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Thermal gradient due to the gas flared at umusadege marginal oil field, Umusadege-Ogbe Kwale Delta State, Nigeria

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ABSTRACT

Technological development and oil exploration are the major causes of environmental degradation and gas flaring. Some of the effects of gas flaring in Niger-delta region includes: greenhouse effect, acid rain, increase in temperature, acidification of aquatic ecosystem and low agricultural productivity. The thermal gradient resulting from the gas flared at Umusadege marginal oil field is hereby reported. Surface temperatures, distances, latitudes and longitudes away from the flaring point were investigated for the four (4) cardinal directions with the aid of thermometer, a fibrous meter tape and a global positioning system (GPS).The results obtained were analyzed using python and surfer 8 programs to obtain the graph of temperature against distance and the contour of temperature on the latitudes and longitudes of the study area. The result did not only show surface temperature elevation of about 9.1^{0}C above the mean normal daily temperature within a radius of 210m but a temperature gradient of 0.050c/m, hence the thermal equilibrium of Umusadege-Ogbe, Kwale has been altered. This rise in temperature has negative effects on man and his environment especially on the socio-economic lives and activities of the inhabitants of the area. It is therefore important that government agencies charged with the duty of monitoring the environment should embark on adequate measures to stop the environmental degradation before enormous and or permanent damage is caused. From the study carried out in the area, it will be important and advisable that residential buildings should be situated at least 210m away from the flare stack. The information obtained will be useful to both the government and individuals. Furthermore, the companies involved in gas flaring should be concerned and aware of the dangers they may be causing the inhabitants and the general populace and hence provide adequate compensation

Keywords: Temperature, distance, gas flare, environment, Umusadege-Ogbe, thermometer, elevation, tape.

INTRODUCTION

The Midwestern oil and gas Plc/Mart Umusadege resources Limited are marginal oil field engaged in the upstream sector of the oil and gas industries in Umusadege marginal oil field. A flare is a device for disposing of waste gas and oil burning the organic materials in an open and uncontrolled manner at an elevation (James 2002). Gas flaring therefore is the combustion of the unutilized excess gas during oil exploration which leads to emissions of carbon (iv) oxide, Nitrogen (ii) oxide, hydrogen sulphide, carbon (ii) oxide, Nitrogen (iv) oxide, soot, smoke, light and being an exothermic reaction also produces heat.

The history of natural gas production in Nigeria dates back to 1956 when Sheel D'Arcy and the British Petroleum discovered the first oil reserviour in Oloibiri presently in Bayelsa state of the Niger Delta Basin (Ugbana, 2004). The Government Agency responsible for the production and disposal of oil and gas in Nigeria is the Nigerian National Petroleum Corporation (NNPC) and it entered into joint venture with other oil companies.

However, NNPC is a conglomeration of many companies known as subsidiary. These include the Nigerian Gas Company (NGC) and the Nigerian Liquefied Natural Gas (NLNG) company charged with the responsibilities of managing natural gas and preparing gas for export respectively. These two subsidiaries worked together with the Nigerian Petroleum Development Company (NPDC) and the National Petroleum Investment Management Service (NAPIMS) to fully develop the gas industry.

Due to the combustion of unutilized gas during exploration and exploitation, some constituent gases are emitted into the atmosphere during gas flaring as a result of the incomplete combustion of fossil fuel compounds which are harmful to the socio – physical environment of the Niger – Delta oil bearing communities in general and flare sites in particular (Stanley C.A, 2006).

The presence of substantial amount of sulphur (iv) oxide in the atmosphere is one of the major causes of acid rain. This colourless and poisonous gas with an irritating smell like that of burning matches is very soluble in water thereby producing trioxosulphate (iv) aids, H_2SO_3 (Ababio, 2004).

Nitrogen (iv) oxide is also very soluble in water forming dioxonitrate (iii) acid and trioxonitrate (v) acid (previously called aqua fortic, meaning strong water, due to its corrosive action on metal). (William and Barbara 2001).

Carbon (ii) oxide is produced from gas flaring due to the incomplete combustion process of carbon compounds such as octane C_8H_{18}, found in petrol. It occurs in traces as impurity in the atmosphere, but is odourless, colourless, poisonous gas as little as 0.5 of it in air may cause a person to die (Ababio 2005). This is because when mixed with heamoglobin to the essential parts of the body, the affinity of the heamoglobin for carbon (ii) oxide is 200 times of oxygen thereby causing carboxy – heamoglobin (Hemminki and Neimi, 1982).

