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Effect of temperature on chemiluminescence of luminol ethyl amine in water and DMSO

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ABSTRACT

Effect of temperature on the chemiluminescence (CL) of Luminol ethyl amine in water and DMSO have been studied and reported. On the basis of experimental results, it is found that the chemiluminescence intensity initially increased with increase of temperature, attains an optimum value of particular temperature and then decreased on further increasing temperature. It is also found that maximum CL of Luminol diethyl amine found for DMSO.

Key words: Chemiluminescence, Luminol, Ethyl amine, Water, DMSO

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. The luminescing properties of various organic compounds were reported by Max Trautz [1]. In 1928 Albrecht[2] described the intense CL of Luminol (5-amino-2, 3-dihydrophthalhydrazine-1, 4-dione) in aqueous alkaline solution. Several reviews have been published relating to applications of chemiluminescence in analysis[3-5]. Luminol the most studied chemiluminescent (CL) compound in aqueous medium, presents an emission, the yield and color of which are dependent on solvent nature[6-8]. In case of many substances which are not luminescent at room temperature shows luminescence at higher temperature[9]. Ettinger et. al have observed pronounced effect on light yield with change in solvent temperature[10].

Recently Kher et. al reported the effect of temperature on the chemiluminescence of alcohols and aldehydes[11]. 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[12] or carbonates[13]. The pH dependence of luminol[12] showed maximum CL intensity at pH 12. The Chemiluminescence (CL) of Luminol diethyl amine in aprotic solvents has not been studied extensively. The CL emission band of luminol[14,15] shifts to longer wavelength region in solvent such as DMSO and DMF. In DMSO, the kinetics has been studied for the CL reactions of dioxetanes[16], of 2,2'-dialkyl-1,1'-biisoquinolydene and of 9,10-dicyanoanthracene.

The present paper deals with the effect of temperature on Chemiluminescence of Luminol-diethyl amine in water and DMSO (Dimethyl Sulphoxide) in presence of H₂O₂-potassium ferricyanide and the results 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 diethyl amines and solution of diethyl amine in DMSO. 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 wound 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 cuvette and other for placing thermocouple in the CL cell. The cuvette 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 cuvette 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 variac. 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 cuvette 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 $30^{\circ}C$ to $70^{\circ}C$.

RESULTS AND DISCUSSION

The optimum CL intensity at different temperatures of CL of Luminol ethyl amine(EA) in water and DMSO have been summarized in Table 1.

Fig. 1: Time dependence of CL intensity of Luminol Diethyl Amine (DEA) at different temperatures in Water

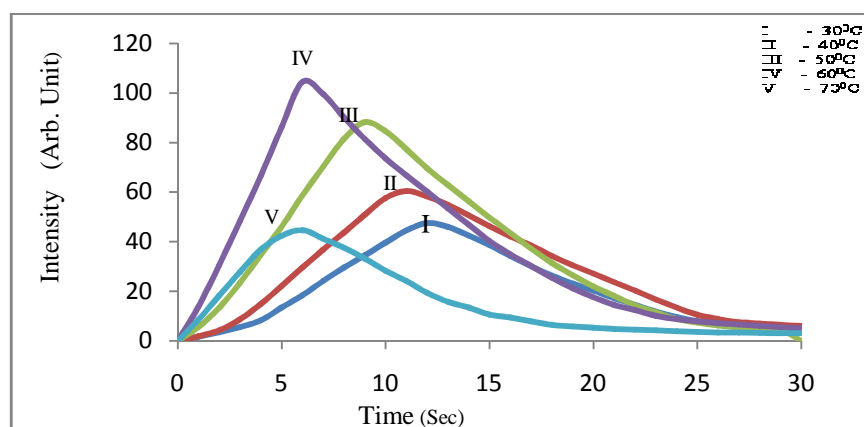


Table 1: Optimum CL intensity of Luminol Diethyl amine in water and DMSO at different temperatures

Sr. No	Temperature (°C)	Optimum CL intensity I _{max} (Arb. Unit) at different temperatures in	
		Water	DMSO
1	30	48.2	69.6
2	40	60.4	84.1
3	50	88.2	124.8
4	60	104.4	146.4
5	70	44.6	62.7

The time dependence of CL intensities of chemiluminescence of Luminol diethyl amine in water and in DMSO at different temperatures in presence of H₂O₂-potassium ferricyanide are as shown in Fig. 1,2.

