Aerobic Mineralisation in Surface water (OECD 309): Experiences and Interpretation

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INTRODUCTION AND OBJECTIVES

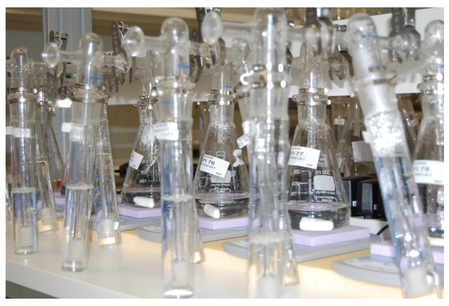
The chemical fate of substances and also the fate of their metabolites is becoming an important part of the environmental risk assessment. One of the required and standardized tests is the aerobic mineralization of substances in surface water. The testing procedure is described in the OECD testing guideline 309, which has now existed for 10 years in its current version. Since every substance is different to each other, this guideline can only be a framework for the real testing procedure. During the last three years Innovative Environmental Services Ltd has performed 24 tests following the OECD testing guideline 309. The data presented here will give you an overview of all OECD 309 tests carried out and illustrate possible difficulties during the course of the studies causes by characteristics of the test substance.

MATERIAL & METHODS

Table 1: Overview of the test system

Characteristics of Studies (OECD 309) performed at IES Ltd (2012-2014)	
^{14}C-labelled	All = 24 (with 1-3 labels)
Tests with suspended solids	3 (10 – 100 mg/L)
Water solubility of test substances	10 µg/L – 20 g/L
Specific activity	0.9 – 15 MBq/mL
Test concentrations	100 and 10 µg/L (majority), but down to 0.5 µg/L
Solvents	Water or organic solvents (test including solvent control)
Source of surface water	Pond (see Picture 1), river or lake with ~pH 8 and 6-8 mg O_2/L
Temperature/light	Incubation at 20-22°C in the dark
Test duration/replicates	60 (- 90) days, duplicate samples at each interval
Volume	100 mL water in 300 mL Erlenmeyer flasks
Test system	Flow-through with NaOH - and Ethylene glycol – traps and Continuous agitation by magnetic stirrer
Degradation capacity reference item (to assess microbial activity)	Benzoic acid (see Table 2)

Picture 1/2: Typical set-up of an OECD 309 study



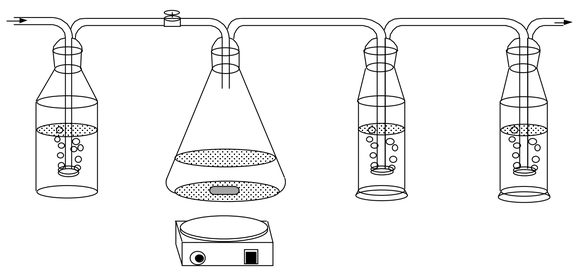
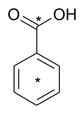


Table 2: Reference item Benzoic Acid



Degradation of the reference substance ^{14}C-Benzoic acid	
Degradation	DT_{90} < 7 days (Majority, no defined criteria in OECD 309)
Mineralization	40-75% CO_2 (= Mineralization) after 14 days (one case only 7%, but almost complete degradation)
Recovery	59-100%

RESULTS

- Degradation results (24 studies):
- 5/24: Degradation mainly through Hydrolysis (k biodegradation = k dissipation rate – k dissipation rate sterile)
- 2/24: Fast degradation: DT_{50}: 4-5 days
- 6/24: Slow degradation: DT_{50}: 20-50 days or 120-270 days
- 10/24: No or almost no degradation
- 1/24: No result as substance too volatile

- Effect of suspended solids:
- One study showed more mineralization with sediment
- One study without difference in degradation rate (but one additional metabolite in sediment)

- Degradation kinetics used for calculation:
- Focus kinetics (on request of clients)
- Single first-order kinetics (on request of clients)
- Lag phase, initial linear part after lag phase (linear regression, requested by the TG 309)

- Specials:
- One extremely sticky substance => Interpretation of degradation difficult
- Two studies prolonged to 90d and one study with 72h as maximum interval
- One study with volatile test substance, three studies where volatile degradation products were blown into the Ethylene glycol – traps (all trapped), one study with volatile degradation products not trapped
- All degradation products (metabolites) < 5% characterized by reference substances except for three studies with diffuse or multicomponent degradation products (appeared at the final two intervals)
- One study with focus on the degradation of the parent (not metabolites), test duration 30 days

CONCLUSION

- Study can be simple or very complex
- Mineralization does not occur often (3/24)
- Effect of suspended solids on degradation rate is unclear
- Identification of unknown metabolites may be challenging due to very low test concentrations

- The comparison of the OECD 309 studies, with the different substances with the different characteristics, show that this “standard” test can be simple but can be very complex as well. From a CRO perspective, this leads to different workloads and therefore different prices of the same type of study, which has to be reflected in the study price.

Picture 1: Typical pond used as source for an OECD 309 study

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