

Bacterial Respiration Inhibition Studies of Fluorotelomer-Based Products

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ABSTRACT: Fluorotelomer-based products provide unique properties to a wide variety of consumer goods. These products may find their way into wastewater treatment plants through normal use and disposal. Bacterial respiration inhibition studies help estimate the effect of the test material on mixed communities of bacteria in aquatic environments, especially in aerobic biological treatment systems. These studies also can be useful to help determine test concentrations to use in biodegradation studies. We studied the inhibition to bacterial growth in activated sludge of municipal wastewater treatment facilities using both guideline and non-guideline methods for a series of fluorotelomer-based products. At the highest test concentration at which they were dosed, 1000 mg L⁻¹, the test substances exhibited no respiration inhibition. The EC₅₀, which is the effective concentration of the test material resulting in a 50% calculated or interpolated inhibition of oxygen consumption compared with a control blank, are estimated to be greater than 1000 mg L⁻¹.

INTRODUCTION

The aim of these studies was to determine the acute toxic behaviour of the test substances towards the microorganisms of activated sludge using OECD test guideline 209.

The objectives of these studies were to:

- Determine the effect of the test substances on microorganisms from municipal sewage sludge and
- Assess the potential of the test substances to adversely affect aerobic municipal sewage treatment plants

The testing protocol used a microbial inoculum derived from a municipal wastewater treatment plant and an artificial sewage feed. The respiration rate of the test system was determined after 30 minutes under controlled laboratory conditions.

MATERIALS & METHODS

Test substances at 5 concentrations: 10, 32, 100, 320, 1000 mg L⁻¹

- Abiotic control at 1000 mg L⁻¹

Reference substance at 3 concentrations: 3.2, 10, and 32 mg L⁻¹

Conditions of the test solutions:

- Synthetic sewage feed
- Microbial inoculum containing approximately 4 g dry weight/L
- Aeration at 0.5 to 1.0 liter per minute
- Continuously stirred using a stir bar and stir plate.
- 30 minute contact period
- O₂ measured for maximum of 10 m with stirring and no aeration
- Respiration rate determined over linear portion of respiration curve

RESULTS ANALYSIS

The inhibitory effects were determined by comparing the rates at each concentration of either test or reference chemical to the rates in the controls. The results are expressed as percentage of the mean value of the respiration rates of the two controls according to:

$$\left[1 - \frac{2R_s}{R_{c1} + R_{c2}} \right] * 100 = \text{Percent inhibition}$$

Where:

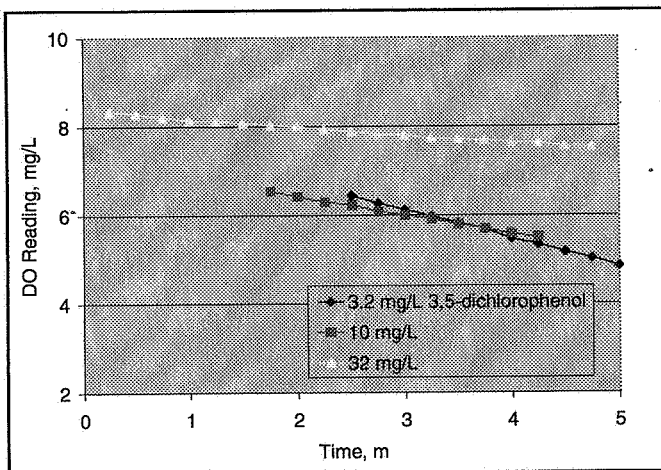
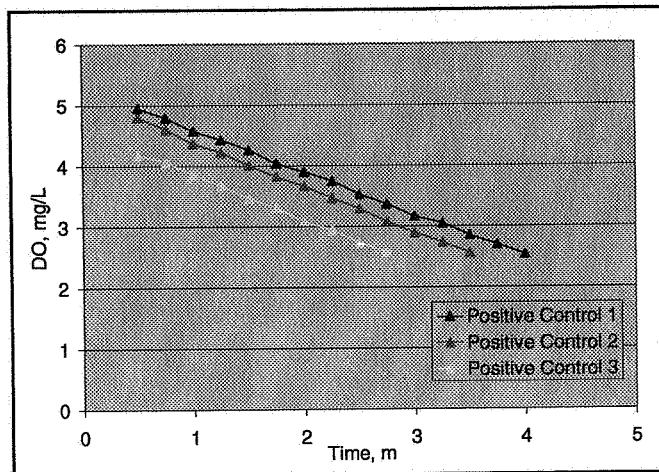
R_s = oxygen consumption rate at tested concentration of test substance

R_{c1} = oxygen consumption rate of positive control 1

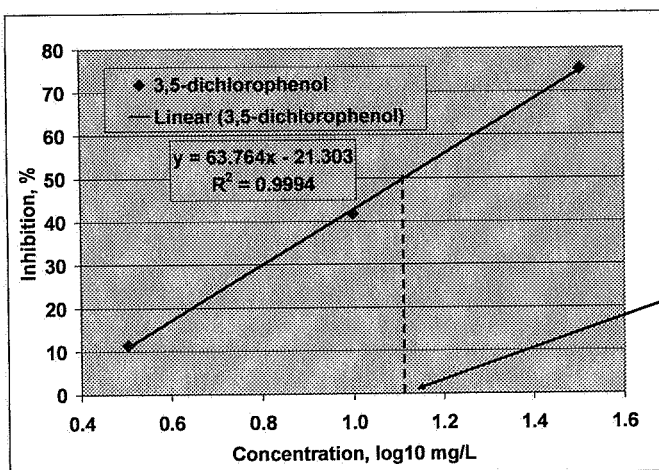
R_{c2} = oxygen consumption rate of positive control 2

The test results are valid when:

The Positive Control respiration rates are within 15 % of each other.



