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Emission Spectrum of Crude Oil flames at Dikom

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ABSTRACT

On September 15, 2005 a huge flame of fire occurred at Dikom (94.6E, 27.3N) as a result of sudden and accidental out burst of oil-well of Oil India Limited. The incident is first of its kind during last five decades. The height of the flame about 100m and it covered an approximate area of 900m^2 and the temperature measured at a distance of 100 meter from the flame was 45^{o}C. Experts from abroad had to be brought to quench the fire and during the time of writing this communication the flame is still in the process of burning and has created sufficient environmental problem. In the present work we report the results of spectroscopic investigation carried out with the help of a miniaturized fiber optic spectrometer (Ocean Optics Inc USA) coupled with a Laptop (Model Travel Mate 2355NXC, Acer). The emission spectrum exhibits a symmetric distribution of intensity profile in the range of wavelength of 4500Å to 9000Å. The prominent lines recorded in the spectrum are at 5893Å, which is presumably originating from sodium atom. The other lines are observed at 7855Å, 7714Å, 7607Å, 7446Å, 7357Å, 7253Å, 7080Å, 7000Å, 6821Å, 6749Å, 6643Å, 6428Å and 5893Å. The higher wavelengths represent the band heads of a diatomic radical. Visual observations with the help of a pocket spectroscope also indicate the presents of atomic lines and ionized lines. The present study analysis the spectroscopic information on a crude oil flame via the use of the persistent lines in the emission spectrum.

INTRODUCTION

Flames are well known sources of many band systems of diatomic and polyatomic origin. Some band systems are observed by the direct combustion of inflammable substances; others by the introduction of additional substances into a flame already established. Without exception flame bands have been found to belong to molecules which are electrically neutral, but very frequently the molecules are not stable in the chemical sense, thus combinations such as CH, NH and OH are of very common occurrence [1, 2]. The 4300Å and 3900Å bands of CH, the 3064 band of OH and the Swan bands of C_2 appear readily enough in the flames of hydrocarbons. Different systems occur most strongly in different parts of the flame; the OH bands are spread through the blue outer cone of a Bunsen flame using coal gas, but the Swan bands are restricted to the greenish inner cone of the roaring flame which in fact owes its colour mainly to the presence of these bands. The red and violet systems of CN are given by a flame of moist cyanogen. The

3360Å band of NH is also obtained strongly from the oxy-ammonia flame, but the systems arising from more excited levels, which are known from other sources, do not appear as well. To obtain other systems by the introduction of additional substances it is necessary that these should be brought to the gaseous state within the flame. Gases and vapours may be mixed directly with the gas being burnt. The bands of C_2 are readily observed during the combustion of hydrocarbons, even being observed in a candle flame. The present work describes the nature of spectrum in the red region originating from a huge crude oil blaze, which is believed to be a rare event that did not occur within few decades.

Origin of the blaze

On September 15, 2005 a huge flame of fire occurred at Dikom, Assam (94.6E, 27.3N) as a result of sudden and accidental out burst of oil well of Oil India Limited. The incident is first of this kind during last five decades. The height of the flame was about 100 metre and it covered an approximate area of 900 m^2 and temperature measured at a distance of 100 metre from the flame was 45^oC. Experts from abroad had to be brought to quench the fire and during the time of writing this communication the flame is still in the process of burning and has created lot of environmental problem. The spectra of the flame has been recorded with the help of a miniaturized fiber optic spectrometer (Ocean Optics, USA) coupled with a Laptop (Model Travel Mate 2355 NXC, Acer). It may be noted that the temperature of the flame is estimated to be about 3000^oC.

RESULTS AND DISCUSSION

Fig. 1 shows the photograph of the flame recorded with the help of a video camera, and Fig. 2 shows the spectrum recorded on the spectrophotometer. The measurements made from this spectrum indicates a large number of bands, the prominent is the atomic line at 5893Å which is presumably due to sodium. The presence of a very strong lines of sodium needs a proper explanation. It is however not unusual that sodium should be present in the flame. The crude oil which emerges from a region which is deep inside from a surface is know to be a source of many elements some of which are also toxic. Additional peaks are observed at 6428 Å, 6643 Å, 6749 Å, 6821 Å, 7000 Å, 7080 Å, 7253 Å, 7446 Å, 7607 Å, 7714 Å and 7855 Å. By a comparison with the standard bands we observe that the red systems are presumably belongs to CN bands. Many bands measured in the present work coincides with the bands of CN. The transition as –

$$A^2\Pi \rightarrow X^2\Sigma$$

These CN bands are degraded to red. These bands usually occur in carbon arc in air, in the flame of burning cyanogen, in discharge tubes containing nitrogen and carbon compounds and especially strongly when vapours such as C_2H_2 and $HCCl_3$ are introduced into active nitrogen. [3 – 5]

In addition of the CN bands it is possible that Swan systems of band [6] due to C_2 including high-pressure bands [7] are also present. It may be noted here that spectra of flames belonging to natural gas do not exhibit the features as observed in the crude oil fire. From what has been described above it is reasonable to believe that the presence of CN band emission itself indicates that the crude oil blaze is harmful to environment.

