

Low Concentration Domestic Wastewater Treated by an UASB Reactor at Psychrophilic Temperature

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Abstract The performance and the sludge characteristics of an upflow anaerobic sludge blanket (UASB) reactor were investigated for the treatment of low concentration ($\text{COD } 400 \sim 600 \text{ mg} \cdot \text{L}^{-1}$) domestic wastewater at psychrophilic temperature ($15 \pm 1^\circ\text{C}$). The laboratory-scale UASB reactor of 20 L of useful volume was operated for a period of 174 days. An organic loading rate of around $3.0 \text{ kg} \cdot \text{m}^{-3} \cdot \text{d}^{-1}$ was treated with a 30% ~ 50% COD removal rate. The characteristics of sludge in UASB reactor were changed. Granular sludge has been obtained in the reactor and was well settleable. The SEM photos of the sludge during the experiment showed that filamentous bacterium and bacillus were key organisms.

Key words anaerobic treatment; UASB reactor; low concentration domestic wastewater; sludge characteristics

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Anaerobic treatment of wastewater is a technique with recycling use of energy at low cost. Generally, Modern high-rate anaerobic reactors are typically applied to the treatment of high-strength wastewaters ($\text{COD} > 1000 \text{ mg} \cdot \text{L}^{-1}$) in the mesophilic temperature range (25 to 40°C). But domestic wastewaters have typically concentration of COD below $1000 \text{ mg} \cdot \text{L}^{-1}$ and many wastewaters have temperatures lower than mesophilic range ($< 25^\circ\text{C}$). Successful anaerobic treatment of such wastewaters with low cost and energy requirements would have an important influence on wastewater treatment^[1]. Several authors studied and observed some successful results in recent years^[2-4]. This experiment did elementary study on treatment of low concentration domestic wastewater by using UASB reactor at psychrophilic temperature ($15 \pm 1^\circ\text{C}$).

1 Experiments

1.1 Experimental set up

The laboratory-scale UASB reactor was made of organic glass (volume: height: diameter: $2.0 \text{ L} : 74 \text{ cm} : 5.2 \text{ cm}$). The temperature of the reactor's contents was controlled at $(15 \pm 1)^\circ\text{C}$ by a biochemical incubator.

1.2 Experimental wastewater

Experimental wastewater is the artificial prepared organic wastewater with low concentration ($\text{COD } 400$

$\sim 600 \text{ mg} \cdot \text{L}^{-1}$).

1.3 Seed sludge

Seed sludge was obtained from the digested pool of western bridge sewage disposal plant of Shijiazhuang. Sludge presented floccular and black with SS of $90.33 \text{ g} \cdot \text{L}^{-1}$ and VSS of $44.45 \text{ g} \cdot \text{L}^{-1}$.

1.4 Analytical methods

During the experiment, PH, chemical oxygen demand (COD), suspended solids (SS), volatile suspended solids (VSS), volatile fatty acids (VFA) were carried out using the Standard Methods of China.

2 Results and discussion

2.1 Operation of UASB reactor

The UASB reactor was inoculated with mesophilic anaerobic sludge. The organic loading rate (OLR) in the start up stage was $0.5 \text{ kg} \cdot \text{m}^{-3} \cdot \text{d}^{-1}$. In the OLR rising stage, the OLR was raised for three times at $0.5 \text{ kg} \cdot \text{m}^{-3} \cdot \text{d}^{-1}$. The highest OLR was $2.0 \text{ kg} \cdot \text{m}^{-3} \cdot \text{d}^{-1}$. In the third stage, OLR was raised for two times from $2.0 \text{ kg} \cdot \text{m}^{-3} \cdot \text{d}^{-1}$ to $3.0 \text{ kg} \cdot \text{m}^{-3} \cdot \text{d}^{-1}$. COD removal rate was above 30% ~ 50%. As shown in Fig 1, a full and stable conversion capacity of psychrophilic UASB system can be achieved within 174 days.

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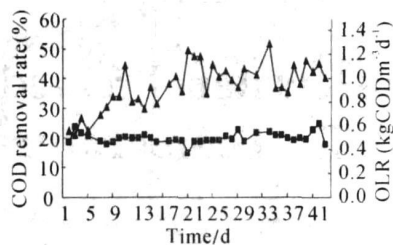


Fig 1 Operation results of the UASB reactor for treating low concentration wastewater

at $(15 \pm 1) ^\circ \text{C}$.

(▲) removal rate (■) OLR

2.2 sludge characteristics

During the course of the experiment seed sludge became floccular with good settling characteristic and at last became granular sludge. Characteristics of the sludge were observed by SEM as shown in Fig 2. The SEM photos of the granular sludge showed that filamentous bacterium and bacillus were key organisms.

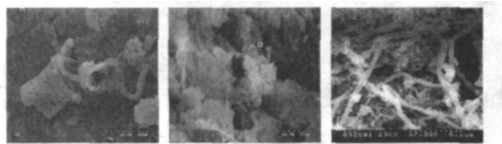


Fig 2 SEM of the microbes in sludge

3 Conclusions

The upflow anaerobic sludge blanket (UASB) reactor presented a stable operation and high performance in the treatment of low concentration ($\text{COD } 400 \sim 600 \text{ mg L}^{-1}$) domestic wastewater at psychrophilic temperature ($15 \pm 1 ^\circ \text{C}$). At psychrophilic temperature the observed increased activity of filamentous bacterium and bacillus could be due to granulation of sludge.

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UASB反应器处理低温低浓度生活污水试验研究

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摘 要: 考察了厌氧处理低温 ($(15 \pm 1) ^\circ \text{C}$) 低浓度 ($\text{COD } 400 \sim 600 \text{ mg L}^{-1}$) 模拟生活污水试验规模 UASB 反应器的工作状况及污泥特性。以厌氧消化污泥作为接种物, 以葡萄糖为有机碳源的模拟生活污水作为试验用水, 采用有机玻璃制成的 UASB 反应器, 有效容积为 20 L, 试验历时 174 个运行日。反应器最高容积负荷达到 $3.0 \text{ kg} \cdot \text{m}^{-3} \cdot \text{d}^{-1}$, COD 去除率为 30% ~ 50%。在试验运行过程中, 反应器内的污泥实现了颗粒化, 且沉降性能稳定良好。扫描电镜照片显示, 污泥中丝状菌和杆状菌是颗粒污泥中微生物组成的优势种群。

关键词: 厌氧处理; UASB 反应器; 低浓度生活污水; 污泥特性

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