Development of nano-catalysts in chemical transformation of carbon dioxide

SHE Task

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Table of Contents

1. Introduction

The 21st century has witnessed the rise of industries and economies to meet the increasing demands of population. Globalization has helped in bringing people together through advancement in technology, infrastructure, transportation and communication. The other side of the coin reveals depletion of fossil fuels, pollution and threat to the existence of living organisms as a serious concern to be mitigated at the earliest as possible. Deforestation, excessive use of fossil fuels and urbanization has led to the release of greenhouse gases to the environment resulting in global warming. Carbon dioxide is a greenhouse gas which is released as a by-product of combustion of natural gases or fossil fuels. The level of atmospheric carbon dioxide in 2017 was recorded to be around 400 ppm pointing as the main reason for the increasing temperatures on Earth's surface(Zhouyang, Palmore, & Sun, 2019). This report summarises the development of nano-catalysts which would help in transforming the chemical composition of Carbon Dioxide thereby making it less toxic to the environment that we live in.

2. Chemical Background

Carbon dioxide is identified to be a greenhouse gas which absorbs the heat that falls on earth and release the heat gradually over a span of time. It is less abundant in nature in comparison to water vapour but is capable to absorb small amounts of thermal energy per molecule. In this way, it contributes to the greenhouse effect on the earth's surface. Without these greenhouse gases, Earth would have been freezing cold and would not have sustained human life(Williams & Shah, 2017). Today the amounts of CO2 have exceeded the Earth's energy balance increasing the average temperature.

Catalysts are substance which are used to enhance the rate of reaction of a chemical process. Many a times, these catalysts function under harsh reaction conditions and by using reactive solvents. Nano-catalysts helps in mitigating these problems. CO2 along with a high energy starting material can be transformed into oxygen containing compounds such as the following in the presence of nano-catalysts(Vessally, Babazadeh, Hosseinian, Arshadi, & Edjlali, 2017). The products formed are as follows: -

1. Cyclic carbamates (50)
2. Cyclic carbonates (50)

3. Carboxylic acids
4. Alcohols (50)
5. Esters (50)
6. Quinazoline-2,4(1H,3H)-diones (50)

According to a research conducted in Imperial College of London, it was noted that in presence of nano-catalysts and chemical reactions, fuels such as methanol, methane and gasoline can be obtained from waste carbon dioxide(Williams & Shah, 2017).

The use of ceria and nanocrystals of metals helps in promoting catalytic reactions. It was observed that there is a strong relation between the adsorbate binding and the conversion of CO2 to syngas or other less pollutant gases(Deng, et al., 2016).

The CO2 reduction reaction can be catalysed by using metal nano-particles to obtain certain products of carbon and thereby improving the efficiency of the process. The selective conversion of CO2 to hydrocarbons is a step towards a clean and green environment. For the effective functioning of this process, the study of the nano-structure needs to be carried out for optimization of the catalysts performance(Zhouyang, Palmore, & Sun, 2019). Thin films of gold, silver nano particles, palladium nano-particles, Sn nano-particles and Nickel nano particles were used as metal catalysts to study optimize the CO2 reduction reaction. It was concluded that Au, Ag and Pd are effective into CO2RR to CO while Sn, Nickel effectiveness can be improved by varying the shell or core interaction or structure(Williams & Shah, 2017).

3. Science as Human Endeavour- Key Concepts

Interaction between Science and Environment

An increasing interest has been put into converting the carbon dioxide that is produced during various processes such as power generation, incineration, chemical production and steel manufacturing into products that are useful for the community. This would also help in reducing the costs associated with carbon sequestration and its storage. There are two major challenges which slows down the whole process(Deng, et al., 2016). Firstly, catalyst which react with CO2 inertly needs to be identified and secondly, source of energy for the reactions to carried out needs to be recognized. If these two problems are sorted out, then the path to a renewable environment by transforming CO2 into a useful component is not far away. This

interaction between science and environment is necessary to maintain a space that is safe for the human beings to survive(Williams & Shah, 2017). The CO2 which is released to the environment due to the technological advancements in science requires new ideas in science to treat them. In carbon sequestration, the carbon dioxide which is released into the environment is captured and stored beneath water bodies or barren lands thereby reducing the amount of CO2 that is available in environment. Here we see that, the CO2 which is a by-product of technological activities of science meets the environment, deteoriates the environment and finally is stored in the environment as a cover-up for the technological advancement that is toxic(Williams & Shah, 2017).

Effect on quality of life

Science has helped in improving the quality of life but has also imposed a lot of dangers because of these technological advancements. For example, setting up of large industries for production of goods on large scale has simplified life of people but the smoke and pollutants released into the environment as result of these processes has imposed dangers to the life of humans. Today a lot of research and funding are concentrated in areasto reduce the side effects that are imposed on us as result of industrialization and globalization. This method of chemical conversion of carbon dioxide into less toxic and useful products using nano-catalysts is one such research which could possibly solve the problem of increasing green-house gases in the environment and limit the rising temperatures on the earth's surface. It should also be identified if these nano-catalysts have any side effects before commercializing it for the chemical transformation of CO2

Environmental implications

Several attempts have been made to reduce the emission and pollutant levels in the environment but none has been successful. This method of using nano-crystals to reduce the amount of CO2 gases in the environment shall provide a new perspective to the effective use of greenhouse gases into products that are useful such as fuels which could meet help in meeting the growing needs of energy as well as curb the amount of CO2 in the environment.

Economic impact

Implantation of conversion strategies for CO2 using nano-catalysts would benefit multinational companies or stakeholders owning chemical companies, process equipment manufacturers and the public. This would open a new sector providing employment to many people. Further the public could reap the benefits financially and through environmental safety. Through this technology, renewable method of electricity generation will be promoted, production of fuels from waste CO2 would reduce the dependence on fossil fuels and would help in balancing energy security(Vessally, Babazadeh, Hosseinian, Arshadi, & Edjlali, 2017). The new products that are developed via this process will attract new exports, create jobs and increase the overall revenue. It will help in developing an environmentally sustainable world without compromising on the technological aspects of the present world.

4. Conclusion

Industrialization and Globalization has helped in improving the lives of people worldwide but has increased the amount of toxic gases in the environment. Carbon dioxide is one such gas and is often referred to as greenhouse gas. This report summarizes the chemical properties of Carbon dioxide that makes it toxic in environment over a period. Further, the use of catalysts to convert carbon dioxide into useful products are studied in detail. This catalyst has few challenges; hence the use of nano-catalysts is recommended. The different methods through which CO2 can be reduced or chemically transformed into useful compounds are studied through advance research and literature review. The key concepts of interaction between science and environment are brushed through. The positive impact on the quality of life, economic impacts and environmental benefits of this method of chemical transformation of CO2 into useful products are explained in brief in this report.

5. References

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