

Propylene Glycol Ethers

Environmental Aspects Report Comparative Biodegradation of Propylene Glycol Ethers

Introduction

Propylene glycol ethers are biodegradable. The biodegradation of glycol ethers or any chemical may be determined by various procedures including measuring the consumption of dissolved oxygen by microorganisms using the organic matter (including the chemical of concern) as fuel. Such a test is called a Biological Oxygen Demand (BOD) test. The test consists of incubating the test chemical in a flask that also contains a microorganism-rich inoculum for a specified period of time during which the chemical is biodegraded, or consumed, by the microbes in the inoculum. The consumption of the chemical by the organisms is a process that requires oxygen. The rate of biodegradation is evaluated indirectly by measuring the disappearance of dissolved oxygen from the incubation medium.

Historically, the amount of oxygen consumed in a five-day period was used as a standard for comparing the microbial degradation of chemicals. More recently, however, longer periods on the order of 20 days and longer are routinely used to assess the propensity of a chemical to biodegrade. Factors that influence the disappearance of oxygen in a BOD test include:

- 1) the source and quantity of the inoculum which often consists of sewage sludge from a local water treatment plant
- 2) incubation temperature
- 3) dose of the test chemical in the incubation medium
- 4) the molecular structure of the test chemical and other factors

Particularly, the type of inoculum may influence the outcome of the BOD test since the types of microbe populations in sewage sludges may vary widely from one treatment plant to another. Different microbes may have very different capacities to use the test chemical as fuel. Commonly, the sewage sludge inoculum is permitted to become accustomed or 'acclimated' to the test chemical by contacting the chemical for prolonged periods. This permits the microorganism to adapt and 'learn' how to consume the test chemical. Some regard a chemical that allows the inoculum to consume 60 percent of the oxygen present within a 28-day period as 'readily biodegradable.' Even in cases where ready biodegradability is not demonstrated, further testing with higher inoculum levels may show that a compound has the ability to biodegrade and is considered biodegradable.

The relative biodegradation potential of propylene glycol ethers has been evaluated at the same time, in the same laboratory, using identical test protocols. Figure 1 shows a bar chart reflecting BOD data from an investigation. Note that an ethylene glycol ether was included as a reference. These data confirm the biodegradability of propylene glycol ethers. Two propylene glycol ethers do not reach the 60 percent level after 28 days of incubation. These are propylene glycol tertiary-butyl ether (PTB) and dipropylene glycol tertiary-butyl ether (DPTB). A tertiary configuration is generally more difficult for micro-organisms to break down. It is not surprising that PTB and DPTB are somewhat harder for the microbes to digest and may take more time to break down. In fact, when this study was carried out to 35 days, dissolved oxygen consumed by the inoculum was 60 percent for PTB and 51 percent for DPTB. Thus, even these branch-chained propylene glycol ethers are biodegradable, even if at a slightly slower rate. In conclusion, most of the propylene glycol ethers are considered readily biodegradable. The highly branched, tertiary-butyl ethers are inherently biodegradable, requiring slightly longer to degrade.

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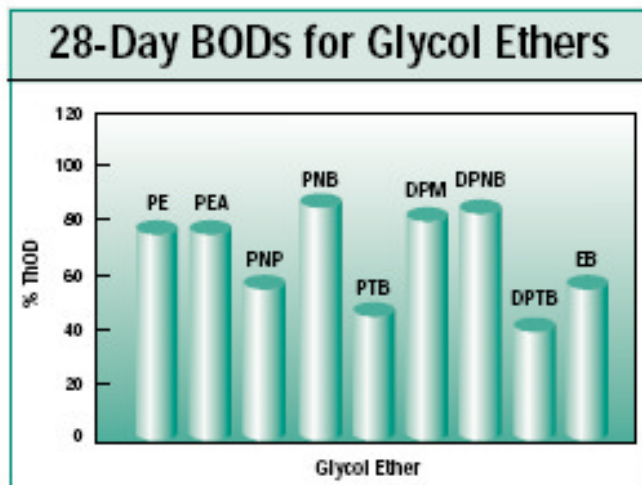


Figure 1. Biodegradation of selected propylene glycol ethers after 28 days incubation. Test performed in the same laboratory, with pre-acclimated inoculum, using the same dose (3.75 mg/l).

References

Lyondell Chemical (formerly ARCO Chemical Company), 1994. Unpublished data from, Ultimate Biological Oxygen Demand (BODU) Test, conducted by Roy F. Weston, Inc.

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