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EFFECT OF pH OF THE MEDIUM ON DEGRADATION OF AQUEOUS OZONE

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ABSTRACT

In the present investigation, experiments were carried out for studying the degradation of ozone in aqueous medium at different pH. It is observed that the rate of self decay of ozone increases with increase in pH. And the study was extended to determine the kinetics of degradation of ozone in aqueous medium. It is found that the self degradation of ozone in aqueous medium is of second order.

Key words: ozone, pH, self degradation, second order, UV spectroscopy.

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INTRODUCTION

Ozone is being used for wastewater treatment since late 19th century due to its highly reactive nature. It is a very powerful oxidizing species with an oxidation potential of 2.07eV.Ozone can be used for treatment of effluents from various industries relating to pulp and paper production (bleaching and secondary effluents) shale oil processing, production and usage of pesticides, dye manufacture, textile dyeing, production of antioxidants for rubber, pharmaceutical production etc. Basically, aqueous systems saturated with ozone are irradiated with UV light of 254 nm. The extinction coefficient of ozone at 254 nm. is 3300 $mol^{-1}cm^{-1}$ (1). The decay rate of ozone is about a factor of 1000 higher than that of H_2O_2 (2). In the present investigation, experiments were carried out for studying the decay of ozone in aqueous medium at different pH and the study was extended to determine the kinetics of degradation of ozone in aqueous medium.

EXPERIMENTAL

Experimental set up

Ozone was produced using an ozone generator model OG250 (manufactured by M/s. Beta Computronics Pvt. Ltd., Nagpur, India), which is a high frequency cold plasma/cold corona ozone generator. The generator was fed with an inlet of pure and dried oxygen gas from an oxygen cylinder with an oxygen flow meter. The overall degradation reaction was carried out for 10min. This ozone produced was used to saturate the double distilled water of a particular pH obtained by using dilute sulphuric acid or dilute sodium hydroxide.

Instrumental method of analysis

Ozone shows a strong absorption peak in the UV region at 254 nm. And has a high molar extinction coefficient of 3300 $mol^{-1}cm^{-1}$. The UV spectrophotometric method was used for the measurement of ozone concentration in aqueous solution. A Chemito double beam UV-Visible spectrophotometer model Chemito- Spectrascan UV2600 was used for this purpose. Different graphs of C/Co Vs time was plotted for ozone at different pH and studied.

RESULTS AND DISCUSSION

The results of the various studies in the present investigation are presented in Table1.

Effect of pH

pH is one of the most important parameter to be studied, since it is strongly related to the degree of dissociation of ozone. The rate of degradation of ozone at different pH was observed by carrying out

the experiments at different pH conditions namely 3, 4.5, 7, 9.2, and 11.2 as depicted in the fig 1. It was observed that the rate of degradation increases in the neutral to alkaline range as compared to the acidic pH conditions. In acidic medium, the rate of oxidation is slow. This is due to the fact that at alkaline pH the generation of hydroxyl radical is more than that at acidic pH.

Kinetics of ozone decay

The self degradation of ozone could be well simulated by the following second order rate form:

$$dC/dt = kC^2$$

Here, k is second order reaction rate constant and C is the concentration of substrate.

Ozone decomposition in aqueous solution is a complex, radical type chain reaction which is very sensitive to the conditions applied (Taube and Bray, 1940). The presence of trace amount of impurities (which may act either as scavengers or promoters), irradiation by light, a change in the ionic media, pH, etc. may each significantly affect the lifetime of ozone in aqueous solution.

It could be apparently seen in the Fig. 2 that for the reaction times t<15 min, the plot between (1/C - 1/Co) verses time is linear, the reaction follows a second order kinetics and the mechanism can be proposed as:

$$O_3 \rightleftharpoons O_2 + O^{\cdot} \quad (1)$$

$$O_3 + O^{\cdot} \rightarrow 2O_2 \quad (2)$$

Table-1: Concentration decrease of ozone with time

Time(min)	Concentration (g/L)	Concentration (g/L)	Concentration (g/L)	Concentration (g/L)	Concentration (g/L)
	pH3	pH4.5	pH7	pH9.2	pH11.2
0	0.000122	0.000119	0.000104	0.000132	0.000136
1	0.000116	0.000113	0.000094	0.000112	0.000114
2	0.000114	0.000110	0.000084	0.000100	0.000095
3	0.000109	0.000107	0.000076	0.000091	0.000088
4	0.000105	0.000103	0.000075	0.000080	0.000080
5	0.000102	0.000101	0.000074	0.000073	0.000074
6	0.000100	0.000099	0.000070	0.000067	0.000069
7	0.000099	0.000097	0.000067	0.000061	0.000064
8	0.000097	0.000098	0.000064	0.000054	0.000057
9	0.000095	0.000094	0.000062	0.000052	0.000049
10	0.000092	0.000086	0.000059	0.000046	0.000040
15	0.000082	0.000083	0.000045	0.000029	0.000013
20	0.000074	0.000075	0.000036	0.000018	0.000002
25	0.000067	0.000069	0.000029	0.000010	0.000000
30	0.000064	0.000062	0.000024	0.000006	
35	0.000057	0.000057	0.000018	0.000002	
40	0.000053	0.000052	0.000014	0.000000	
50	0.000047	0.000042	0.000007		
60	0.000040	0.000033	0.000002		

CONCLUSION

1. The self decay of ozone in aqueous medium was investigated, which could be well simulated with second order reaction rate form.

2. The effect of pH of the medium on self decay of ozone was studied and found that the rate of degradation increases with the increase in pH. The rate of degradation increases from acidic to neutral to alkaline pH which is attributed to the increase in the number hydroxyl radicals.

