

## Effect of pH on 17 beta-estradiol adsorption by anaerobic granule sludge combined with iron

Bai-Hang Zhao<sup>a,\*</sup>, Zhan-Zhao Wang<sup>a</sup>, Jing Zhang<sup>a</sup>, Jun Li<sup>a</sup>, Jie-Yi Zhai<sup>a</sup>, Wei Bian<sup>a</sup>, Wei-Hua Li<sup>b</sup>, Xian-Huai Huang<sup>b</sup>

<sup>a</sup>Department of Municipal Engineering, Beijing University of Technology, Beijing 100124, China, emails: bhzh@bjut.edu.cn (B.H. Zhao), wangzhanzhao@emails.bjut.edu.cn (Z.Z. Wang), b201604017@emails.bjut.edu.cn (J. Zhang), jgljun@bjut.edu.cn (J. Li), jieyizhai@126.com (J.Y. Zhai), yangzhoubw@126.com (W. Bian)

<sup>b</sup>School of Environment and Energy Engineering, Anhui Jianzhu University, Hefei 230601, China, emails: weihuali0311@126.com (W.H. Li), xianhuaihuang@126.com (X.H. Huang)

Received 8 October 2017; Accepted 5 April 2018

---

### ABSTRACT

Estrogens have great harmfulness to living organisms. Adsorption is a key step to estrogen removal in biological process. As a typical estrogen with high estrogen activity, 17 beta-estradiol (E2) adsorption behavior by anaerobic granular sludge (AnGS) combined with zero-valent iron (ZVI) was researched here. The effect of pH on E2 adsorption by ZVI/AnGS was investigated and analyzed through adsorption equilibrium, adsorption kinetics, adsorption thermodynamics, and zeta potential. ZVI/AnGS had high E2 adsorption capacity. The optimized condition was pH 6 with 92.78% E2 adsorption efficiency, 4.95  $\mu\text{g}\cdot\text{gVSS}^{-1}$  equilibrium adsorption capacity, and 0.07  $\mu\text{g}\cdot\mu\text{g}^{-1}\cdot\text{min}^{-1}$  adsorption rate. E2 was adsorbed as cationic forms or neutral inner-sphere surface complexes at a pH range of 2–10. The adsorption rate was controlled by film diffusion or intraparticle diffusion. Freundlich and Langmuir isotherms were both suitable for describing E2 adsorption process, which was exothermic and spontaneous.

*Keywords:* Estrogen; Adsorption; pH; Anaerobic granular sludge; Zero-valent iron

---

\* Corresponding author.