SONOCHEMICAL DEGRADATION OF VOLATILE AND NON-VOLATILE CHLORINATED COMPOUNDS IN AQUEOUS SOLUTION

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Introduction

Pollutant properties determine the sonochemical reaction site. Hydrophobic and/or volatile chemicals have a strong tendency to diffuse into the gaseous bubble interior [1]. The most effective site for their destruction is the bubble-liquid interface [2] and/or the bubble itself [3] undergoing by thermal and oxidation effects. In contrast, hydrophilic and/or non-volatile compounds tend to remain in the bulk during the irradiation and so the major reaction site for these chemicals is, therefore, the liquid medium [5] at low concentration and/or bubble-liquid interface [6] at higher concentration. The efficiency of pyrolys of nonvolatile solutes at the interface depends on the hydrophobicity which dictates their ability to accumulate at the interface. In this way, the sonochemical degradation of perchloroethylene (PCE) and trichloroacetic acid (TCAA) has been analyzed.

Physico-chemical properties

<table>
<thead>
<tr>
<th>Property</th>
<th>PCE</th>
<th>TCAA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Molecular weight</td>
<td>165.83 g/mol</td>
<td>163.86 g/mol</td>
</tr>
<tr>
<td>Melting point</td>
<td>-19°C</td>
<td>56°C</td>
</tr>
<tr>
<td>Boiling point</td>
<td>107°C</td>
<td>196°C</td>
</tr>
<tr>
<td>Density at 25°C</td>
<td>1.203 g/mL</td>
<td>1.208 g/mL</td>
</tr>
<tr>
<td>Density at 85°C</td>
<td>1.150 g/mL</td>
<td>85.7 g/mL</td>
</tr>
<tr>
<td>Vapour pressure at 25°C</td>
<td>16.6 mmHg</td>
<td>1 mmHg (31°C)</td>
</tr>
</tbody>
</table>

Henry’s law constant at 25°C: 1.6×10⁻⁴ atm·mol⁻¹ at 1.38×10⁻⁴ atm·mol⁻¹ (for PCE)

Sonochemical reactions

Sonochemical behavior of TCAA

Study of reaction variables

Comparison of the C-Cl bond breakage during the reaction at 378 and 850 kHz, different temperatures (290 or 305K) and gases dissolved in the solution (Ar or natural air).

Mechanism of reaction

The reaction with a radical scavenger (n-butanol) in the solution inhibits the C-Cl breakage in a high degree.

378 kHz reactions were carried out at 0.028 W cm⁻³ and 850 kHz at 0.047 W cm⁻³, both calorimetrically measured; the initial concentration of TCAA was 0.5 mM in a 500 mL reaction cell.

Comparison between PCE and TCAA degradation

Physico-chemical properties.

The low degradation rate of TCAA under sonochemical treatment contrasts with the good response of PCE, as a direct consequence of the difference in the volatile and hydrophobic characteristics of both pollutants. In the PCE reactions 2L volume and a PCE concentration of 0.15 mM were used.

CONCLUSIONS:

➢ TCAA usually appears in industrial waste water together with PCE as a product of its natural degradation but its hydrophobic nature does not allow its accumulation in the liquid-vapour interface, which avoids effective degradation in a sonochemical treatment.

➢ The slow degradation of TCAA is a significant extent the result of a radical mechanism, as can be deduced for the test with a radical scavenger in the solution. Further work is in progress.

➢ The opposite effect is observed for PCE that readily penetrates into the bubble and is mainly degraded by pyrolysis.

ACKNOWLEDGEMENT: