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Photocatalytic conversion of CO_2 to methanol using membrane-integrated Green approach: A review on capture, conversion and purification

Sankha Chakrabortty[a,b,*], Jayato Nayak[c,**], Biswajit Ruj[b,**], Parimal Pal[d,**], Ramesh Kumar[e], Shirsendu Banerjee[a], Moumita Sardar[f], Prasenjit Chakraborty[d]

[a] School of Chemical Technology, Kalinga Institute of Industrial Technology, Bhubaneswar, 751024, Odisha, India
[b] Environmental Engineering Group, CSIR-Central Mechanical Engineering Research Institute, Durgapur, India
[c] Department of Chemical Engineering, VSB Engineering College, Karur, Tamil Nadu639111, India
[d] Department of Chemical Engineering, National Institute of Technology Durgapur, M.G Avenue, India
[e] Department of Chemistry, The Burdwan University, Burdwan, West Bengal,India
[f] Department of Chemical Engineering, National Institute of Technology Rourkela, Rourkela, Odisha,769008, India

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ABSTRACT

In the modern world, due to the ever increasing demand of electricity, industrialization and auto-mobilization, the abundance of greenhouse gases has shoot up to a critical level. A critical review has been initiated which provides a comprehensive literatures survey in the last two decades on the novel approaches available on different technologies for the anthropogenic CO_2 capturing and conversion to methanol. In addition to that, merits and demerits of existing conventional technologies for downstream separation, purification and concentration enrichment of methanol have been discussed and compared with membrane-based system to find out the best optimal conditions. Extensive literature review reveals that the development of graphene based, $TiO_2/CuSO_4$ coupled photocatalyst for conversion of CO_2 to methanol (33–37 mg/g catalyst) and downstream separation and purification using microfiltration membranes (Flux 100-110 L/m^2h) stand out to be the best possible options for catalyst recycle and product recovery. In the previous studies the conversion was found as low as in the range of 10–20 mg/g catalyst without any development of hydrogen exfoliation graphene based nanocomposite material as well as any integration of spent catalyst recycle or product purification technology based on membrane separation. Such innovation and integration of process design employing cutting-edge schemes not only reduces the concentration of CO_2 in biosphere but also produces renewable energy. These efforts towards green manufacturing while confirming the potentials of sustainable business is undeniably essential and should be stimulated.

1. Introduction

In the modern era with the population explosion, the demand of high energy in domestic, industrial and automobile sectors has caused the gigantic emission and concentration of CO_2 in biosphere. Till date, fossil fuel being the main source of energy production in power generation sectors which results in 1.9 billion tons of CO_2 generation as reported in 2015 [1]. In are port of U.S. Energy Information Administration, the global energy consumption is estimated to escalate by 56% at the end of 2040 which will direct responsible for global climate change due to greenhouse gases (GHGs). Amongst all the GHGs, CO_2 contributes maximum concentration in troposphere which has direct effect on the global warming and climate change [2]. This is why, hydrogenation of CO_2 as well as development of respective abatement strategies and environmental policies are the matters of high concern. In the present era, the devotion of researchers has been directed towards capture and further utilization or conversion of anthropogenic CO_2 to fuel [3]. This indeed serves the dual profits of Pollutant abatement and generation of valuable products at a low cost because such practice nullifies the cost of carbon source, as the raw material is being amply present in troposphere.

As per The US Department of Energy, separation of carbon dioxide is difficult because storage, transports and sequestration operations of CO_2 involves around 75% of the total operational cost. For that reason,

* Corresponding author at: School of Chemical Technology, Kalinga Institute of Industrial Technology, Bhubaneswar, 751024, Odisha, India.
** Corresponding authors.
E-mail addresses: sankha.nit@gmail.com (S. Chakrabortty), nayak.jayato@gmail.com (J. Nayak), bruj@cmeri.res.in (B. Ruj), parimalpal2000@yahoo.com (P. Pal).

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