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EFFECT OF TEMPERATURE ON CHEMILUMINESCENCE OF LUMINOL IN AQUEOUS ALIPHATIC AMINES

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ABSTRACT

Effect of temperature on the chemiluminescence (CL) of Luminol in some aqueous aliphatic amines such as ethyl amine (EA), diethyl amine (DEA), and triethyl amine (TEA), have been studied and reported. On the basis of experimental results, it is found that the chemiluminescence intensity initially increased with temperature, attains an optimum value of particular temperature and then decrease on further increase in temperature. It is also found that maximum CL intensity (I max) of chemiluminescence of Luminol founds in diethyl amine.

KEYWORDS: Chemiluminescence, Temperature, Intensity, Luminol, Amines.

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INTRODUCTION

An enormous interest in the studies on the effect of temperature on luminescence properties have been emerged in past few years as it provides important information concerning the nature of luminescent material. Several reviews have been published relating to applications of chemiluminescence in analysis[1-3]. It is also proved to be useful for analytical applications and increasing investigations resulted in highly sensitive and selective detection methods[4-7].In case of many substances which are not luminescent at room temperature shows luminescence at higher temperature[8]. Ettinger et. al[9] have observed pronounced effect on light yield with change in solvent temperature. Recently Kher et. al[10] reported the effect of temperature on the chemiluminescence of alcohols and aldehydes. Obviously the dependence of luminescence intensity on temperature is extremely interesting from experimental and theoretical point of view as it helps in understanding the basic mechanism of Chemiluminescence (CL) excitation in chemical components. The CL of Luminol has been studied either in aqueous alkaline solution of sodium hydroxide[11] or carbonates[12]. Very little work on chemiluminescence of Luminol in aqueous aliphatic amines at different temperatures have been reported. The pH dependence of luminol[11] showed maximum CL intensity at pH 12. It is observed that aqueous solution of aliphatic amines has pH of 10 to 12. The present paper reports the studies on the effect of temperature on the chemiluminescence of Luminol-H_2O_2 in some aliphatic aqueous amines such as ethyl amine(EA), diethyl amine(DEA) and triethyl amine(TEA) in presence of potassium ferricyanide and the result have been discussed on the basis of present theories.

MATERIALS AND METHODS

MATERIALS

All the chemicals used in the present investigation were taken in solution and prepared by using AR grade material adopting standard method. Solutions of all chemical compound was prepared in double distill water. Commercially available Luminol was used without further purification. The alkaline solution of Luminol was prepared by adding aqueous solution of amines such as ethyl amine(EA), diethyl amine(DEA) and triethyl amine(TEA). It is observed that aqueous solution of aliphatic amines has pH of 10 to 12. All solutions used were freshly prepared. Luminol in aqueous alkaline medium showed a self glow. Therefore, it is necessary to prepare these solutions whenever required. Solutions of known concentrations of different amines are prepared in double distill water. An exact concentration of Luminol is prepared by dissolving a known weight of the substance in one litre of aqueous amine solution. Binary mixtures of oxidants as hydrogen peroxide and potassium ferricyanide is used to study their effects on CL of Luminol at different temperatures.

METHODS

All the experiments were performed on a chemiluminometer setup which essentially consists of chemiluminescent cell, high voltage supply and light detector with a recorder. The chemiluminescence cell is a double walled cubical box and inner part of the cell is cylindrical. A heater coil is wounded round the cylinder, which may be connected to a variac. Two circular holes were made in the top surface of the box. One for placing syringe to inject H_2O_2 solution in the cuvate and other for placing thermocouple in the CL cell. The cuvate is fitted inside the top surface of the light tight box and it rests just below the circular hole in which the syringe is placed. The cuvate was highly transparent glass tube of 1.0 cm diameter and 5 cm length. The box was covered with black cloths and syringe was placed on the hole. The light emitted during the reaction was detected by photomultiplier tube. All the measurement was carried out in dark.As mentioned earlier the CL cell has the heating arrangement in it. The heater was connected to the varica. The

temperature of the cell was varied by changing voltage by the variac. The temperature of the CL cell was measured by inserting a thermocouple in the cell through the hole made at the top surface of the light tight box. To avoid the heating of the photomultiplier tube, a thick rubber sheet with a hole at its center was placed between the CL cell and PMT housing. In order to measure the CL intensity at different temperature the cuvate containing the solution was placed in the CL cell and the cell was heated by applying suitable voltage to the heater by variac. In the present investigation the temperature of the sample solution was varied from 30^0C to 80^0C.

