Intensification of continuous bio-hydrogen production from C5/C6 sugars

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Chemoheterotrophic (”dark”) fermentation at extreme thermophilic (70oC) 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 is 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±1ºC, 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 treatment of the granules at 121ºC for 45 min 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. Scaning electron microscope (SEM) analysis showed microorganisms attached to surface of granules in both reactor systems. A greatly improved hydrogen production rate amounting up to 2500 mL H_2 $L^{-1}d^{-1}$ in steady state was demonstrated by EHTG in EGSB system. In comparison, almost no hydrogen production was recorded by HTG, only occasional hydrogen production peaks in the range 800-1500 mL H2 L-1d-1 without real steady state were observed. EGSB reactor system with EHTG as microbial carriers, appears to be the most preferred a promising process for highly efficient dark fermentative hydrogen production from sugar containing feedstocks under extreme thermophilic conditions.