OXIDATION OF LUMINOL CATALYZED BY STABILIZED SOLUTION OF HAEMINE

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The influences of H_2O_2 and of stabilized haemine in their broader concentration ranges on the chemiluminescence of luminol in a system of hydrazide of 3-aminophthalic acid–NaOH–H_2O–H_2O_2-stabilized solution of haemine was studied.

Light is emitted during the reaction of luminol with oxidants. Its itensity can be considerably increased by addition of some metallic ions or complexes. Mechanism of the chemiluminescent reaction of luminol is described in[1-7] from the chemical point of view.

EXPERIMENTAL

Solutions of luminol and catalyst were prepared by the method described by Kubal[8,9]. Apparatus used for the study of chemiluminescence was in the principle identical with the apparatus described in the above mentioned papers. The detection of radiation emitted by reaction was carried out by photomultiplier S12 FS35, which was fed from the high-voltage source Tesla NBZ 411. Photocurrent was recorded by EZ-2 recorder. Kinetic curves were measured as follows: 10 ml of luminol solution was pipetted into the reaction cell together with 10 ml of haemine-Cu catalyst. Volume of the mixture was filled up to 80 ml with three times distilled water. The rest to 100 ml was hydrogen peroxide of different concentrations. The reaction cell was then inserted into the light proof box the temperature of which was 21°C. This value was kept with the precision of ±0·5°C during all measurements. Concentrations of luminol and NaOH in the reaction cell had the constant values in all measurements; they equalled to $4 \cdot 10^{-4}$ mol/l and $5 \cdot 10^{-2}$ mol/l, resp.

RESULTS

Time dependences of light intensity were measured. From these kinetic curves the maximum light intensity can be obtained as well as the area below these curves can be determined. This area is proportional to the total sum of radiation emitted during the reaction J_Σ. The maximum of light intensity occurs at the time $t = 0$, however, this value is poorly reproducible. That is why, instead of this value, the value of relative light intensity J_m is presented in the given dependences. This value was recorded 3 minutes after the start of reaction and had a good reproducibility. Its magnitude was close to the maximum light intensity.

Results of these measurements are given in Figs 1 and 2. Dependences of J_m and J_Σ on H_2O_2 concentrations show a linear course for haemine-Cu catalyst in the range

of concentrations 10^{-8} to 10^{-4} mol/l H_2O_2. In the range of H_2O_2 concentrations between 10^{-4} to 10^{-1} mol/l the increase of J_m and J_Σ diminishes along with the increase of H_2O_2 concentrations. In the concentrations above 10^{-1} mol/l H_2O_2 a rapid decrease of J_m and J_Σ as well as a rapid oxidation of organic components occur. The colour of the reaction mixture is getting brown due to this oxidation. Hence the optimal concentrations of the used catalyst for the given luminol concentration follow from Fig. 2: haemine 50 μg/100 ml, Cu $2{\cdot}4 \cdot 10^{-4}$ mol/l. Optimum concentration of H_2O_2 ranges from 10^{-2} to 10^{-1} mol/l.

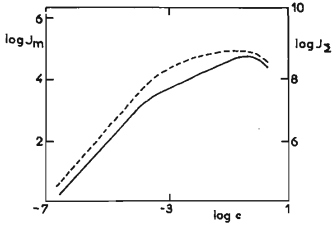

FIG. 1

Dependences of the Maximum Intensity J_m (full line) and the Total Sum of Radiation J_Σ (dotted line) on the H_2O_2 Concentrations c mol/l

Concentrations of the components: luminol $4 \cdot 10^{-4}$ mol/l NaOH $5 \cdot 10^{-2}$ mol/l, haemine 50 μg/100 ml, Cu $2{\cdot}4 \cdot 10^{-4}$ mol/l.

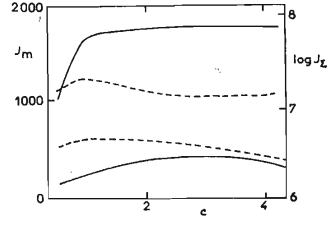

FIG. 2

Dependences of the Maximum Intensity J_m (full line) and the Total Sum of Radiation J_Σ (dotted line) on the Catalyst Concentration

Concentration scale: unit concentration means 50 μg/100 ml of haemine and $2{\cdot}4 \cdot 10^{-4}$ mol/l of Cu. The lower two curves correspond to $2 \cdot 10^{-5}$ mol/l H_2O_2, the upper ones to $1 \cdot 10^{-1}$ mol/l H_2O_2.

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