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Engineered heat treated methanogenic granules (EHTG): a promising biotechnological approach for high rate extreme thermophilic (70°C) biohydrogen production in expanded granular sludge bed (EGSB) reactors

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Chemoheterotrophic (dark) fermentation at extreme thermophilic (70°C) conditions presents a promising route of biological hydrogen production. To achieve satisfactory hydrogen production rate, immobilized-cell systems such as EGSB could be an alternative to carrier-free (suspended-cell) systems. However, a major drawback in the immobilized system is the long period that takes to develop the active hydrogen producing granules. Therefore, ready constructed anaerobic granules containing active and fast growing hydrogen producers are a prerequisite for fast and efficient hydrogen production. This work aimed to develop an efficient EGSB reactor system containing engineered granules for high rate extreme thermophilic biohydrogen production from carbohydrate feedstocks. Heat treated methanogenic granules (HTG) and engineered heat treated methanogenic granules (EHTG) were individually inoculated in each reactor operated at 70 ± 1°C, pH 5.5 and fed with a mixture of glucose and arabinose (1:1) at a final concentration of 5 g COD L^{-1}. HTG were obtained by heat treatment to completely inhibit methanogenic activity. EHTG were obtained by surface attachment immobilized-cell technique with an H_2-producing mixed culture enriched from digested household solid waste, using HTG as carriers. A greatly improved hydrogen production rate up to 2.5 L H_2 L^{-1} d^{-1} and a substrate conversion rate of 175 mL H_2 g^{-1} in steady state were demonstrated by EHTG in EGSB system. In comparison, almost no hydrogen production was recorded by HTG, only occasional hydrogen production peaks in the range 0.8—1.5 L H_2 $L^{-1}d^{-1}$ without real steady state were observed. Microbial biofilm developed on EHTG substan-

tially enhanced the arabinose utilization (two times) compared to HTG reactor system. Results obtained showed that application of surface attachment immobilized cell technique to construct EHTG resulted in improved biohydrogen process performance. EGSB reactor system with EHTG as microbial carriers, appears to be a promising process for highly efficient dark fermentative hydrogen production from sugar containing feedstocks under extreme thermophilic conditions.

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