water bodies, due to total petroleum hydrocarbon affect the aquatic environment which is of great concern to humans. When the level of petroleum hydrocarbons exceeds the allowed limits it becomes toxic to both man and aquatic organisms and drastically affects the ecosystem and its food chain [20-22]. Due to the resultant effect of petroleum hydrocarbons on human health and the environment, regulatory bodies has been put in place to check and monitor its discharge [23-24].

This work therefore, was undertaken to examine the concentrations of the different fractions of petroleum hydrocarbon in the Taylor Creek within the Engenni axis of the creeks in Ahoada West Local Government Area of Rivers State, Nigeria.

Materials and Methods

Study Area

The Taylor Creek is located along Biseni, Edagberi, Okordia, and Zarama communities of the Niger Delta Region of Nigeria. The Taylor Creek takes is tribute from the Orashi River and terminates into River Nun., The study sites are located in the Edagberi-Engenni axis of the creek. The sites are located between $6^{o}29^{o}18.7$'E and 6^{o} 30' 20.5''E and $5^{o}35.8$''N and 5^{o} 11' 1.2''N.

Four sampling stations along the shores of the creek were selected for this research work. The interval between two sampled locations ranged between 1.5 – 2 Km. Stations 1 and 2 are in the Better land axis while 3 and 4 are in the Edagberi axis of the creek. There are no special activities or features between the different stations except that there is a bridge in station 3. The major activities of the community dwellers along the Taylor Creek include; fishing, farming, petty trading (mostly in agricultural products), transportation of goods along the coasts of the creek, and illegal oil bunkering activities. The communities host to Shell Petroleum Development Company (SPDC) and the area is free from other industrial activities.

Sample Collection

Water samples for analysis were collected from the four sampling stations. The samples were collected with glass bottles 20 -25 cm below the surface water and corked under the surface. Three samples were collected within a designated area and combined together to obtain composite sample. The collected samples were then preserved with Hydrochloric acid and then stored in one litre glass bottle previously washed and rinsed with dichloromethane. The samples were transferred to ice pack vessel and then transported to the laboratory where they were stored at a temperature of 4^{o}C until time for analysis.

Samples Extraction and Determination of Total Petroleum Hydrocarbon

Water samples were filtered and then subjected to extraction procedures through the use of separatory funnel. One litre of the filtered water sample was put into a separatory funnel with a glass stopper which contains 40ml of dichloromethane (DCM) as the solvent of extraction. The separatory funnel was shaken for about 6 minutes to enable the organic layer separate out completely from the aqueous layer. The equilibrated contents in the separatory funnel was allowed to settle out for about 10 minutes. The process of extraction was repeated at least thrice for each sample. The phases were separated by filtration, leaving the organic layer. Each of the sample extract was then concentrated with rotary evaporator with water bath at a temperature of 40 ^{o}C. Thereafter the concentrated sample extracts were transferred to a bottle previously weighed and then evaporated to dryness [25-26].

Sample Clean-Up, Seperation and Detection

Extracted water samples were transferred to a chromatographic column packed with silica gel sherry with about 3cm anhydrous sulphate layer on top to remove polar organic substance in the solvent. The chromatographic column was then eluted with 25ml of n-hexane to obtain the hydrocarbon fractions. The eluates were then concentrated to 3 ml with the use of a rotary evaporator at 40^{o}c and then evaporate to dryness. The samples were then treated as in Maioli *et al*. [27].

The extracts were dissolved in a 4ml Tetrachloroethylene and an Agilent 6890 gas chromatography with flame ionization detector (GC-FID) was used to determine the concentration of total petroleum hydrocarbon in the water

sample. The detector temperature was kept at 350^{o}C and the total sum of all the aliphatic and all the aromatic hydrocarbons measured by GC-FID gives a measure of total petroleum hydrocarbon concentration.