While Carbon (iv) oxide gas, when released during gas flaring into the atmosphere combines with rain water to form this trioxocarbonate (iv) acid which results to acid rain. This acid rain causes damage to the terrestrial ecosystems by increasing soil acidity, decreasing nutrient availability, reduce the productivity of fresh water, accelerates corrosion of metals and roofing sheets amongst other (William and Barbara 2001).

Lastly is the black particulate matter (Soot) which is formed during incomplete combustion of fuel during gas flaring, and is accompanied by smog. The emitted particles ranged in sizes from fairly large visible particles to sub micro particles. Smog and soot have dark and tiny physical characteristics. Their dark characteristics make them good absorbers of sunlight. In absorbing sunlight, layers of air and heat are radiated. This increased the temperature around the flaring zone and creates a congenial environment for atmospheric chemical process to take place (Hemminki and Neimi, 1982; McDonald et al, 1996).

Agoawike (1995), in an article 'our dying environment' summarized that in oil producing areas from Warri in Delta State to Ogoni in Rivers State and Oguta in Imo State, the story is the same; farmlands are rendered useless, rivers depleted of aquatic lives and polluted by gas emission.

James (2002) highlighted the impact of oil exploration and exploitation to include gas flaring in the world. In environmental day conference in Port-Harcourt, he described the oil communities as being sapped by oil spillage, gas flaring and other pollution, which have become long-term destabilize of ecosystem and lifestyle. He further stated that oil communities have been transformed into victims of unfavorable disenchantment, negative resources flow and endemic poverty syndrome. According to him, quality of life, land and sea are wholly and continuously polluted.

Ahijakwo (1995) stated that oil industry in Nigeria is the foundation of under-development in Ogba land where cases of atmospheric, thermal and surface pollution abound.

Salau (1992) reported that there was pollution in some surrounding creeks in Bonny Local Government Area of river State and this has affected fishing which is the primary occupation of the people. The consequence is that most men have migrated to nearby towns and cities to work and so women have taken leadership in community's matters.

Expert's reports of oil exploration in Iko Community in Ikot Abasi Local Government Area of Akwa Ibom State reveals that gas flaring has caused most building in the community especially those with corrugated iron sheet roof to experience massive damage resulting in frequent changes and leakages. Apart from the burning and "dieback" effect of gas flare that is visible in plantain and coco-yam leaves, the dry humid morning in Ikot environment harbor photochemical smog in the lower atmosphere and this causes irritation of the eye and the body (Environmental Research Management, 1997).

In 1995, SPDC close the flare at utapete, shortly after the local environmental agencies issued a report on its effects. In other cases, inefficient technology in the flares means that many of them burn without sufficient oxygen or with small amounts of oil mixed with the gas, creating soot that is deposited on nearby land and vegetation visibly damaging the vegetation near to the flare. Respiratory problems among children are reported, but apparently not researched (Environmental Research Management, 1997).

Scope and objectives of the study

This study is limited to Umusadege Marginal oil field in Umusadege-Ogbe, Kwale located in Ndokwa – West Local Government Area of Delta State, Nigeria. The plant manages the production of oil from numerous wells in within the field. Oil produced at the plant is sent through booster station via Kwale/Okpai gas plant to Brass terminal for export and some of the associated gases are re-injected into the formation to enhance oil recovery, while a greater quantity of the gas is flared to the atmosphere owing to lack of gas utilization infrastructure (Adewoye, 1998; Ugbana, 2004).

The main objectives of the study are to determine the minimum distance away from the flare point residential buildings should be sited and to estimate the thermal gradient resulting from the gas flared at Umusadege Marginal oil field in Umusade-Ogbe, kwale.. The base map of the study area showing the flare stack and communities close to the field is shown in figure 1 below.

