

Chapter 5

Microbiological Carbon Sequestration: A Novel Solution for Atmospheric Carbon – Carbon Sequestration through Biological Approach

Mohammad Oves

King Abdulaziz University, Saudi Arabia

I.M.I. Ismail

King Abdulaziz University, Saudi Arabia

Fohad M. Hussain

King Saud University, Saudi Arabia

Nadeen M. Felemban

King Abdulaziz University, Saudi Arabia

Huda A. Qari

King Abdulaziz University, Saudi Arabia

ABSTRACT

Global modernization demands a huge energy for developing new technologies to meet the increasing human needs. The initial source of energy was fossil fuels that might release some harmful gases. Burning of fossil fuels was practiced since the 18th century, which consequently resulted in 40% increase in atmospheric CO₂ according researcher. Presently, the atmospheric level of C is increasing day by day. However, this level would reach ~1000 ppm at the end of this century. The consistent discharge of CO₂ into the atmosphere is a major threat to global warming; hence, it is important to minimize the atmospheric CO₂ by using innovative carbon sequestration technologies. Therefore, soil and water can act as a sink for C storage with the assistance of microorganisms. Here, an attempt is made to discuss these processes in details, interactions between plant and microbes, and the requirement of C sources for C sequestration in the context of climate change. We also conferred about the development of microbial inoculants for C sequestrations and their application for sustainability of agro-ecosystems.

DOI: 10.4018/978-1-5225-2325-3.ch005

INTRODUCTION

Carbon sequestration is a process of capturing and assimilation of C from CO₂ or other C associated gases as well as their transformation into organic and inorganic materials. In another word, C sequestration can be defined as;

1. “The process of removing C from the atmosphere to be deposited in a reservoir;”
2. “Capturing and storage of C where CO₂ is removed from fuel gases (such as on power stations) before it is stored in underground reservoirs” (UNFCCC, 2007), or
3. Long-term storage of CO₂ or other forms of C in reservoirs to either mitigate or diminish the global warming and avoid the risk of climate change.

Furthermore, C sequestration has been proposed as a strategy to enhance terrestrial status (soil, sediments, and vegetation), geological, and marine accumulation of the atmospheric greenhouse gases. These gases are mostly generated by anthropogenic activities particularly by burning fossil fuels either in natural or deliberate processes. Various biological, chemical or physical processes contribute to building up the global ‘C-cycle’, in which CO₂ is naturally captured and secured and its equilibrium is maintained in the atmosphere to sustain life. Similarly, some anthropogenic sequestration techniques (intentional geological or ocean storage) exploit these natural processes to capture CO₂ from its source of emission, and then stored in the ocean or underground channels such as old oil reservoirs, aquifers, and coal seams (Akinola, 2014).

Global industrial revolution is responsible for generating a huge amount of C emitted into the atmosphere. Also, rapid growth of anthropogenic activities is increasing the atmospheric level of CO₂ rapidly. Moreover, studies have shown that C emission is strongly combined with world economy and country development (Canadell et al., 2007). When comparing the growth rate of CO₂ emission from fossil fuel consumption during the period 1990 to 2006 it was found that the rate was increased from 1.3 to 3.3% y⁻¹. (Canadell et al., 2007). In another study, there was a significant increase of C emission (about 29%) between 2000 and 2008 from fossil fuel consumption by emerging economies while C emission from land-use changes remained constant without any change (Canadell et al., 2007; Le Quéré et al., 2009). According to Mona Loa Observatory (USA), the average of CO₂ emission rate was observed from 2005 to 2014 and it was about 2.1 ppm y⁻¹. While the emission rate was almost two times the observed rate in 1960, the overall average of annual increasing of concentration in 2014 was 3.98.55 ppm (<http://co2now.org/>, 2015). European Commission and Netherland Environmental Assessment Agency (EU-NEAA) collected the data of CO₂ emission from worldwide locations. The agency has reported that China, America, European Union, India, and Russia are the major countries that emit a significant amount of CO₂; however, Australia, America, Saudi Arabia, Canada and South Korea released the highest amount of CO₂ per capita (<http://edgar.jrc.ec.europa.eu/news>, 2014).

Since then, the global emissions of C that resulted from burning fossil fuels, land-use change, and depleting soil organic C into atmospheric C was approximately 270±30 Pg, 136±55 Pg, and 78±12 Pg (Pg = petagram = 10¹⁵ g = 1 billion ton), respectively (Lal, 2004). Another estimation has shown a significant increase of CO₂ emission from anthropogenic activities that increased from 6.3 Gt C to 8.7 Gt C during 1994 and 2009 respectively (Boden & Marland, 2014), which represents about 39% increase over that period (Sommer and Bossio 2014). Moreover, land-use changes such as burning forest, deforestation, soil degradation, and soil organic C (SOC) depletion, released annually additional 2

24 more pages are available in the full version of this document, which may be purchased using the "Add to Cart" button on the publisher's webpage:
www.igi-global.com/chapter/microbiological-carbon-sequestration/176460

Related Content

Novel Synthesis of 4nm Anatase Nanoparticles at Room Temperature Obtained from TiO₂ Nanotube Structures by Anodizing Ti

C. Y. Torres López, J. J. Pérez Bueno, I. Zamudio Torres, M. L. Mendoza-López, A. Hurtado Macías and J. E. Urbina (2015). *Nanotechnology Applications for Improvements in Energy Efficiency and Environmental Management* (pp. 87-115).

www.irma-international.org/chapter/novel-synthesis-of-4nm-anatase-nanoparticles-at-room-temperature-obtained-from-tio2-nanotube-structures-by-anodizing-ti/115723

Mitigation of Seismic Accelerations by Soft Caissons

A. J. Brennan, A. Klarand S. P. G. Madabhushi (2013). *International Journal of Geotechnical Earthquake Engineering* (pp. 1-17).

www.irma-international.org/article/mitigation-of-seismic-accelerations-by-soft-caissons/108915

Liquefaction Susceptibility of Silty Sands and Low Plastic Clay Soils

Akhila M., Rangaswamy K. and Sankar N. (2019). *International Journal of Geotechnical Earthquake Engineering* (pp. 1-17).

www.irma-international.org/article/liquefaction-susceptibility-of-silty-sands-and-low-plastic-clay-soils/252834

Seismic Protection of Buildings by Rubber-Soil Mixture as Foundation Isolation

Radhikesh Prasad Nanda, Sayantan Dutta, Hasim Ali Khan and Subhrasmita Majumder (2018). *International Journal of Geotechnical Earthquake Engineering* (pp. 99-109).

www.irma-international.org/article/seismic-protection-of-buildings-by-rubber-soil-mixture-as-foundation-isolation/201136

Promoting Humanitarian Engineering Approaches for Earthquake-Resilient Housing in Indonesia

Krishna Suryanto Pribadi, Muhamad Abduh, Patria Kusumaningrum, Budi Hasiholan, Reini D. Wirahadikusumah and Roi Milyardi (2023). *Transcending Humanitarian Engineering Strategies for Sustainable Futures* (pp. 235-262).

www.irma-international.org/chapter/promoting-humanitarian-engineering-approaches-for-earthquake-resilient-housing-in-indonesia/320354