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Partial separation of simulated lignocellulosic hydrolyzate via nanofiltration

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In recent years, bioconversion of lignocellulosic biomass into ethanol has been identified as a promising technology for producing liquid biofuels. However, lignocellulosic biomass hydrolysis produces a mixture of hexose and pentose sugars, which together are difficult to ferment to produce ethanol. Moreover, it also contains several fermentation inhibitors such as acetic acid, furfural, 5-hydroxyl methyl furfural and some phenolic compounds. Thus in literature several recombinant strains, capable of simultaneous uptake of glucose and xylose have been developed. Along with use of recombinant strains, nanofiltration has also been applied to concentrate the sugars in hydrolyzate and for simultaneously removal of inhibitors from hydrolyzate, which increased the overall sugar consumption and improved the ethanol yield [Sasaki K. et al Bioresource Technology 169, 380, 2014 also 185, 263, 2015 & Maiti S.K. et al, ibid,114, 419, 2012]. However, genetically modified strains may suffer from low yields, low productivities and genetic instability. In this study, a new strategy is used where nanofiltration is applied for separating the xylose from a synthetic hydrolyzate mixture (as shown in Fig. 1). Sjoman E. et al [Sjoman E. et al JMS 292, 106, 2007] had already shown that glucose and xylose can be separated by using nanofiltration membranes, however, their aim was towards complete separation. On the other hand in the proposed process, hydrolyzate is divided into two streams one has higher glucose to xylose ratio (retentate stream) and another has lower glucose to xylose ratio (permeate stream). Most of the inhibitors, present in hydrolyzate get enriched along with glucose in the retentate stream, which can be easily fermented by S. cerevisiae. Permeate stream with lower inhibitors concentration and lower glucose to xylose ratio can be effectively fermented by suitably adapted P. stipitis [Patent pending]. In this study simulated hydrolyzate solutions were experimentally examined using commercially available spiral wound nanofiltration modules. Experiments were performed in the volume reduction (dynamic) mode at variety of operating conditions by using different cut-off nanofiltration membranes in order to optimize the operating conditions and to identify the best suitable cut-off for maximizing the separation. The optimization study involved would be to minimize presence of xylose in the glucose enriched stream by combination of suitable concentration factor and separation factor.

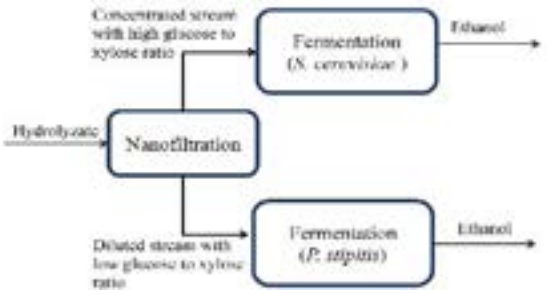

Fig. : Proposed strategy for processing of hydrolyzate from lignocellulosic biomass via nanofiltration

Biography

Dr. Gopal P. Agarwal is a Professor in the Department of Biochemical Engineering and Biotechnology at Indian Institute of Technology Delhi, INDIA for over 22 years. He has been teaching a course on Applications of membranes in Bioprocessing and Biotechnology. His research interests are also in applications of pressure driven membrane processes in downstream processing in food and biotechnology. He has been Principal Investigator of several sponsored projects worth Rs 3.5 crores from Government of India Agencies agencies like DST, DBT, IFCPAR, MDWS and ICAR. He has over 30 publications in the Journals of Membrane, Bioseparation, Separation Science & Technology, Journal of Chromatography and Bio-resource Technology.

Dr. Manish Jain worked in the area of membrane separation applied to systems in chemical and chemical industry. He has seven international publications in the field of membrane technology. He is currently working on application of nanofiltration for biofuel production.

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