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FATE AND BIODEGRADATION OF ESTROGENS IN THE ENVIRONMENT AND ENGINEERING SYSTEMS – A REVIEW

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Abstract

Estrogens excreted by humans and animals are groups of endocrine disruptors, which degrade rapidly in soil and water as reported. This review focuses on biodegradation of estrone (E1), 17β-estradiol (E2) and 17α-ethynylestradiol (EE2) in surface water, STPs (sewage treatment plants), manure, soil and sediments, and illustrates possible pathways and mechanisms. In general, half-lives of EE2 are much longer than E1 and E2, because an ethinyl group at one hydroxyl group containing C-atom makes the cleavage of this ring rather difficult. Thus, EE2 has great estrogenic potential although the secreted amount is much smaller than that of E2 or E1. Various kinds of bacteria and fungus, Cornybacterium spp., Nitrosomonas europaea etc., are reported to be capable of degrading estrogens. Moreover, reports indicate that temperature, pH values, etc. exert impacts on degradation to different extents. The biodegradation in the sludge phase was assumed by researchers to follow a pseudo-first-order reaction, and the sequence of K-values is E2 > E1>>EE2 for the same sludge. As for the pathways, it was found that E2 is oxidised to E1 by the first step. The half-live of this step is about 4 to 12 hours in aerobic water and soil. However, this step cannot remarkably reduce the estrogenic potential. Further degradation of E1 needs the cleavage of one ring. Therefore, half-lives and concentrations of E1 are much longer and higher than those of E2. As a matter of fact, pathways of EE2 are still controversial, as several incompatible theories have been proposed.

Key words: biodegradation, co-metabolism, endocrine disruption, estrogen

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