REMOVAL OF METHYLMERCURY FROM WATER BY HETEROGENEOUS PHOTOCATALYSIS

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INTRODUCTION

Pollution of water with mercury and its compounds is a worldwide problem due to their adverse effects in the human health and the environment. Mercury is listed as priority and hazardous pollutant by the European Union [1]. Mercury enters the environment from a large number of human activities including industries such as chloro-alkali factories, agricultural applications, mining, and electrical products.

Among the different chemical forms of mercury, organomercurials are the most toxic species because they are efficiently retained and bioconcentrated by organisms at various levels in the food chain.

It is therefore urgent to develop technologies for the treatment of waters polluted with mercury before being discharged to aquatic systems.

In a previous study we have demonstrated the feasibility of heterogeneous photocatalysis for uptake of aqueous inorganic mercury Hg(II), achieving the currently established disposal limits (100-200 mgL^{-1}) [2].

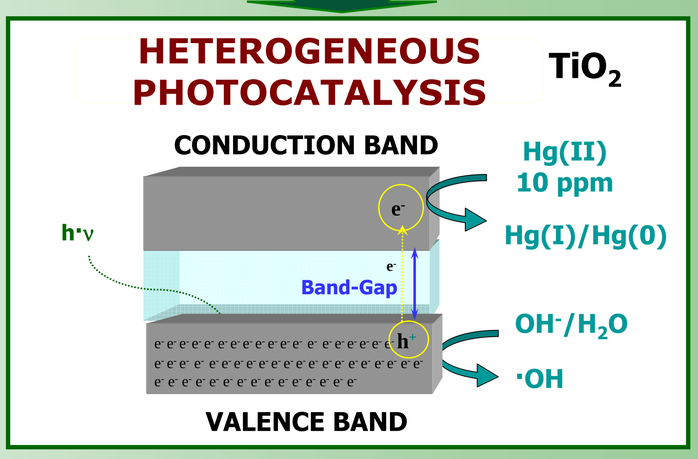
OBJECTIVE

To study the efficiency of heterogeneous photocatalysis for the treatment of water polluted with organic mercury.