Fig. 2: Time dependence of CL intensity of Luminol Diethyl Amine (DEA) at different temperatures in DMSO

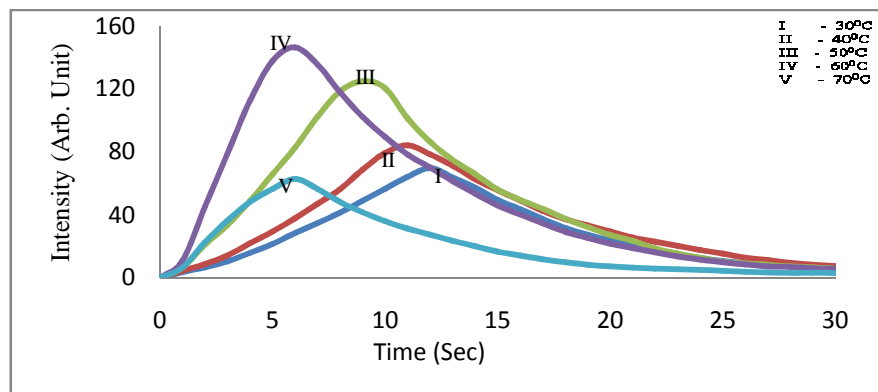


Fig. 3: Effect of temperature on peak CL intensity for Luminol Diethyl amine (DEA) in Water

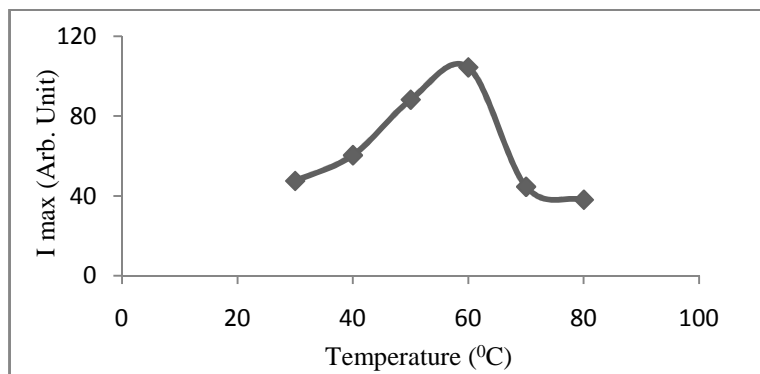
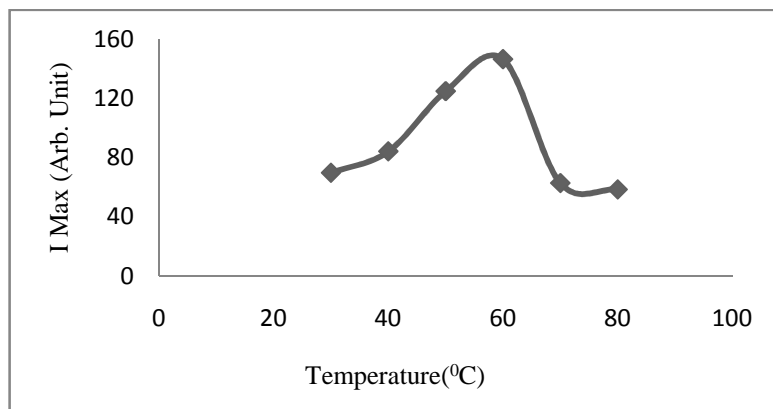


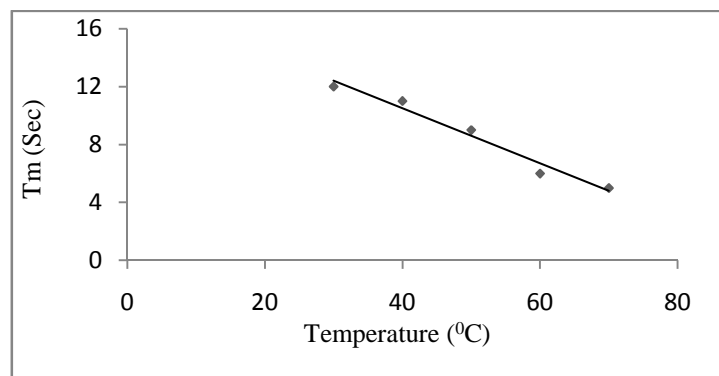
Fig.4: Effect of temperature on peak CL intensity for Luminol Diethyl amine (DEA) in DMSO



It is 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-DEA in water and DMSO attains an optimum value at 60°C, then decreases with further increase in temperature and finally disappears (Fig.3,4). It is also observed that the time corresponding to attain the optimum CL peak decreases with increase in temperature (Fig. 5)

Fig.5: Dependence of Tm for Luminol Diethyl amine in water and DMSO at different temperatures



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 diethyl amine in DMSO (aprotic solvent) shows highest optimum CL intensity at 60°C than Luminol diethyl amine in water (protic solvent).

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