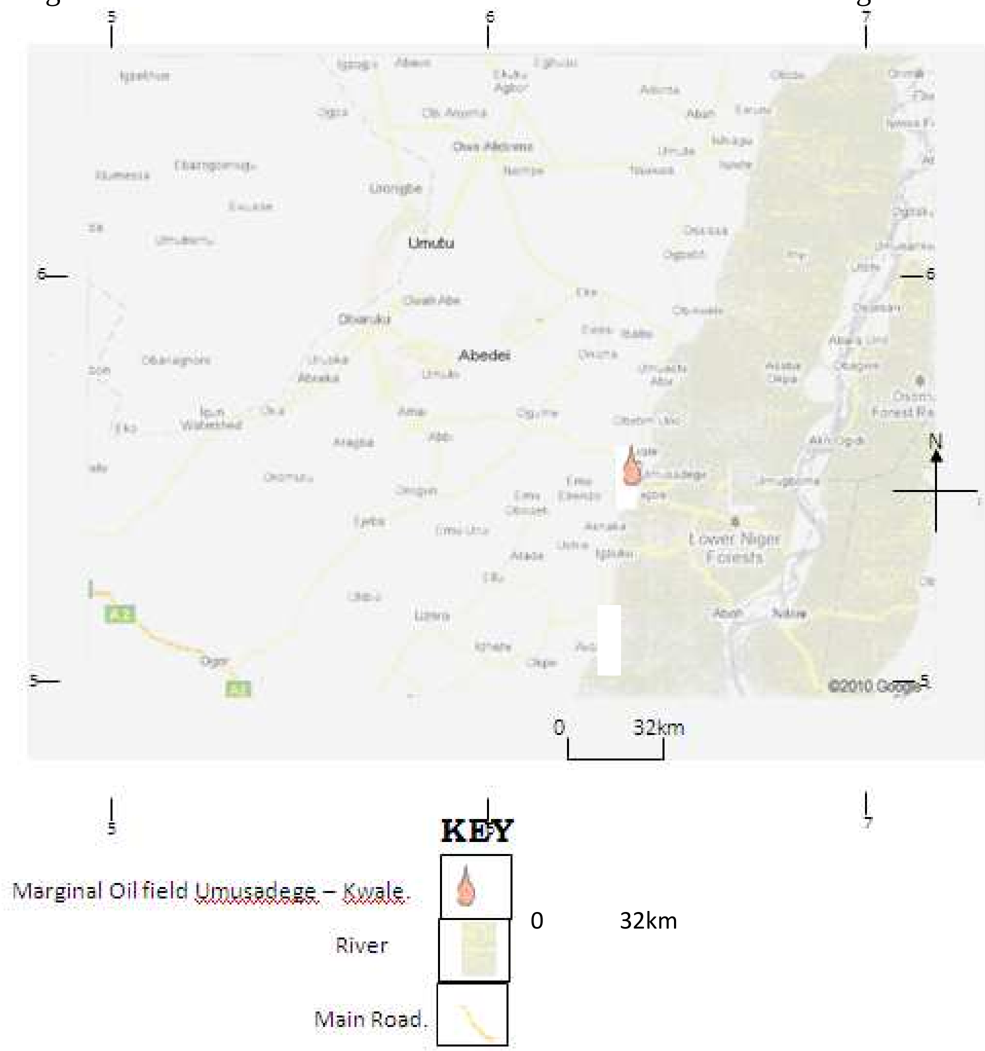

FIGURE 1: The Geographical Location of Umusadege-Kwale in Ndokwa West Local Government Area of Delta State located between latitude 6^0 and 7^0 north of the equator and longitude 5^0 and 6^030^1 east of the Greenwich meridian.

Field Procedure

In this research, the instruments used are the fibrous measuring tape, the thermometer and the global positioning system (GPS) while the standard procedure for land data acquisition was employed. Readings were taken twice when walking away from the flare point and another two sets of readings were taken when walking towards the flare point and the mean value obtained were recorded (Ebeniro and Avwiri, 1996).The measurements were carried out at a constant height of 1.70m from the ground level and between 9.00 and 11.00h GMT to minimize the effects of weather conditions. Length measurements (distance) were carried out using fibrous tape. The use of a metal tape was excluded in this research because of errors which may arise from the expansion and contraction of the metal.The fibrous tape is graduated in meters, it is 50 meters long with sub-divisions in centimeters and is housed in a circular casing with a roller for coiling back the tape. With the aid of the global positioning system, the latitudes and longitudes of the measured points were recorded accordingly. Temperature readings were recorded with varying distances away from the flare points along the 4 cardinal points with the aid of a thermometer.However, due to the presence of security operatives around the flare point, I was not permitted to go too close to the flare point. Measurements therefore began at a distance of 20 m away from the flare stack and then at every other 10 m to a distance of 310 m away from the flare point.