Results and Discussion

The results of the concentrations of total petroleum hydrocarbons are presented in Tables 1-4. The results showed the individual concentrations of the various fractions of the hydrocarbon constituents in the surface water of the creek, that sum up to the total petroleum hydrocarbons in the various stations in the different months. In December, the concentration levels of individual hydrocarbon fractions recorded was between undetected to 3.24000 ml/L in station 4 in C_{10} fraction. The total petroleum hydrocarbon content for the stations are 0.0000 mg/L Station 1, 3.3923896 ml/L, Station 2, 0.0000 ml/L, Station 3 and 6.448809 ml/L Station 4. In February, individual level of hydrocarbon fractions recorded ranged from undetected level to 4.434 ml/L in Station 1, in C_{26} fraction. Total petroleum hydrocarbon was found to be 8.58765 ml/L, Stations 1, 4.10542 ml/L, in station 2, 4.11413 ml/L, Station 3 and 6.85027 ml/L in Station 4. April result showed that total petroleum hydrocarbon content in surface water ranged from not detected to 3.7440 ml/L in Station 4 in C_{20} fraction. Total petroleum hydrocarbon for the Stations are, 10.23631ml/L, 8.5456ml/L, 6.63388ml/L and 10.1614ml/L for stations 1,2,3 and 4 respectively. In the month of June, the concentrations of different hydrocarbon fractions ranged from not detected to 4.7292ml/L in station 3, in C_{30} fraction. Total petroleum hydrocarbons for the different stations in the month are 4.51851ml/L, 10.63723ml/L, 16.0705ml/L and 8.80781ml/L for Station for 1,2,3 and 4, respectively.

Table 1: Total Petroleum Hydrocarbon concentrations in Surface water of Taylor Creek in December.

Carbon Length	Stations			
(ml/L)	1	2	3	4
C8	-	0.94232	-	0.590962
C9	-	0.10094	-	0.142899
C10	-	0.0665166	-	3.24000
C11	-	0.22098	-	1.03673
C12	-	0.934653	-	0.877684
C13	-	0.789223	-	0.560634
C14	-	0.279603	-	-
C15	-	-	-	-
C16	-	-	-	-
C17	-	-	-	-
C18	-	-	-	-
C19	-	-	-	-
C20	-	-	-	-
C21	-	-	-	-
C22	-	-	-	-
C23	-	-	-	-
C24	-	-	-	-
C25	-	-	-	-
C26	-	-	-	-
C27	-	-	-	-
C28	-	-	-	-
C29	-	-	-	-
C30	-	-	-	-
C31	-	-	-	-
C32	-	-	-	-
C33	-	-	-	-
C34	-	-	-	-
C35	-	-	-	-
C36	-	-	-	-
C37	-	-	-	-
C38	-	-	-	-
C39	-	-	-	-
C40	-	-	-	-
Total	-	3.3923896	-	6.448809

Table 2: Total Petroleum Hydrocarbon concentrations in Surface water of Taylor Creek in February

Carbon Length	Stations			
(ml/L)	1	2	3	4
C8	-	-	-	-
C9	-	-	4.11413	-
C10	-	-	-	-
C11	-	-	-	-
C12	-	-	-	-
C13	-	-	-	-
C14	-	-	-	-
C15	-	-	-	-
C16	-	-	-	-
C17	-	-	-	-
C18	-	-	-	-
C19	4.15355	-	-	-
C20	-	-	-	0.09870
C21	-	-	-	-
C22	-	-	-	2.03494
C23	-	-	-	-
C24	-	-	-	0.36884
C25	-	-	-	-
C26	4.4341	-	-	2.40623
C27	-	-	-	-
C28	-	-	-	0.01883
C29	-	-	-	-
C30	-	0.47454	-	1.92271
C31	-	-	-	-
C32	-	0.05619	-	-
C33	-	-	-	-
C34	-	0.67475	-	-
C35	-	-	-	-
C36	-	2.89994	-	-
C37	-	-	-	-
C38	-	-	-	-
C39	-	-	-	-
C40	-	-	-	-
Total	8.58765	4.10542	4.11413	6.85027

