EasyChair Preprint

№ 10947

Environment Sustainability from CO2 Absorption in Heterogeneous Mechanochemical Systems: a Green Technology

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September 22, 2023

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Abstract

The public health is essential as living environments transformed at an accelerating rate due to the advancement of technology, civilization, and unintended environmental factors under consciousness of nature or environmental reactions over mankind from anthropogenic activities. The science, technology, and policy intervention towards environmental justice during the 21st century by transforming mechanochemical molecules for the advancement of green technology and socioeconomic integrity. Carbon is one of the fundamental elements for life on land responsible for the exchange of energy between thermodynamic reservoirs. The physiochemical CO_2 capture, storage, and utilization have a tremendous scientific potential for the production of cheaper materials and energy.

Keywords: Environmental loadings, Policy, Materials and energy, Cytotoxicity

1. Introduction

The mother planet is warming up fast due to anthropogenic activities and global greenhouse emissions continue to rise ahead of the second half 20th century influenced livelihoods or ecosystems. The impact of rubbing mechanical contacts on CO_2 emissions, energy consumption, and economic expenditure are studied on a global scale for transportation, manufacturing, energy generation, and residential sectors accounting for ~23 % (119 EJ) of global energy consumption at the tribological interface [1]. The 2nd law of thermodynamics is valuable for balancing materials and energy at rubbing mechanical contacts of man and machine interface in pursual of mechanical work as per the requirement of sustainability and balancing work-life fulcrum [2-3]. The incomplete combustion of fossil fuel in the absence of oxygen and environmental loading produces black carbon for a range of carbonaceous substances in its form in surrounding environmental conditions at local, regional, and global scales [4]. The covid#19 pandemic and post-pandemic zones in India have streamlined the academic fraternity for maintaining social distancing, promotion of virtual activities, and a synergistic general health useful for the decarbonization of the economy (Table-1).

Keywords	Synergy
Tribology	Friction, lubrication, and wear at interacting surfaces in relative motion for evolution of carbon footprints from mechanical machines primarily from urban transport sector
Thermodynamics	The transformation of chemical energy into mechanical work by IC engines for advancement of research of sink zone as carbon cycle channel from plant-based absorption in reducing environmental loadings
Hybrid Vehicles	Enhancement of mechanical efficiency of transport vehicles or passengers' cars in India during post pandemic zone a key factor for environmental synergy without influencing quantity of mechanical work
Electric Vehicles	Incorporation of electric vehicles in public transport buses for modulation of technology from convention internal combustion engines to high energy density batteries as per the requirement of Socioeconomy
Cytotoxicity	The environmental reaction of carbon emission, air borne syndrome, air droplets, and influence over the public health due to supramolecular adhesion of charged particulate matter over biological membranes

Table 1; The fundamental factor for re-searching of sustainability as per the global requirement for optimization of environmental load evolved from industrial revolution [1-4]

2. Global policies

The greenhouse gas (GHG) emissions in the atmosphere are evolving reactive forces for threatening mankind and economies to limit global temperature rise to below 2°C aiming for 1.5°C ratified in the Paris Agreement, political parties must cut ~30 Gt of GHG emissions annually by 2030 for the achievement of sustainable development goals (SDGs) [5-7]. World Bank report of three steps with data may ease to help for decarbonizing smoothly towards getting net-zero scenario and neutralize climate actions over mankind starts with planning for the long term/short term political goals [8]. The air passenger journeys in 2050 could exceed 10 billion for extrapolation of carbon emissions ~21.2 CO_2 Gt for a pledge of Fly Net Zero at the 77th IATA Annual General Meeting in Boston, USA, on 4 October 2021 in achieving net-zero carbon emissions [9]. The use of sustainable aviation fuel (SAF), new technology such as electric and hydrogen, infrastructure and operational efficiency, and offsets/carbon capture altogether may ease in the achievement of a net zero scenario. The emissions of greenhouse gases are primarily from human activities caused by global warming of surface temperature rise harming the green health of the planet with unequal ongoing contributions arising from unsustainable energy utilization, land-use change, work-life imbalance, and patterns of consumption and production amongst individuals expressed by IPCC/AR6 synthesis report on climate change [10]. The Faster Adoption and Manufacturing of Electric Vehicles (FAME) scheme was initially launched in April 2015 to encourage hybrid vehicle/EVs manufacturing for public and shared mobility by providing financial support up to charging infrastructures [11]. The biodiversity, ecosystems, climate, and human society interdependence have been quoted in a diverse form of knowledge between mitigation, adaptation, ecology, human well-being, and sustainability in climate action.