RESULTS AND DISCUSSION

The graphs of the temperature variation in T^0c against the distance, the characteristics curve for the temperature gradient with latitude and longitude, and the contour lines of temperature on the latitudes and longitudes due North, East, South and West directions within a distance of 310 m away from the gas flare stack were plotted as shown in figures 2, 3 and 4 below. The curves revealed a decrease in temperature with increasing distance away from the flare point while that of latitude and longitude shows a decrease in latitude with increasing longitude away from the flare point. This temperature decrease with increasing distance obeys the known theory of temperature distribution associated with heat transfer over a temperature gradient (Oseji 2007, Oseji 2010). From the graphs, surface temperature along the four cardinal directions began to normalize at 36.1^0c within a distance of 80m and finally normalized at 39.1^0c within a distance of 210 m away from the flare point. While that of latitudes and longitudes Normalized at latitude 5.8 within a longitude of 6.36 and finally normalized at latitude 5.8 within a longitude of 6.75. The mean daily temperature of the study area is 26.8^0c (DPR, 1996; J.O Oseji 2007).

Thermal air pollution occurs if the recorded air temperature of a place at a given time is higher than its normal ambient temperature (Oseji, 2010; DPR, 1996). The mean temperature of our planet is fixed by a steady balance between the energy received from the sun and the quality of heat energy radiated back by the earth (Ademoroti, 1996). Disturbance in either incoming or outgoing energy would upset this balance and the average mean energy temperature of the earth's surface would drifts off to a different steady value. The radiation energy that sends heat back into space cannot travel freely through the air. The by-products of gas flaring such as water vapour, CO_2 absorb some of the radiation. In this way, they act as blanket around the earth, hindering the escape of heat from the atmosphere. As more CO_2 is produced due to gas flaring the CO_2 causes hindrance to the escape of energy radiated from the earth surface and so the earth warms up the more leading to an increase temperature. This increase in temperature has an undesirable effect on man and his environment (Avwiri and Ebeniro 1995),

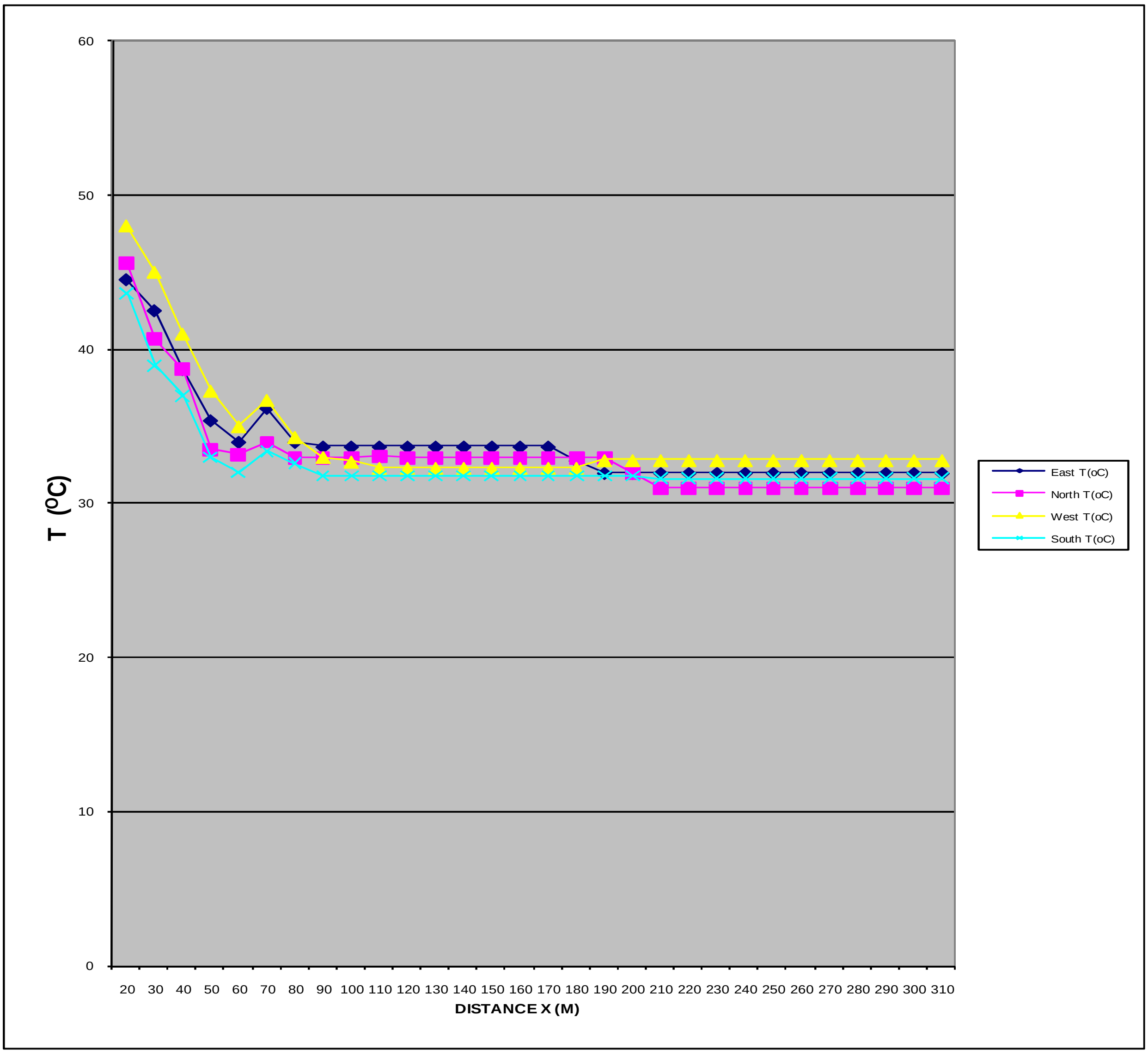

Fig. 2: The characteristic curves for the variation of temperature (T^0C) with Distance X(m) for North, South, East and West directions of the flare stack at marginal oil field Umusadege – Kwale. Normalize at about 80m and 210m away from the flare point.

