

EFFECTIVE REMOVAL OF NATURAL AND SYNTHETIC STEROIDS FROM SEWAGE SLUDGE DURING AEROBIC AND ANAEROBIC SLUDGE STABILISATION

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Abstract

Natural steroids were rapidly eliminated during municipal sewage sludge treatment by more than 90 % under all oxygen and temperature conditions studied. 17 β -estradiol degradation led to the well-known metabolite estrone. A moderate to very good elimination of 17 α -ethynylestradiol and mestranol was observed under anaerobic and aerobic-psychrophilic conditions. Surprisingly, 17 α -ethynylestradiol was not degradable under aerobic-thermophilic conditions.

Introduction

- Endocrine disruption has become one of the most important environmental issues. One important class of hormonally active agents (HAA), also called endocrine disrupting compounds (EDC), are substances that mimic female sexual hormones (estrogens).
- Environmental occurrence and behaviour of selected natural estrogens (17 β -estradiol (E2), estrone (E1) and xenobiotic estrogens (17 α -ethynylestradiol (EE2), mestranol (ME), alkylphenols, bisphenol A) are studied.
- In this study the removal of natural and synthetic steroids from sewage sludge was investigated under aerobic and anaerobic conditions.

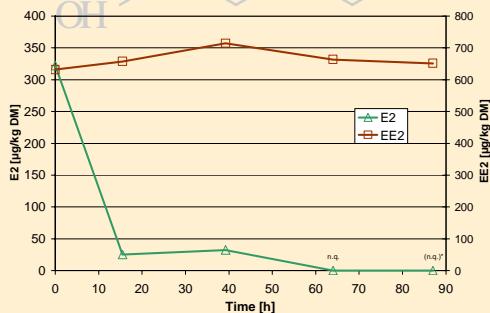


Figure 1: 17 β -estradiol and 17 α -ethynylestradiol concentrations during aerobic-thermophilic sludge digestion static batch experiment

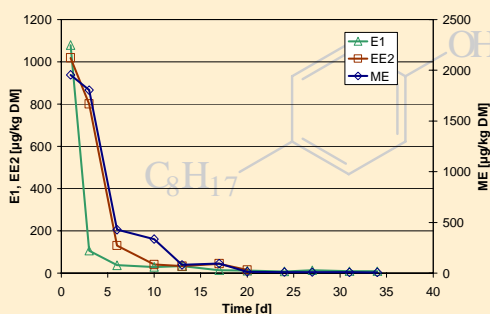


Figure 2: 17 β -estradiol, 17 α -ethynylestradiol and mestranol concentrations during aerobic-psychrophilic sludge digestion static batch experiment

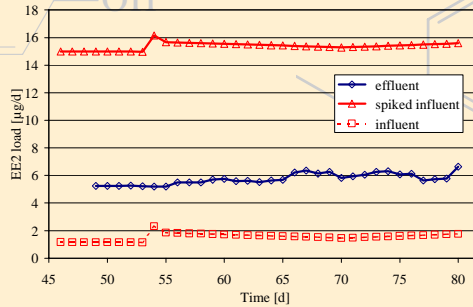


Figure 4: 17 α -ethynylestradiol mass fluxes during anaerobic-mesophilic sludge digestion; semi-continuous batch experiment

Materials and Methods

- Static batch (aerobic-thermophilic and aerobic-psychrophilic) and semi-continuous batch (anaerobic-mesophilic) experiments were realised using 1.5 and 5 liter bio reactors under controlled temperature and oxygen conditions.
- Simultaneous-aerobic degradation experiments were carried out using two parallel operating lab-scale waste water treatment plants (WWTP).
- Analytical procedure is displayed by Gehring et al. and described in detail by Weltin et al.

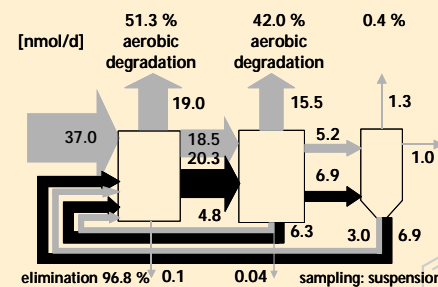


Figure 3: Cumulated (17 β -estradiol and estrone) mass balance of simultaneous-aerobic lab-scale WWTP experiment

Gehring et al. (2003): Recycled Paper Distingly Contributes ..., SETAC Conference, York, 2003

Weltin et al. (in press): Proceedings of the Institute of Waste Management and Contaminated Site Treatment, Dresden University of Technology, vol. 18

Tennhardt et al. (in press): Proceedings of the Institute of Waste Management and Contaminated Site Treatment, Dresden University of Technology, vol. 30

Results and Discussion

- Aerobic-thermophilic:** 92 % of E2 eliminated within the first 16 hours; EE2 not degraded
- Aerobic-psychrophilic:** E2 and E1 eliminated by 91 % after 6 days and by 99 % after 34 days, respectively; extensive removal of EE2 and ME amounting to 98 % elimination after 20 days and 99 % after 34 days

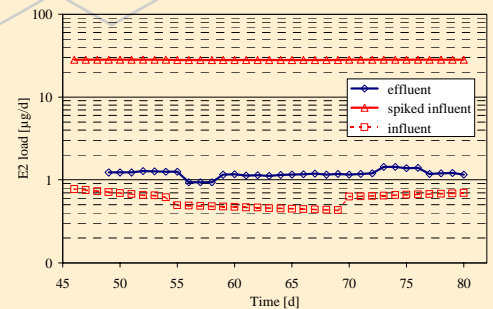


Figure 5: 17 β -estradiol mass fluxes during anaerobic-mesophilic sludge digestion; semi-continuous batch experiment

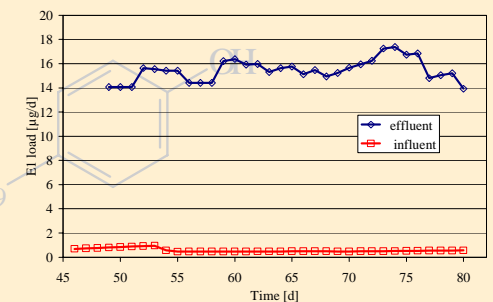


Figure 6: Estrone mass fluxes during anaerobic-mesophilic sludge digestion; semi-continuous batch experiment

- Simultaneous-aerobic:** E2 elimination 98.6 to 99.6 %; 68.4 to 90.3 % of E2 removed in the first, anoxic denitrification vessel; at the same time, formation of E1; overall elimination of E2+E1 96.1 to 98.0 % (on molar basis)
- Anaerobic-mesophilic:** E2 elimination 94.9 to 97.3 %; high simultaneous increase of E1 concentration; EE2 moderately eliminated by 57.5 to 69.2 %
- see Tennhardt et al.

Conclusions

Natural steroids were rapidly eliminated during sewage sludge treatment under aerobic and anaerobic conditions while synthetic steroids were eliminated to over 90 % under aerobic-psychrophilic conditions, moderately eliminated under anaerobic conditions and not degraded under aerobic-thermophilic conditions.



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