Solvent-Driven Radiolytic Transformation of Hexachlorobenzene in Acetone under Gamma Irradiation

S. Karimov*
French-Azerbaijani University under Azerbaijan State Oil and Industry University, Baku, Azerbaijan

E. Abdullayev
French-Azerbaijani University under Azerbaijan State Oil and Industry University, Baku, Azerbaijan

M. Gurbanov
French-Azerbaijani University under Azerbaijan State Oil and Industry University, Baku, Azerbaijan

Abstract

Hexachlorobenzene (HCB) is a persistent organic pollutant characterized by exceptional chemical stability and long-term environmental persistence. In this work, the degradation behavior of HCB dissolved in acetone was investigated under gamma irradiation in order to evaluate radiolysis as a potential remediation approach. Irradiation experiments were performed using a cobalt-60 source with absorbed doses up to 170 kGy. Reaction products generated during irradiation were analyzed by gas chromatography–mass spectrometry (GC–MS). Several radiolytic transformation products were detected, including 2,5-hexanedione, 1,1-diethoxypentan-4-one, methylpentachlorobenzoate, and 1-propoxy-2-propanol. Figure given below, illustrates the structure of these main byproducts. The evolution of these compounds was monitored by evaluating their chromatographic peak areas at irradiation times ranging from 0.5 to 27 hours. The results demonstrate that the formation of these species increases with increasing irradiation dose, indicating progressive fragmentation and transformation of HCB molecules in the solvent medium. The progressive decrease in the peak areas of all detected compounds with increasing absorbed dose indicates that the intermediate byproducts formed during the process undergo further degradation. It leads to their gradual removal from the system.

Overall, the findings provide insight into the degradation behavior of chlorinated aromatic compounds, particularly POPs, in alcoholic solvents under ionizing radiation. At the same time, the broad distribution of radiolytic products, other than reported as main products in this abstract, suggests that acetone promotes complex and non-selective reaction pathways. Therefore, further studies should investigate alternative solvent systems that may facilitate more selective degradation of HCB while minimizing the formation of environmentally hazardous intermediates.

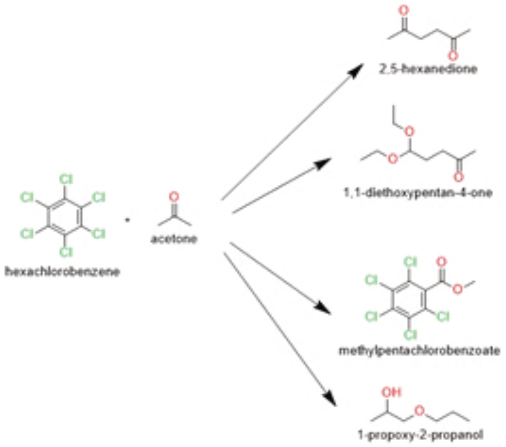

Figure: The Main Byproducts of HCB + Acetone and Their Structures