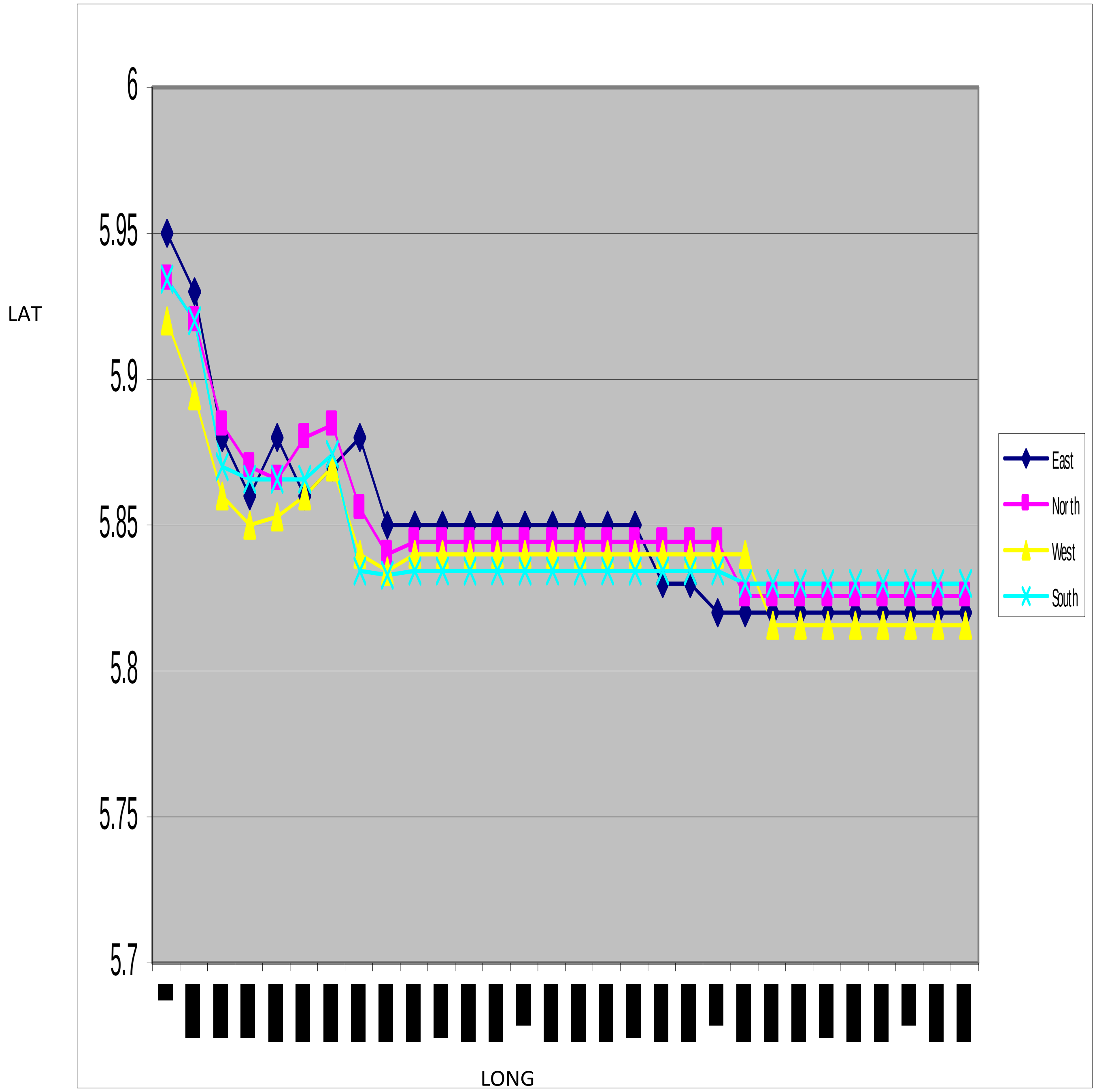

Fig. 3: The Characteristic curves for the temperature gradient (temperature variation) with latitude and longitude for the gas flared due North South, East, and West directions of the flare stack at marginal oil field Umusadege – Kwale. Normalized at 6.36 and 6.75 away from the flare point

