Kinetic and inhibition studies for the aerobic cometabolism of 1,1,1-trichloroethane, 1,1-dichloroethylene, and 1,1-dichloroethane by a butane-grown mixed culture

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Abstract:
Batch kinetic and inhibition studies were performed for the aerobic cometabolism of 1,1,1-trichloroethane (1,1,1-TCA), 1,1-dichloroethylene (1,1-DCE), and 1,1-dichloroethane (1,1-DCA) by a butane-grown mixed culture. These chlorinated aliphatic hydrocarbons (CAHs) are often found together as cocontaminants in groundwater. The maximum degradation rates (k(max)) and half-saturation coefficients (K-s) were determined in single compound kinetic tests. The highest k(max). was obtained for butane (2.6 mumol/mg TSS/ h) followed by 1,1-DCE (1.3 mumol/mg TSS/h), 1,1-DCA (0.49 mumol/mg TSS/h), and 1,1,1-TCA (0.19 mumol/mg TSS/ h), while the order of K-s from the highest to lowest was 1,1-DCA (19 muM), butane (19 muM), 1,1,1-TCA (12 muM) and 1,1-DCE (1.5 muM). The inhibition types were determined using direct linear plots, while inhibition coefficients (K-ic. and K-iu) were estimated by nonlinear least squares regression (NLSR) fits to the kinetic model of the identified inhibition type. Two different inhibition types were observed among the compounds. Competitive inhibition among CAHs was indicated from direct linear plots, and the CAHs also competitively inhibited butane utilization. 1,1-DCE was a stronger inhibitor than the other CAHs. Mixed inhibition of 1,1,1-TCA, 1,1-DCA, and 1,1-DCE transformations by butane was observed. Thus, both competitive and mixed inhibitions are important in cometabolism of CAHs by this butane culture. For competitive inhibition between CAHs, the ratio of the K-s values was a reasonable indicator of competitive inhibition observed. Butane was a strong inhibitor of CAH transformation, having a much lower inhibition coefficient than the Ks value of butane, while the CAHs were weak inhibitors of butane utilization. Model simulations of reactor systems where both the growth substrate and the CAHs are present indicate that reactor performance is significantly affected by inhibition type and inhibition coefficients. Thus, determining inhibition type and measuring inhibition coefficients is important in designing CAH treatment systems. (C) 2002 Wiley Periodicals, Inc.