Table 3: Total Petroleum Hydrocarbon concentrations in Surface water of Taylor Creek in April

Carbon Length	Stations			
(ml/L)	1	2	3	4
C8	-	-	-	-
C9	0.00638342	-	-	-
C10	0.0208697	-	-	-
C11	0.0237607	-	-	-
C12	0.0436640	-	-	-
C13	0.0349060	-	-	-
C14	0.0126077	-	-	-
C15	0.0212257	-	-	-
C16	0.00700206	-	-	-
C17	0.105536	-	-	-
C18	0.0533051	-	-	0.1773
C19	0.0155841	-	0.37318	1.8373
C20	0.343677	0.21094	1.36134	3.7440

C21	-	-	-	-
C22	0.774912	1.25385	0.4556	0.2238
C23	-	-	-	-
C24	0.388561	0.30685	0.03406	1.7675
C25	-	-	-	-
C26	0.826773	1.58359	1.44326	0.3767
C27	-	-	-	-
C28	2.51997	0.89439	0.67362	2.0174
C29	-	-	-	-
C30	2.46126	2.10037	2.29282	0.0174
C31	-	-	-	-
C32	0.733961	1.70459	-	-
C33	-	-	-	-
C34	1.81179	-	-	-
C35	-	-	-	-
C36	0.0262723	-	-	-
C37	-	-	-	-
C38	0.0026619	-	-	-
C39	-	-	-	-
C40	0.000727552	-	-	-
Total	10.23631	8.05456	6.63388	10.1614

Table 4: Total Petroleum Hydrocarbon concentrations in Surface water of Taylor Creek in June

Carbon Length	**Stations**			
(ml/L)	**1**	**2**	**3**	**4**
C8	-	-	-	-
C9	-	-	-	-
C10	-	-	-	-
C11	-	-	-	-
C12	-	-	-	-
C13	-	-	-	-
C14	-	-	-	-
C15	-	-	-	-
C16	-	-	-	-
C17	-	0.25545	-	-
C18	0.72269	1.72714	-	-
C19	0.54416	0.51214	-	0.94544
C20	3.09302	2.73052	-	0.23566
C21	-	-	-	-
C22	-	0.30779	-	-
C23	-	-	-	-
C24	0.15864	0.66883	2.7618	1.75247
C25	-	-	-	-
C26	-	0.56434	3.9686	0.78866
C27	-	-	-	-
C28	-	0.19433	4.6109	2.30861
C29	-	-	-	-
C30	-	0.69287	4.7292	2.33470
C31	-	-	-	-
C32	-	0.60062	-	0.44227
C33	-	-	-	-
C34	-	2.38320	-	-
C35	-	-	-	-
C36	-	-	-	-
C37	-	-	-	-

C38	-	-	-	-
C39	-	-	-	-
C40	-	-	-	-
Total	4.51851	1.63723	16.0705	8.80781

The mean concentration of the total petroleum hydrocarbons of the various stations in the months are shown in Tables 5 and 6. The value obtained were2.461± 2.687, 5.914±1.906, 8.772±1.513 and 10.009±4.145ml/L respectively for the months of December, February, April and June. Also, the mean levels of concentrations of total petroleum hydrocarbon in the various stations revealed that 5.836±3.960, 6.547±2.954, 6.705 ± 5.903 and 8.062±1.503ml/L were recorded for stations 1,2,3 and 4 respectively. The mean concentration level of total petroleum hydrocarbon reported in this work in the stations or months fall below or within the DPR allowed limit of 10.00ml/L in water [28], and also below that of the EUEPA (European Union Environment Protection Agencies allowable limit of 300µg/l in river water [29].

