环境科学

纳滤膜过滤MBR出水的污染原因与清洗方法

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中文摘要

为研究膜-生物反应器（MBR）出水对纳滤膜的污染原因及清洗方法，使用场发射扫描电镜、傅立叶变换红外光谱仪、原子力显微镜和接触角仪对经MBR出水污染的纳滤膜表面污染层进行了检测.结果表明，纳滤膜表面污染物包括有机物和无机物，所含元素包括磷、镁等.对经过不同清洗步骤的膜表面进行的检测表明，柠檬酸清洗可以去除镁和大部分磷，这些物质主要以无机形态存在于膜面污染物中；后续NaOH清洗可以进一步去除磷，这部分磷主要来自有机酸、有机磷或蛋白质等膜面污染物.污染使膜表面粗糙度由79.5 nm增大至111.2 nm，但接触角由55.6°变为62.1°，表明亲水性变化不大；酸洗后表面粗糙度显著减小至51.9 nm，接触角变为96.0°，表明有机污染物暴露出来，膜面呈现疏水性；再经碱洗后，膜面粗糙度与亲水性均接近于新膜.这些结果说明，先酸洗后碱洗的方法可以去除绝大部分的膜面污染物，进一步推知膜污染初期主要为有机污染，之后无机物的作用使污染进一步加重.

英文摘要

In order to investigate the fouling reasons and cleaning methods of nanofiltration membrane fouled with the effluent of membrane bioreactor (MBR), FEG-SEM-EDS, FTIR, AFM and contact angle system, were applied to analyze the membrane fouling layer. The results showed that, the foulants included both organic and inorganic substances, which contained phosphorous (P) and magnesium (Mg). After investigations of membrane surfaces through different cleaning steps, it was showed that critic acid cleaning could remove Mg and most of P, which were inorganic; and subsequent sodium hydroxide cleaning could remove the residual P, which probably came from organic acid, organic phosphorous or protein. The roughness increased from 79.5 nm to 111.2 nm with fouling, but the hydrophilicity didn't change obviously according to the contact angle from 55.6° to 62.1°. But after acid cleaning, the roughness decreased to 51.9 nm and the contact angle changed to be 96.0°, which showed the organic foulants were exposed and the surface changed to be hydrophobic. And after subsequent alkali cleaning, the roughness and the hydrophilicity were both close to those of the new membrane. These results concluded that acid cleaning followed by alkali cleaning could remove most of the foulants. It was also suggested that organic matters fouled the membrane in the initial stage, and inorganic matters aggravated the membrane fouling subsequently.