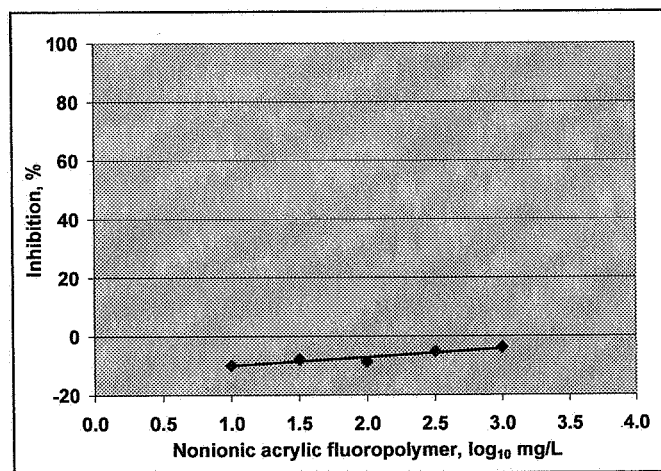
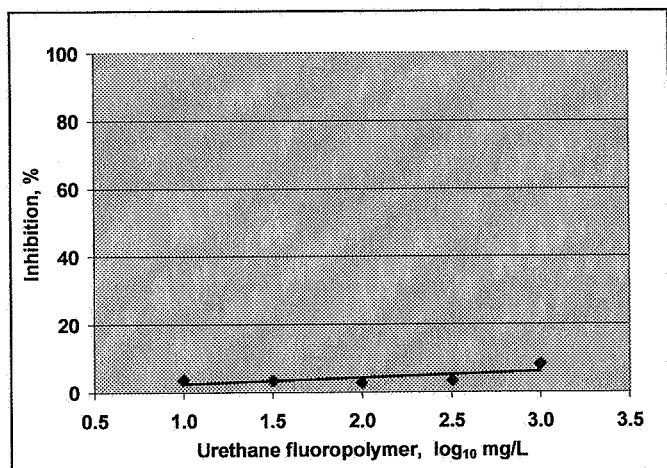
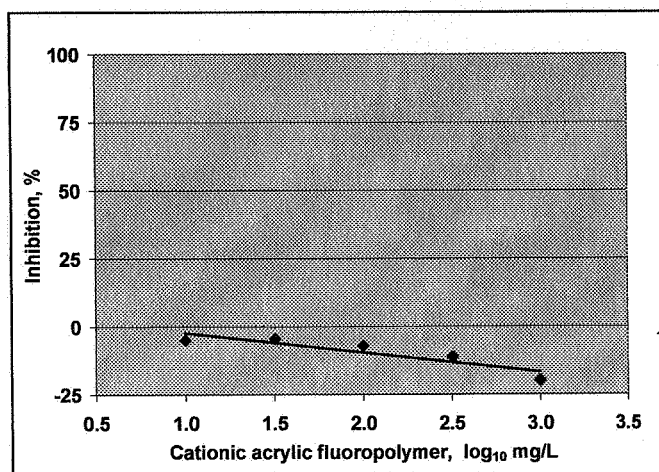
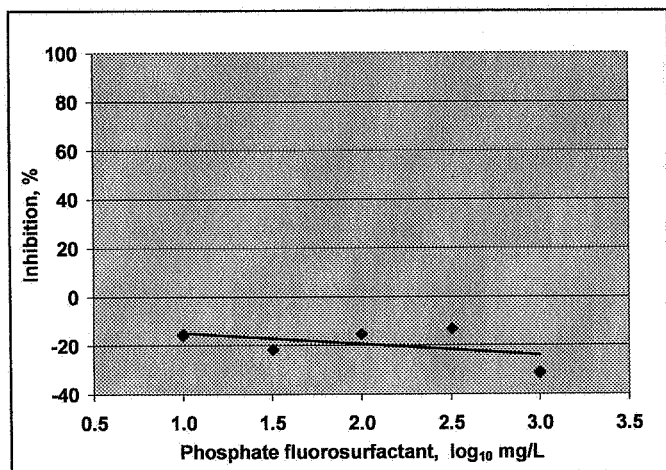
The EC_{50} of reference chemical 3,5-dichlorophenol is in the accepted range of 5 to 30 mg L⁻¹.



$EC_{50} = 13 \text{ mg L}^{-1}$

RESULTS

The test substances showed no acute toxic effect towards the microbial inoculum (activated sludge) at the highest concentration of 1000 mg L⁻¹ that was tested.



CONCLUSIONS

- The EC₅₀ of the test substances is estimated to be much greater than 1000 mg L⁻¹
- Biodegradation studies can be performed at concentrations greater than 1000 mg L⁻¹ with no negative effect on the respiration of the microorganisms.



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