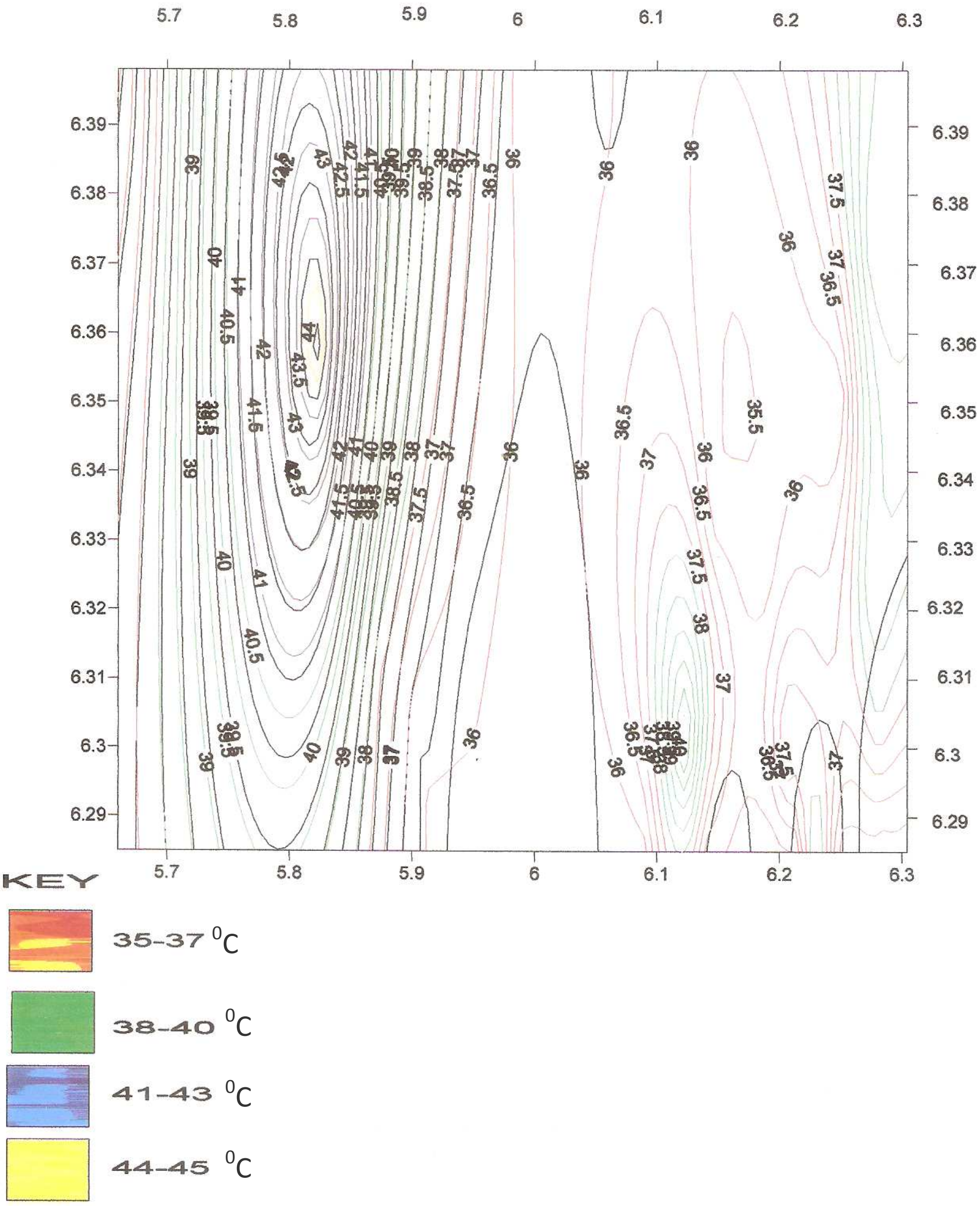

Figure 4: The contour lines of temperature on the latitudes and longitudes due North, South, East and West directions of the flare point.

From the graphs, the surface temperature along the four cardinal directions normalized at 35.9^0 C within a radius of about 210m away from the flare point. According to Avwiri and Ebeniro (1995), the surface temperature elevation is obtained by subtracting the normal daily temperature of the study area from the average temperature of normalization,

$\Rightarrow \quad 35.9^0C - 26.8^oC \quad = 9.1^0 C,$

While the temperature gradient is obtained by subtracting the average temperature of normalization point from the highest temperature per unit of the difference between the highest and the lowest distance covered Hence

$$\text{Temperature gradient} = \frac{45 - 36.1}{310 - 2} = \frac{8.9}{190}$$

$$= 0.0468 \qquad = 0.05^0 \text{ c/m}$$

The study revealed that the surface temperature has increased by 9.3^0c with a temperature gradient of 0.05^0c/m when compared with the mean normal daily temperature. Hence the thermal equilibrium has been altered. This increase in temperature has enormous effects on the socio-economic lives and activities of the inhabitant.

The physical observations of the study area revealed stunted growth of crops and the deaths of cassava, plantain, palm trees, yam and other crops that were grown within the flare area. This could be due to the gas flaring activities within the area which raised the temperature above normal leading to light pollution. Umusadege and nearby towns such as Kwale have familiar sights of corrosive roofs as a result of the acidity of the rainfall in the area. Also observed were the migration of inhabitants who are mainly farmers from Azunze in Umusadege to neighboring towns such as Obetim- uno, Ogume to carry out the farming activities.

CONCLUSION

The Nigeria Oil Industries did not only affect the country positively by fashioning a remarkable economic landscape and contributing to foreign exchange earnings, but has left enormous negative impacts on the socio-economic life and environment of the host communities and or its inhabitants. The temperature of the environment is bearable at a distance of about 210m away from the flare point, as such residential areas should therefore be located within the range of 210m away from the flare stack.

Recommendations

In view of the results obtained from the study, it is paramount that good recommendations that will not only improve the health and life span of organisms in the area be made but that which will lead environment and economic growth positively. Looking at economic aspect of utilizing gas, the economy of the country can grow or improve. A lot of benefits can be obtained.

Environmental law enforcement agencies, especially DPR (Department of Petroleum Resources), should be more involved in enforcing all existing environmental laws on gas flaring.

With reference to marginal oil field Umusadege Kwale, residential areas should be situated at 210m away from the flare point for security reason.

The application of the existing technologies in oil production will go a long way in minimizing the potential for unconfined flaring of gas in numerous oil fields in Nigeria. Such technologies should be imported by the government to assist the multinational oil companies.

Gas rather than being flared should be utilized for power generation. The government should build gas turbines that will utilize the gas to curb the epileptic power supply by NEPA in Nigeria. This will help boost the economic and social life of the country.

Water and chemical analysis should be carried out within and outside the area to ascertain the portability of water and determine the extent of corrosion (effects of acid rain).

Infrastructure for gas harnessing and utilization should be provided by the government and the public enterprise. Most companies that are involved in gas flaring complain of facilities which are too expensive. They should be supported by the government financially so that gas flaring will be a thing of the past.

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