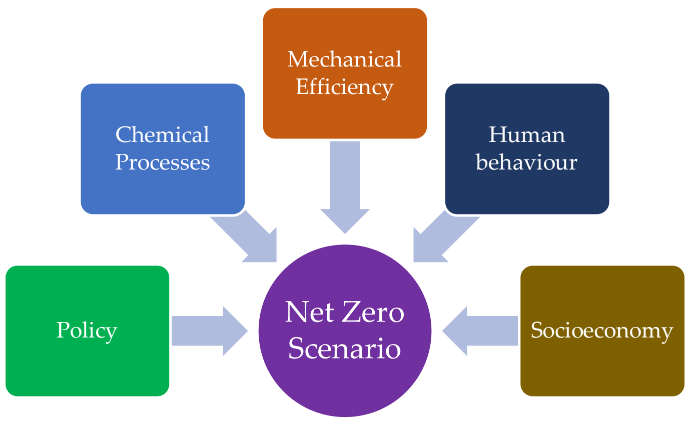

Fig. 1 The net zero carbon emission by 2050 have been expressed as a function of policy quoted as SDGs/Paris Agreement/IPCC/FAME/Fly Net Zero; Chemical processes for CO_2 capture, storage, and utilization; Mechanical efficiency upgradation of mechanical machines used in transport by use of Hybrid/EVs/Technology innovation; Human behaviour for synchronization of per capita carbon budget; Socioeconomy for re-searching of tribology energy involvement at mechanical surfaces, interfaces, and interphases;

3. CO_2 absorption

Plant-based CO_2 absorption is a natural way of transforming the gaseous form of carbon into a solid matter of cellulose, hemicellulose, and lignin in forming an anisotropic and inhomogeneous macromolecule [12]. Chlorophyll and other light-sensitive pigments or photosynthetic cells absorb solar irradiation in the presence of CO_2 and transform solar energy into glucose in addition photosynthetic cells not only regulate the carbon cycle but also evolve oxygen molecules in the atmosphere [13]. The photosynthesis equation is a way to the reinforcement of the most abundant biopolymer of hydrophilic cellulose macrostructure in a matrix of residual hydrophobic molecules. Cellulose biomacromolecule synthesis by atmospheric CO_2 absorption represents a carbon flux of ≈3.6 Gt annually for a plant-based carbon sink in ecosystems whereas cellulose microfibres from the plant cell walls represent 5–10% matter [14]. Natural Fiber is preferred in industries such as textile, automotive, packaging, and household due to the physiochemical properties of biodiversity including abaca, bagasse, bamboo, banana, coconut, coir, cotton, flax, hemp, jute, pineapple, ramie, and sisal [15]. Natural Fibre Composites benefit from the environment of renewability, biodegradability, recyclability, lightweight, and lower raw material costs easing the sustainability of products all over their life cycle stages in daily actions [16-17]. The involvement of natural bamboo material in the design and fabrication of super mileage low-cost vehicles useful for SAE academic competition is incorporated for mechanical strength prediction by the rule of mixture [18]. The green technology covered a wide area of science and technology for reducing environmental harm extending till the economical applications of cellulose biopolymers in energy generation, buildings, and automobile sectors as per the global requirement of sustainability.