The mean concentrations of total petroleum hydrocarbon in this study was found to be less than that of Daniel and Nna [2] which ranged between 9.68200 ± 0.233 – 24.85462 ± 8.058, of 1352 – 12,100µg/L range reported in ground water samples in some Niger Delta communities, Ogeleke *et al*., in Odidi and Egwa Rivers in Warri Delta State which were 97592 ± 46mg/L and 91590 ± 51mg/L and from the surface water of Ubeji River which was 73,500mg/L. Also in comparison of the level of total petroleum hydrocarbon in this work and that of other parts of the world showed that it lesser than that of Suratmen [30] in his work on the strait of Johor Peninsular, Malaysia of 25 – 2,795mg/L and that of Sammarco et al [31], which work was conducted in the deepwater horizon, Gulf of Mexico which concentration was 60,000 – 260,000mg/L.

In general, lighter fractions of the total petroleum were not found in majority of the stations in the different months. This may be due to rapid evaporation of the lighter fraction especially during hot temperatures and strong wind [2,32]. The near absence of the higher fractions in the Taylor Creek may be revelation that the crude oil produced along these areas may contain little quantity of these fractions. The abundance of the fractions increased from December to June. This is an indication that, during December, the possibility of rainfall is low, and hence the fractions evaporated faster and no runoffs due to rainfall. The slight increase in February may have resulted from a bit of rainfall, which may have precipitated flared components or from little runoffs. The increased values of the different fractions in April and June may be due to increased rainfall, which accompanied runoffs from farms, drainages, adjoining valleys, sewage and wastes. There is also the possibility of resuspension of the fractions from the sediment due to increased current in the creek, which is a consequence of flooding. During flooding, the movement of the surface water in the creek is fast and turbulent. The study also revealed that great variation existed in the pattern of occurrence of the total petroleum hydrocarbons in the study stations and months which is an indication that the origin of the pollution is anthropogenic. This statement is corroborated by Daniel and Nna, [2].

The Taylor Creek flow only in one direction and that accounts for the low presence of total petroleum hydrocarbon, no matter the quantity put into it. Trees and grasses grow along the bank of the river and some of the petroleum hydrocarbon fraction adhere or stick to these and hence cannot be accounted for in the surface water of the Creek. The annual flooding of the Creek is another factor and mechanism which the creek uses in reducing the total content of the hydrocarbons. During this period the Creek overflows its bank thereby depositing the hydrocarbons on the adjoining lands and tree tops. These are self-purification mechanisms in fresh water rivers and creeks to reduce or eliminate the contamination of total petroleum hydrocarbons in the system.

Table 5: Mean Bimonthly Concentrations (ml/L) of Total Petroleum Hydrocarbons in Surface Water at the different Stations

Stations	**Months**			
	December	**February**	**April**	**June**
1	-	8.588	10.236	4.519
2	3.392	4.105	8.055	10.637
3	-	4.114	6.634	16.071
4	6.449	6.850	10.161	8.808
Total	9.841	23.658	35.086	40.034
Mean	2.461± 2.687	5.914±1.906	8.772±1.513	10.009±4.145

Table 6: Mean Spatial (Station) Variation of Total Petroleum Concentrations (ml/L) in Surface Water within the examined Months

Stations	Months			
	1	**2**	**3**	**4**
December	-	3.392	-	6.449
February	8.588	4.105	4.114	6.850
April	10.236	8.055	6.634	10.161
June	4.519	10.637	16.071	8.808
Total	23.342	26.190	26.819	32.268
Mean	5.836±3.960	6.547±2.954	6.705 ± 5.903	8.062±1.503

Conclusion

The determination of the content of total petroleum hydrocarbon in surface water of Taylor Creek revealed that the concentration is low in all the months and stations where sampling took place. The contamination level of total petroleum hydrocarbon when compared to laid down limits by certain agencies was within acceptable level. Even though the findings showed such, effort should be made to regularly monitor the activities of illegal oil bunkering along the creek in order to reduce it further or totally eliminate total petroleum hydrocarbon due to human or self-inflicting activities. This will bring back the water to its original or natural state, which will then add value to the livelihood of the communities as was applicable before now.

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