RESULTS AND DISCUSSION

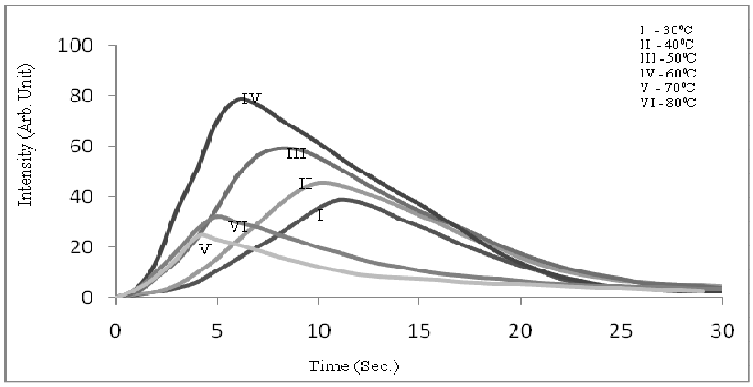
The optimum CL intensity at different temperatures of CL of Luminol in ethyl amine(EA), diethyl amine(DEA) and triethyl amine(TEA) have been summarized in Table 1.

Table 1
Optimum CL intensity of Luminol in Ethyl Amine(EA), Diethyl Amine(DEA) and Triethyl Amine(TEA).

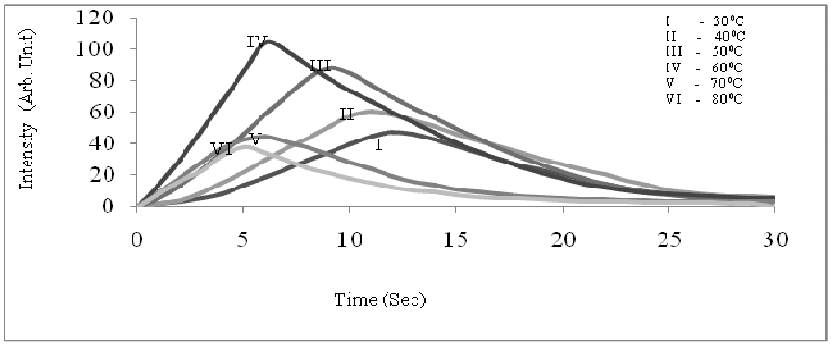
Sr. No	Temperature (^{0}C)	Optimum CL intensity I max (Arb. Unit) at different temperatures in		
		Ethyl Amine (EA)	Diethyl Amine (DEA)	Triethyl Amine (TEA)
1	30	38.9	48.2	40.1
2	40	45.4	60.4	47.5
3	50	59.2	88.2	64.3
4	60	78.5	104.4	90.2
5	70	32.4	44.6	36.5
6	80	24.5	38.1	34.1

The time dependence of CL intensities of chemiluminescence of Luminol with H_2O_2 at different temperatures in ethyl amine, diethyl amine and triethyl amine in presence of potassium ferricyanide are as shown in Graph 1, 2 and 3. It was observed that there is only one peak in the CL intensity versus time curve and the shape of the glow curve is almost same at all the temperatures. It is further observed that CL intensity initially increases with increase in time, attains an optimum value and then with further increase in time it decreases. We found that the peak CL intensity of chemiluminescence of Luminol in EA, DEA and TEA attains an optimum value at 60^0C, then decreases with further increase in temperature and finally disappears. It is also observed that the time corresponding to attain the optimum CL peak decreases with increase in temperature.

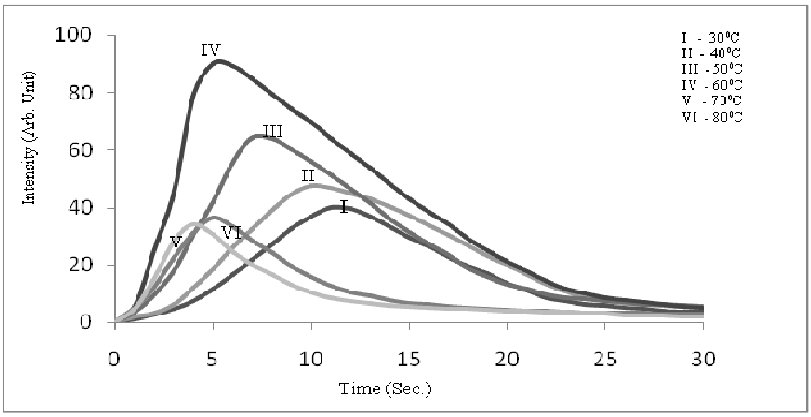
Graph 1
Time dependence of CL intensity of Luminol at different temperatures in Ethyl amine (EA)



Graph 2
Time dependence of CL intensity of Luminol at different temperatures in Diethyl Amine (DEA)



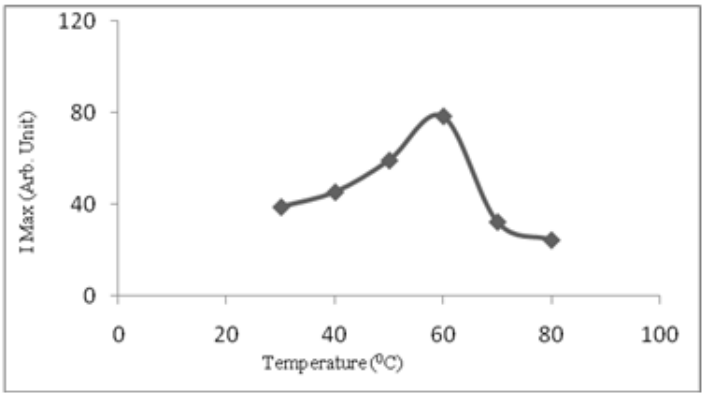
Graph 3
Time dependence of CL intensity of Luminol at different temperatures in Triethyl Amine(TEA)



