Supporting Information

Continuous photo-hydrogen production in anaerobic fluidized bed photo-reactor with activated carbon fiber as carrier

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Experimental Section

Bacterium strain and medium

The photo-fermentative bacterium for hydrogen production was *Rhodopseudomonas faecalis* RLD-53.[1] The medium for the photo-hydrogen production was described previously.[2] The cultures were incubated at 35 °C anaerobically with light intensity of 150 W/m^2. Argon was used to create anaerobic atmosphere.

Photo-reactor

The novel anaerobic fluidized bed photo-reactor (AFBPR) was constructed of transparent glass with the following dimensions: an internal diameter of 80 mm, 160 mm height with a conic bottom, and a working volume of 500 ml. As shown in Fig. 1, the photo-reactor had three ports at the top: one for feeding the fresh medium, one for collecting the gas evolved by the culture, and one for recycling the culture. On the bottom of the photo-reactor was another port for recycling the culture. The medium culture was recycled with a recycling pump connecting the two recycling ports. In particular, the photo-reactor had an effluent tube in its side wall. This effluent tube was 50 mm in length and was mounted at 80 mm above the photo-reactor bottom. Moreover, our previous research had demonstrated that ACF immobilized cells gave fairly good hydrogen production performance in batch system.[3] Therefore, particles of ACF were used as carrier for biomass immobilization in AFBPR. Based on previous study, the physical characteristics of ACF particles were chosen as follows: specific surface area 1500 m^2/g, and length 1

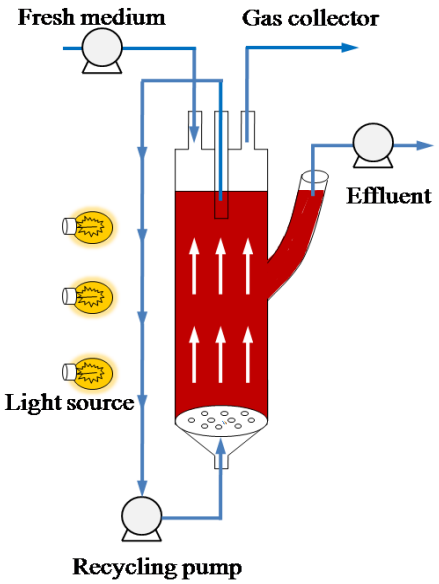

Fig.1. Schematic diagram of the anaerobic fluidized bed photo-reactor.

mm.^{3} 0.4 g ACF particles and 500 ml culture medium were loaded into the photo-reactor.

The continuous photo-reactor system and operation

The schematic diagram of the experimental system was depicted in Fig. 1. Each experimental system consisted of a photo-reactor, two light sources, three peristaltic pumps, a substrate flask, and a gas collector. The system was connected using silicon hoses. The temperature was kept at approximately 35 °C during the whole experiments. The substrate medium was fed by peristaltic pumps (BT00-100M, Baoding Longer Precision Pump Co. Ltd.), and the fresh medium can be distributed uniformly over the whole reactor by fluidization effect. Tungsten lamps were used as light sources and were located on both sides of the reactor. The biogas of each reactor was collected and measured with a measuring cylinder. All gas production data reported were standarded to the standard temperature (0 °C) and pressure (760 mmHg). The composition of biogas and organic acid concentration in each reactor were monitored separately.

Before the start-up of the AFBPR, the photo-reactor, culture medium, ACF particles and pipeline system were sterilized at 121 °C for 15 min. Inoculum of 10% (v/v) was added to each photo-reactor anaerobically. During the start-up stage, the medium was recycled to maintain the fluidization of ACF immobilized cells and no further medium was added. After four days of batch operation, the culture medium was provided by a peristaltic pump, and the AFBPR was operated on continuous mode. The hydrogen produced by the photo-reactor was measured each day until constant data was obtained, indicating that the cells had successfully immobilized on the surface of ACF particles and formed stable biofilm. Evaluation of the AFBPR system performance was performed according to the steady state conditions.

Analytical methods

For analysis with scanning electron microscopy (SEM), a gold layer was coated on the surface of specimens using Sputter Coater (Hitachi E-1010, Japan). The specimens were then examined by a scanning electron microscope (Hitachi S-3400N, Japan), according to the measure described previously by Xie et al..[4] The produced biogas was measured by water displacement method. The biogas composition was analyzed using a gas chromatograph (GC122, Shanghai analysis instrument factory) with a thermal conductivity detector, and a 2 m stainless column packed with 5 Å molecular sieve. The operating temperatures of the injection port, the column oven and the detector were 100, 60 and 105 °C, respectively. Argon was used as the carrying gas at a flow rate of 70 ml/min. The acetate concentration in effluent was determined by a second gas chromatograph (Agilent 7890A, USA) equipped with a flame ionization detector. The liquor samples were first centrifuged at 12,000 rpm for 5 min, and were then acidified with hydrochloric acid. Thereafter, they were filtrated through a 0.2 mm membrane and were finally measured for free acids. Nitrogen was used as carrier gas. The light intensity (lux) was measured with a digital luxmeter (TES-1332A, China). The pH value was measured by using a pH meter (pHS-25, China).

References

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