Fig. 1: Photograph of the flame recorded with the help of a video camera

It is worth while to note that the prominent line of Na (sodium) at 5893 Å appears with very high intensity. This feature seems to be of considerable importance. It is reasonable to believe that the presence of a very strong Na (sodium) line in the flame indicates some geophysical characteristics of the region far below the surface.Assuming that the increase in temparature takes place exponentially as we approach the flame from a distance of 50 meter we observe that the temparature of the flame is about 3000^0C. Fig.3 shows the nature of graph in the log linear scale where the solide line represents the actual measurement of temparature at various distance.

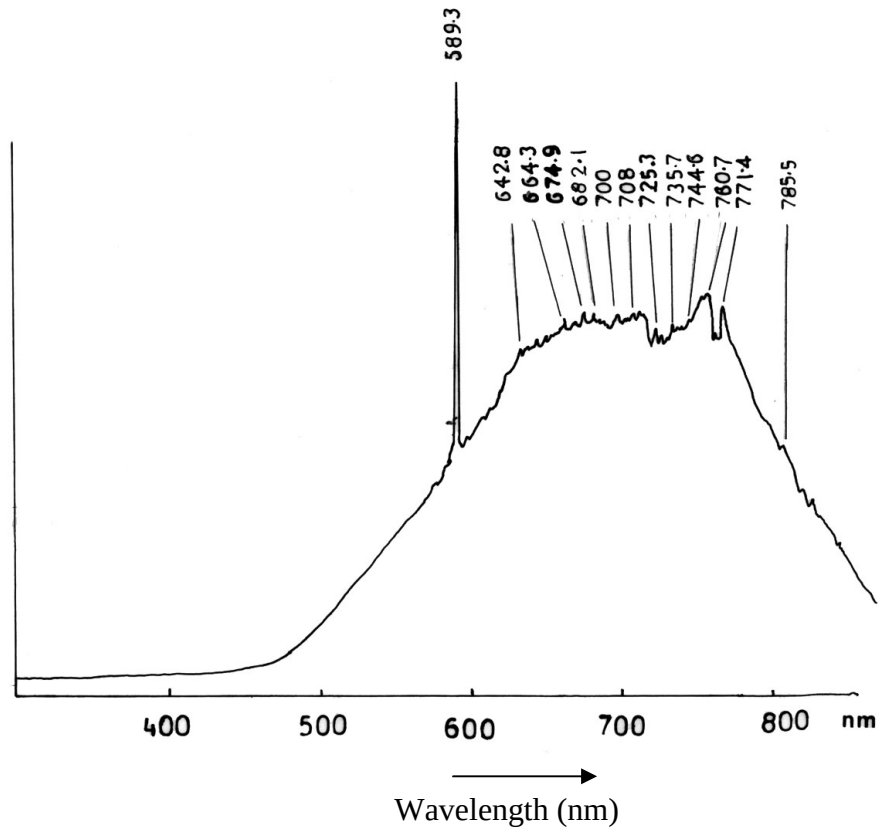

Fig.: 2 The spectrum recorded on the spectrophotometer

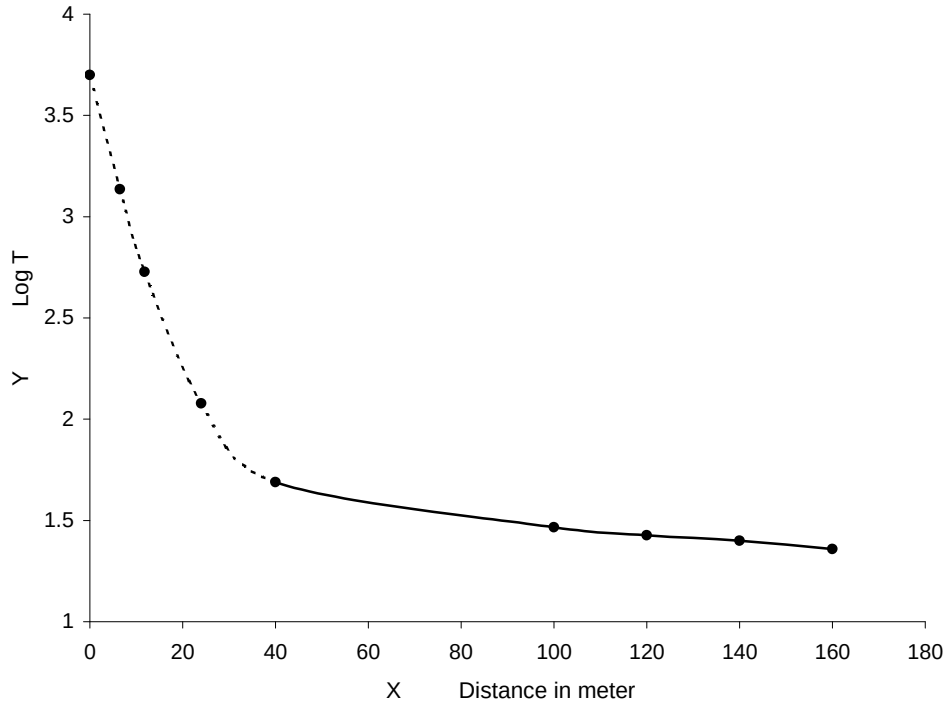

Fig 3 Temperature vs distance curve in Dikom fire

CONCLUSION

The crude oil blaze at Dikom contains harmful ingredients which are not environment friendly.

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