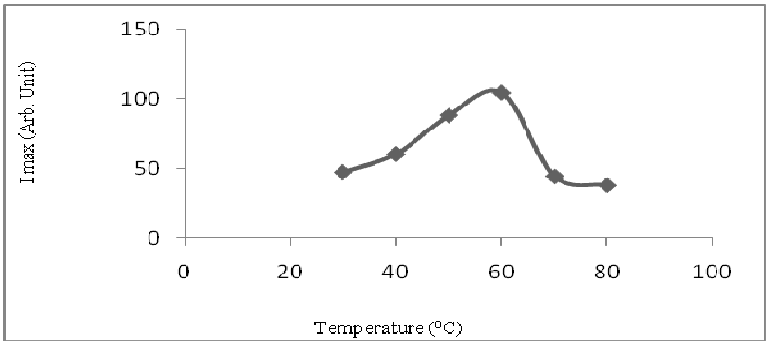
Graph. 4, 5 and 6. Shows the effect of temperature on CL intensity of chemiluminescence of Luminol with H_2O_2 in ethyl amine (EA), diethyl amine (DEA) and triethyl amine (TEA) in presence of potassium

ferricyanide. It is clear from the figures that CL intensities of Luminol initially increases with increase in temperature, attains a maximum value, then it decreases with further increase in temperature.

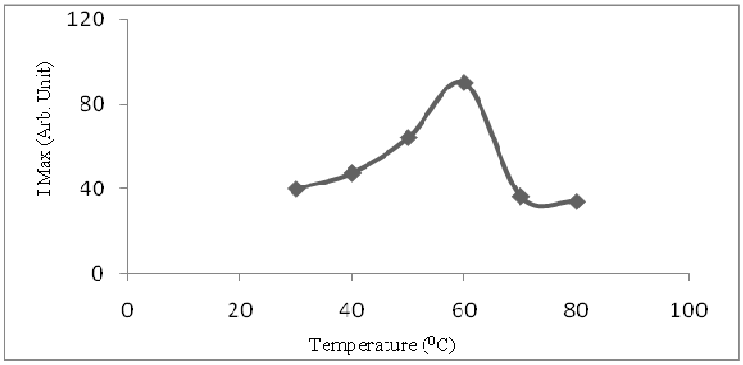
Graph 4
Effect of temperature on peak CL intensity for Luminol in Ethyl amine (EA)



Graph 5
Effect of temperature on peak CL intensity for Luminol in Diethyl amine (DEA)

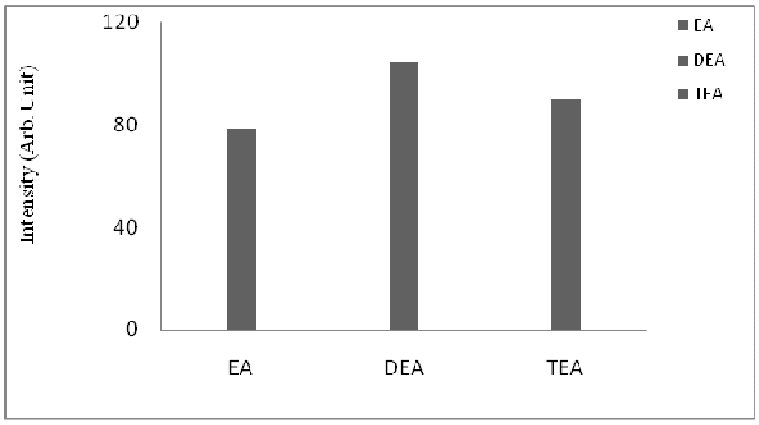


Graph 6
Effect of temperature on peak CL intensity for Luminol in Triethyl amine (TEA)



The CL intensity of CL of Luminol in ethyl amine shows highest optimum CL intensity at 60^0C than methyl amine and triethyl amine as shown in Graph.7.

Graph 7
Optimum CL intensities at 60^0C in Ethyl amine (EA), Diethyl amine (DEA) and Triethyl amine (TEA)



CONCLUSION

In the present investigation we have found that the CL intensity initially increases with increase in temperature attains an optimum value then decreases with further increase in temperature. Rate of reaction increases with increase in temperature and probability of radiative process may decrease with further increase in temperature. Thus we expect that the CL intensity should be optimum at a particular temperature. From this study on effect of temperature on the chemiluminescence of Luminol in aliphatic amines shows CL and CL intensity initially increases with increase in temperature attains an optimum value then decreases with further increase in temperature. It is also conclude that the CL intensity of CL of Luminol in ethyl amine shows highest optimum CL intensity at 60^0C than methyl amine and triethyl amine

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