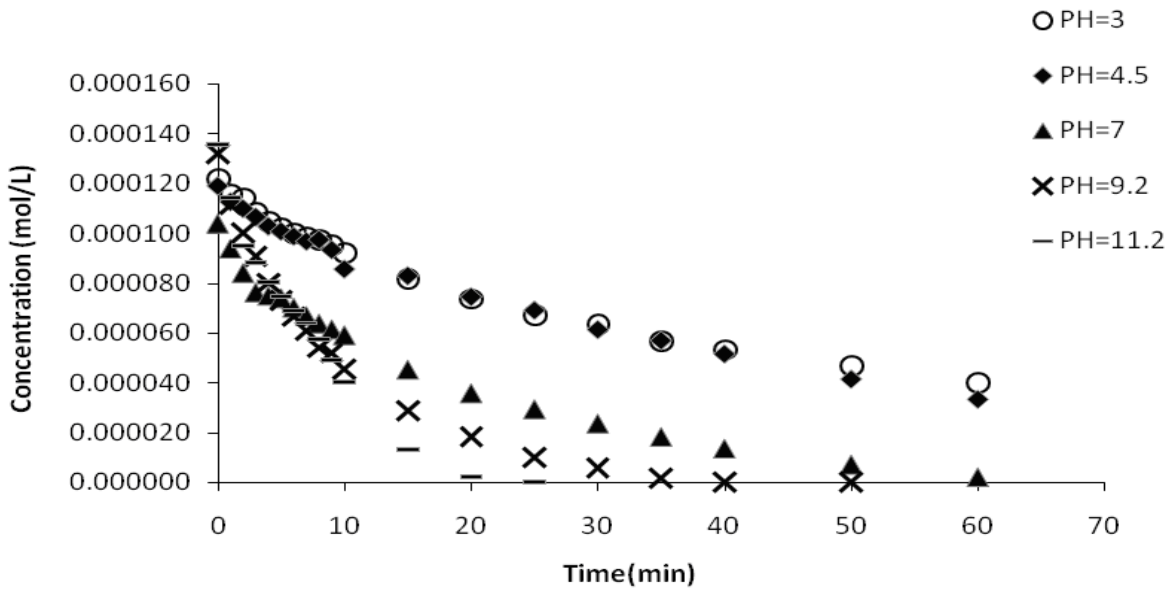

Fig-1: Degradation of ozone with time at different pH

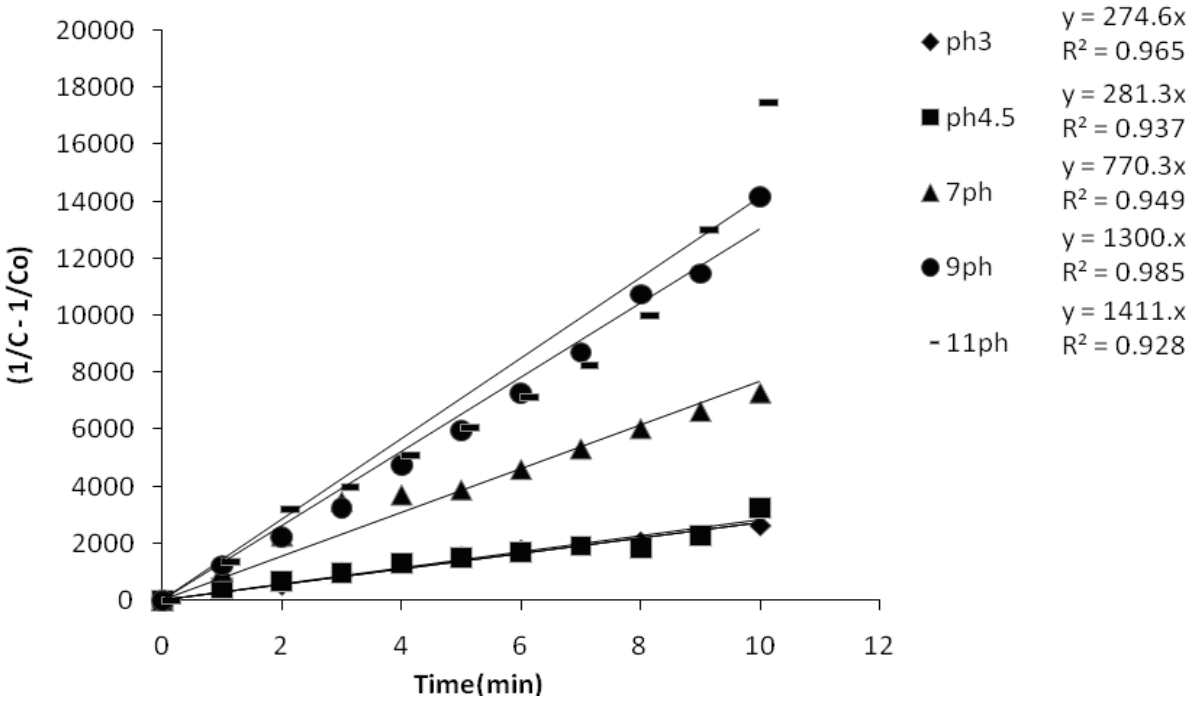

Fig.-2: Self degradation of ozone at different pH

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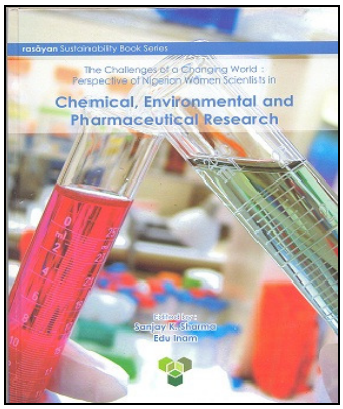

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