INVESTIGATION ON PROCESS VARIABLES AFFECTING BIOHYDROGEN CONCENTRATION USING A COMMERCIAL GAS SEPARATION MEMBRANE

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ABSTRACT

In this work biohydrogen recovery measurements were performed by using a commercial polyimide membrane module – product of UBE Industries Ltd. – in mixed gas experiments. The impact of major process variables (gas composition, temperature, ratio of retentate and feed flow) on real selectivity was sought by statistical experimental design. It was found that all the parameters tested could considerably influence the attainable selectivity. It was also shown that the theoretical and real separation factors were significantly dissimilar. Nevertheless, in comparison with other commercially available membranes the module used possessed potential for hydrogen purification.

The research on environmental-friendly and renewable energy sources has gained considerable attention in the recent decades [1]. Among possible alternatives, hydrogen is highly promising and can play a key role in sustainable economical growth due to its carbon neutral characteristic. Moreover, it has the highest energy content (122 MJ/kg) of all the known fuels – excluding nuclear energy carriers – on gravimetric base. However, the annual hydrogen consumption is presently being satisfied through the conversion of traditional, fossil-based chemical substances such as methane [2]. Therefore, H_2 generation needs green technologies to be developed in order to make it an attractive option. In recent years, enormous efforts have been done to achieve the aforementioned aim and the biological production ways – providing biohydrogen – are in the spotlight of the research [3-5]. These methods can help to accomplish the dual goal of simultaneous organic waste management and energy production. The biohydrogen produced can be fed into highly energy-efficient fuel cells or internal combustion engines [6,7]. However, these applications require purified hydrogen and therefore its separation from the different gaseous by-products – mainly CO_2 – formed during the fermentation is an essential task.

A broad range of processes e.g. chemical absorption, cryogenic distillation, adsorption and membrane separation are available and compete with each other for biohydrogen upgrading purposes [8-10]. Recently, significant improvements have been realized in membrane technology, hence it is being considered as an energy- and cost-effective, environmental-gentle method [11,12]. Furthermore, a main benefit of membranes is that they can easily be attached to hydrogen producing bioreactors leading to the chance of integrated production and purification.

Among the various membrane-based purification systems, membrane contactors, supported liquid membranes and gas separation membranes show potential for biohydrogen enrichment.