4. Biodegradable products

Indian sugar mills have a capacity of sugar production of ~31.1 Mt from October 1, 2022, to April 15, 2023, leaving a plethora of "Bagasse" bioproducts useful for the production of cheaper hydrophilic and biological absorbable surfaces, interfaces, and interphases [19]. The global demand for paper and paperboard is predicted to reach 490 million tonnes for reinforcement of bagasse pulping for the paper industry as per the reduction of deforestation due to cheaper availability of sugar by-product [20]. The need for energy and environmental sustainability of sugarcane bagasse can be regarded as a feedstock for biofuels production such as bio-methane, bio-ethanol, bio-hydrogen, and bio-butanol in addition to xylitol, organic acids, xylooligosaccharides, and enzymes provide functional economic relevance [21]. The pulp and paper global market size was assessed $351.53 billion in 2021 and is predicted to rise $372.70 billion by 2029 due to the adoption of paper-based packaging, and corrugated boxes for the advancement of sustainability in reducing environmental harm [22]. Biodegradable materials may replace synthetic polymers in food packaging especially those derived from replenishable and natural resources therefore the chemical structure of the biopolymer for enhancement of biodegradability opens up economic and technological potential [23]. Human behavior is the driving force for mitigation of climate change in fighting and mitigating inverse impacts in addition to scientific modulation such as chemical processes/mechanical efficiency of vehicle upgradation/virtual evolution [24]. Sustainability investigates the entropy of global, risks to human well-being, socioeconomic paradigm, environmental reactions, and human systems for resolving the complexity that promotes the degradation of these systems.

5. CO_2 capture, storage, and utilization

The CO_2 capture, storage, and utilization ~230 Mt are annually used in direct pathways for urea production ~130 Mt, enhanced oil recovery ~80 Mt and new utilisation pathways in the production of cheaper materials and energy are gaining technological inertia for achievement of net zero scenario [25]. Urea is synthesized from CO_2 and NH_3 for economic value of CO_2 in consuming carbon dioxide molecules on a large scale influencing global warming, economy, and agriculture fertility for regulating net zero scenario from physiochemical conversion [26]. The chemical equation of urea synthesis from Habor-Bosch process is expressed fundamentally at a pressure range 10-20 MPa and temperature 400^0C to 500^0C most economical fixation of nitrogen;

$$N_2 + 3H_2 \xrightarrow{Haber-Bosc} 2NH_3 \quad \text{(i)}$$

$$2NH_3 + CO_2 \xrightarrow{Urea\ synthesi} (NH_2)_2CO + H_2O \quad \text{(ii)}$$

The two amino functional groups and carbonyl group are mechanochemical bonded in the synthesis of urea transform most quantitative CO_2 molecules of atmosphere into solid matter. The CO_2 evolution from industry ~7 Gt, transport ~7 Gt, energy ~13 Gt added net flow of ~17 Gt in atmosphere with plant & water cycle-based sinking of CO_2 loading in thermodynamic cycle [27]. The energy and carbon utilization of materials efficiently convert CO_2 using technological advancement of electrocatalytic and photocatalytic reduction, polymerization, biohybrids, and molecular machine technologies for technoeconomic resilience of CO_2 utilization in the production of chemicals [28]. Carbon dioxide (CO_2) has been valuable notoriously inert molecules in enhanced oil recovery (CO_2-EOR) due to its physiochemical potential to increase recovery from conventional oil reserves, reduce global greenhouse gas emissions, and synergistic interactions with nanomaterials due to surface functionalization [29]. The urea synthesis, enhanced oil recovery, and carbon dioxide capture and storage have been seen for reducing anthropogenic loadings.

Conclusions

The environmental loadings of carbon emission primarily from transport sector has evolved respiratory stress during covid#19 pandemic for technological evolution of materials and energy balance. The research of friction, lubrication, and wear at rubbing mechanical contacts of transport vehicles are visible for the last few decades for saving energy dissipation. The global industrialization in past had accelerated the use of fossil fuels as a source of energy responsible for environmental load of greenhouse gasses especially CO_2 for a threat to the environment green health henceforth CO_2 capture, storage, and utilization is accepted as a potential technological frontier for advancement of green technology. The human behavior, biological absorbable economy, and virtual etiquettes shall balance the fulcrum of CO_2 loadings over urban cities.

Acknowledgement

Author may like to acknowledge JioFiber, Reliance Industry for providing cyber facility useful for writing of academic content prepared by researching during covid#19 pandemic and post pandemic zones in India.

Author Contribution

Author wrote paper with published preprints for originality of academic expression as per the requirement for achievement of performance indicators

Conflict of Interests

None conflict of interests to declare

Funding Resources

None funding resource in writing of academic content

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