METHOD

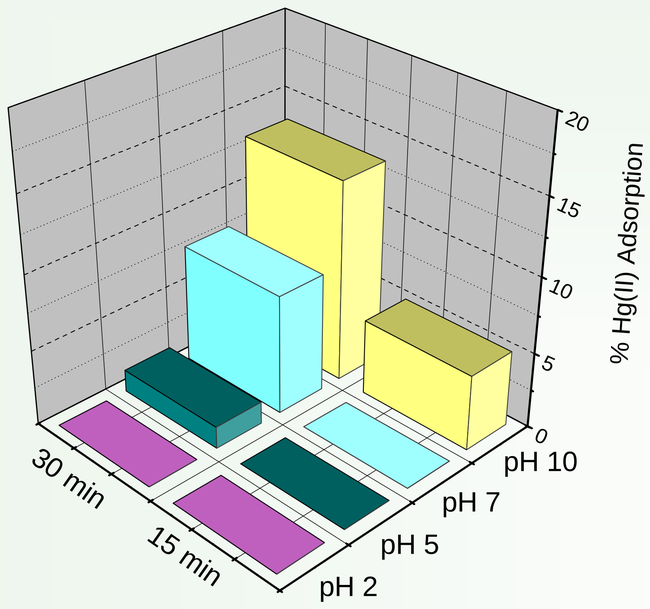
Mercury pollutant: CH_3HgCl

Catalyst: TiO_2



RESULTS AND DISCUSSION

Adsorption



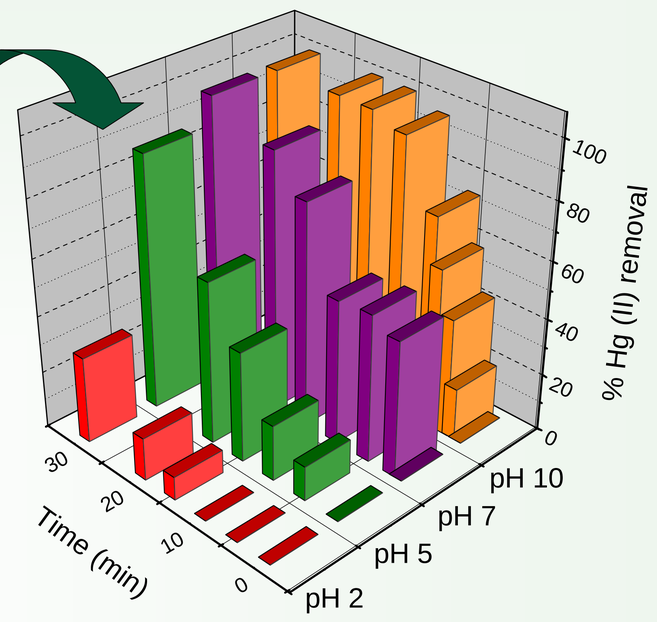
Adsorption increases with pH

Heterogeneous photocatalysis

1. In absence of oxygen

High efficiency for organomercurial uptake at pH ≥ 5

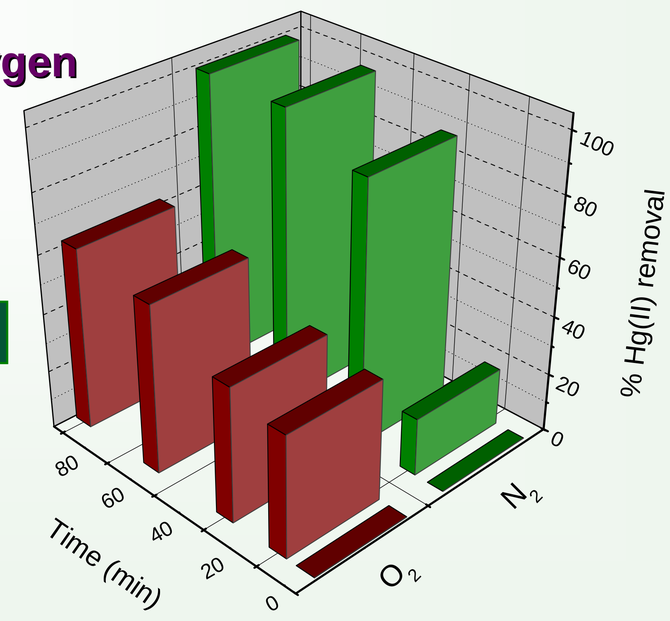
Hg(II) concentration values bellow 50 ppb



Mercury is deposited as Hg(0) on titania surface

Recovery from catalyst by treatment with HNO_3

2. In absence and presence of oxygen



Oxygen decreases efficiency for mercury uptake

Competition with Hg(II) for electrons

$O_2 + 1e^- \rightarrow O_2^-$

$2H^+ + O_2^- + 1e^- \rightarrow H_2O_2$

$H_2O_2 + 1e^- \rightarrow 2\ OH^\cdot$

Hg(II) reduction

$Hg(II)_{ads} + 1e^- \rightarrow Hg_2Cl_{2ads}$

$Hg(II)_{ads} + 2e^- \rightarrow Hg^0_{ads}$

Organic products

Nitrogen bubbling

Product: CH_3OH

Oxygen bubbling

Product: CH_4 CO and CO_2

CONCLUSIONS

- Heterogeneous photocatalysis appears as a promising technique for the removal of methylmercury from aqueous solutions. Legislated concentrations limits can be achieved.
- The pH value and presence of oxygen have a strong influence on the photocatalytic process. The highest efficieny for Hg(II) removal is achieved in alkaline and deaerated conditions.

Acknowledgments

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References

1. Directive 2008/105/EC of the European Parliament and of the Council of 16 December 2008 on environmental quality standards in the field of water policy.
2. López-Muñoz, M.J., Aguado, J., Arencibia A., Pascual, R. Mercury removal from aqueous solutions of $HgCl_2$ by heterogeneous photocatalysis with TiO_2, Appl. Catal. B.: Environ. In press