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Physico-chemical changes in water by contamination of crude oil in oil field areas of Sivasagar district, Assam, India

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Abstract

Natural resources that are in the womb of nature crude oil is the most important mineral. For the use of humanity, oil is extracted through scientific means. During the drilling operation while this is extracted and refined various chemical substances get mixed up with soil and water occurs. A study of effluent monitoring was undertaken in Sivasagar district, Assam to determine its characteristics and possible impacts on the environment. Parameters examined for water samples were pH, total hardness, Cl^- , SO_4^{2-} , Pb , Cr , Cu , Fe and Ni . Safety and environment management department of the drilling company has set up to monitor the pollution control measures.

Keywords: Drilling operation, pollution, heavy metal

1. Introduction

Crude oil is the most important and predominant energy resource for humans and the raw material of various petroleum products which are essential for daily life. However, during crude oil exploration a vast amount of drilling mud/fluid is generated. Further, oil spills, leaks and other releases of petroleum occur frequently during its transportation and result in the contamination of cultivated soil and groundwater especially when associated with accidental spills. This huge amount of toxic and persistent pollutants like PAHs, heavy metals, oil, grease, phenols, drilling fluid and mud affect organisms in the biosphere from genetic through molecular levels ^[1]. Assam is well blessed by nature in respect of oil and natural gas. North- East region is one of the major on shore oil producing regions of India ^[2]. The upper Assam basin is continuously being explored since discovery in Digboi primarily by Oil India Limited (OIL) and Oil and Natural Gas Corporation Limited (ONGCL). Till date, lot of wells have been drilled by these two organizations in quest of hydrocarbon exploration ^[3]. Crude oil pollution is a regular phenomenon in the oil drilling sites as well as the areas through which oil transportation pipelines carries the crude oil either to the oil collecting station or to the oil refineries ^[4]. Crude oil is not a single chemical but a collection of hundreds of widely different properties and toxicities and when mixed with soil and water it changes the Physico-chemical changes. Oil may effects soil in two ways. It may penetrate into the soil where it directly affects plant root system, microbial population and oxygen content ^[4].

Water is put to numerous uses by man. These uses include inter alia domestic, agricultural, livestock watering, industrial, sports and recreation. Apart from natural factors, the quality of water in an area may also be affected by contributions from anthropogenic sources. The release of waste gases and particulate matter into the atmosphere by various industries, release of waste industrial effluents and sewage into water courses on land etc have added dimensions to the water quality aspects ^[5].

Such regionalized concentration has serious implications on the bio –economy both in terms of health and economy especially since the proximity of crude oil sites to paddy fields and/or tea plantations uniquely marks the landscape of upper Assam ^[1].

A study was undertaken in the vicinity of oil drilling sites of Deudubi, Bhatiapaar, Lakwa, Dimual, Patsaku, Laipling and Bordeudhai Nakatari in Sivasagar district Assam to investigate some Physico - chemical parameters through survey and filling up of questionnaires. Surface water samples were analyzed for pH, total hardness, Cl^- , SO_4^{2-} , Pb , Cr , Cu , Fe and Ni .

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2. Methodology

An effort has been made to investigate factual information regarding crude oil pollution and its impact on water. Physico-chemical properties in eight crude oil spill areas of major oil fields of upper Assam has selected. The study area of the present investigation are Deudubi oil field, Bhatiapar oil field, Gaurisagar oil field, Lakwa oil field, Dimual oil field, Patsaku oil field, Laipling oil field and Bordeudhai Nakatari oil field of Sivasagar district of upper Assam where oil exploration activities are conducted by Oil and Natural Gas Cooperation Limited (ONGCL). Water samples

from the study area were collected in clean dry 1 litre wide mouthed transparent glass bottles with Teflon covers. Sample bottles were properly labeled indicating sample name and date of collection.

The pH of the water samples were determined by deluxe pH meter-101. The total hardness of the water samples were determined by standard titrimetric method using EDTA solution. Cl⁻ and SO₄²⁻ ions are estimated by standard methods. The estimation and analysis of heavy metals in water samples were done by atomic absorption IS 3025(Flame-AAS).



Fig 1: Map of Sivasagar District, Assam



Fig-2



Fig-3



Fig-4



Fig-5

Fig (2-5): Crude oil spillage due to drilling in some areas of Sivasagar district

3. Result and discussion

The results of the experimental findings are presented in Table 1 and Table 2 which are given below

Table 1: Results of water analysis

Serial No	Sample location	Source	pH	Total hardness(mg/L)	Cl ⁻ (mg/L)	SO ₄ ²⁻ (mg/L)
1	Deudubi	Surface water	7.58	90	352	0.182
2	Bhatiapar I	Surface water	8.52	165	710	1.759
3	Bhatiapar II	Surface water	8.36	130	532	0.54
4	Gaurisagar I	Surface water	8.12	60	285	0.469
5	Gaurisagar II	Surface water	8.43	110	354	0.243
6	Laipling	Surface water	7.70	80	603	0.208
7	Dimual	Surface water	8.30	95	270	0.486
8	Control	Surface water	8.02	55	167	0.154

Table 2: Elemental analysis of water

Serial No	Sample location	Source	Pb (mg/L)	Cr (mg/L)	Cu (mg/L)	Fe (mg/L)	Ni (mg/L)
1	Deudubi	Surface water	ND	ND	0.027	0.198	ND
2	Bhatiapar I	Surface water	0.72	ND	1.232	2.480	0.72
3	Bhatiapar II	Surface water	0.02	0.012	0.048	0.462	ND
4	Gaurisagar I	Surface water	ND	0.05	0.039	0.354	0.06
5	Gaurisagar II	Surface water	ND	0.008	0.073	0.329	0.030
6	Laipling	Surface water	0.01	ND	ND	0.163	0.01
7	Dimual	Surface water	ND	0.068	0.090	0.552	ND
8	Control	Surface water	0.03	0.006	ND	0.043	0.02

It has been found from the above study that the pH value is ranging from 7.58 to 8.52. From the table 1 and table 2 it is observed that total hardness is higher in Bhatiapar I area and lower in Gaurisagar I oil field. The Cl⁻ ion presence is higher in Bhatiapar I and the values ranges from 270-710 mg/L. The presence of the heavy metals is listed in table 2.

Lead is toxic to many plant species although a few are relatively tolerant when ingested. Lead can cause a disease called Plumbism. Lead can also damage the brain, the central nervous system, Kidney, liver and reproductive system^[6].

Acute toxic effects may occur when breathing very high levels of chromium (VI) in air which can damage and irritate the nose, lungs, stomach and intestine^[6].

The iron toxicity (Fe) rarely creates problems in this field. Although it can find its way to the ground water thereby polluting it. The high iron concentration could be because of D76 which contains iron as one of the chemicals used for drilling operations^[6].

4. Conclusion

Oil drilling sites are a major source of PAHs and heavy metal pollution but suffers from poor management and lack of environmental controls which, in turn, may have a significant impact on the surrounding environment^[1]. Crude oil drilling sites are mostly adjacent to the rice fields, tea gardens and plantations of upper Assam area. Therefore accidental spillage during drilling and transportation and subsequent contamination of tea and rice field is a common feature of these regions. Moreover it has been established that heavy metals enter into plant bodies in acidic soil. By implication then, since tea plants normally grow in acidic soil, they become prone to accumulate heavy metals in their Systems. This possibility necessitates a serious consideration of the impact of oil drilling sites on tea plantations near them, given the importance of tea in the states bio-economy^[1].

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