Heterogeneous Catalytic Ozonation of Cationic Dyes using Volcanic Sand

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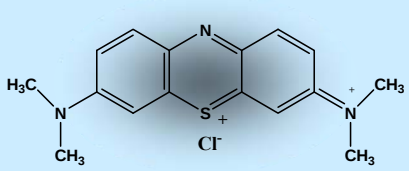
INTRODUCTION

Molecular structure of methylene blue



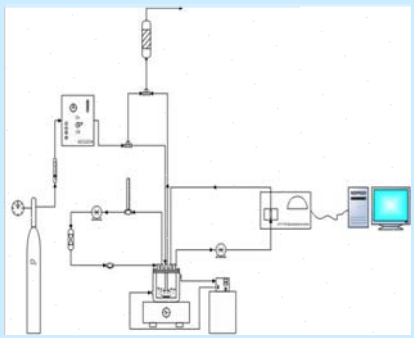
Molecular weight (g/mol)	Solubility (g/L)	Density (g/cm³)	Molecular size (Å)	*pKa* (20ºC)
319.85	50	1.16	18	1.01

OBJECTIVES

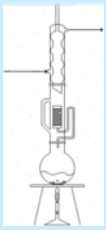
This work presents experimental results on a novel catalytic heterogeneous ozonation process using volcanic sand (VS) for colour removal.

METHODS

Experimental system



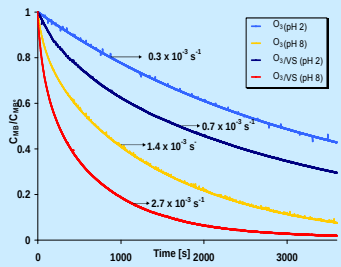
Volcanic sand chemical modification by refluxing in HCl



RESULTS

1.- COMPARISION OF pH EFFECT ON MB REMOVAL BY O_3 and O_3/VS.

T= 293 K, pH = (2-8), 50 g/dm³ VS, C_{MBo}= 30 mg/dm³, C_{O3o}= 6 mg/dm³.

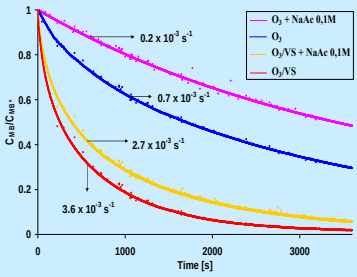


Heterogeneous ozonation, using volcanic sand, enhanced MB removal for each pH level studied. The increased fraction of removed MB could be related to the enhancement of radicals coming from ozone interaction with volcanic sand.

3.- EFFECT OF THE PRESENCE OF RADICAL SCAVENGERS

T= 20 °C, pH (8), 50 g/L VS,

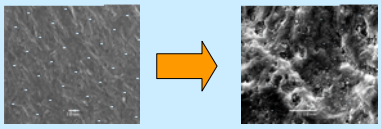
C_{MBo}= 30 mg/L, C_{O3o}= 6 mg/L.



The presence of radical scavengers (Ac^-) imply a reduction on MB removal rate around 70 % for homogeneous ozonation, where as only a 37 % for the heterogeneous system. The reduction on MB removal rate by Ac^- ions could be related to the inhibition of radical chain reactions taking place in the solution bulk.

3.- EFFECT OF VS CHEMICAL SURFACE COMPOSITION.

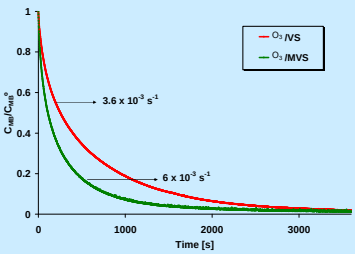
VS physicochemical characterisation



Volcanic Sand **Modified Volcanic Sand**

2.5	Bulk density (g cm^{-3})	2.5
0.21	S_{N2} (m^2 g^{-1})	2.42
63.7	SiO_2 (%)	66.8
13.9	Al_2O_3 (%)	15.26
0.7	TiO_2 (%)	0.87
4.7	Fe_2O_3 (%)	5.16
3.8	Na_2O (%)	4.15
3.0	K_2O (%)	2.65
2.9	CaO (%)	3.6
1.2	MgO (%)	1.42
0.1	MnO (%)	0.09
6.8	pH_{PZC}	4.4

T= 20 °C, pH = 8, 50 g/L solid dosage, C_{MBo}= 30 mg/L, C_{O3o}= 6 mg/L.



The increase in acid sites enhances MB adsorption, increasing the electrostatic interactions between MB^+ and negative surface sites of modified volcanic sand. O_3 could adsorb on deprotonated surface hydroxyl groups and converts to radicals ($HO^\bullet$ or O-radicals), leading to an enhancement on MB removal rate.

CONCLUSIONS

Volcanic sand increased MB removal rate probably due to a synergistic mechanism that combines mainly the adsorption of MB, O_3, and radicals on volcanic sand, surface reactions, and MB oxidation on the solution bulk.

Results obtained here show the quantitative importance of volcanic sand chemical surface composition on MB oxidation reactions.

ACKNOWLEDGEMENTS. The authors wish to thank FONDECYT (Grants N° 1060304 and 1060892) for their financial support.

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