IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

AN EVOLUTIONARY IMPACT OF UPGRADING IN GREEN CHEMISTRY

NEETU TANWAR[a]SHASHIPANDEY[b]POOJA KHATANA*

K L MEHTA DAYANAND COLLEGE FOR WOMEN,FARIDABAD, HARYANA

ABSTRACT

Urbanisation and industrialization are such a high wave in the last few years which on one hand is raising the world economic power and on other hand is its ugliest side which remains untouchable, hasaffected the mother universe vigorously.Each element of the universe like earth,air,fire, water and space got under the trap of harmful effects of harsh chemicals.Green chemistry turns out to be a gold coin or we can say a round clock having the twelve principles which represents the methodology techniques under eco-friendly chemical processes. It is based on development of green synthesis of participating chemicals by using renewable sources and on that discussion, we have to emphasize upon the valuable application of green chemistry beneficial for human health and environment. The impact of green chemistry on pharmaceutical analysis, environmental pollution analysis and company are described in this review.Since they are multidimensional, every choice and analytical altitude has consequences both in the final product and in everything that surrounds it. The future of green chemistry as well as our future and the environment is also contemplated in this work.

Keyword – Eco friendly, Renewable, Environment, Sustainable, Green, Chemistry, Bio Catalysis

INTRODUCTION

Since twenty years green chemistry becamea blessing in the field of chemistry. It deals with process which involves the reduction in the production of harmful products and also in the reduction of chemical used for various chemical reactions(1). Twelve principles of green chemistry influenced the chemical industries towards its safest side. Our mother earth also started smiling and paying gratitude to Paul Anastas and John warmer who brought these twelve principles of green chemistry in the world.Though the seed of implementing the idea of environment protection originated a decade ago, many of them failed in execution due to lack of collaborative efforts from industries.But these principles of green chemistry have brought magical impact in the field of chemical industries·Useof biodegradable chemicals,green solvents like water,perflourine,and polyethylene glycol is less hazardous to our nature. Biocatalyst which are also called green catalyst like some bacteria,fungi are used to speed up many chemical reactions (2). New processes of chemical reactions are available which reduce the formation of multiple derivatives in between the reaction. Use of microwave heating in place of heating done by the use of solvents decreases globalwarming around the world.Technologies are invented which increase the yield of product formation in the reaction which further reduces the wastage of chemicals. Hence green chemistry has proved to be saviour of chemicals and various natural resources for our future generation (3).

TWELVE PRINCIPLES OF GREEN CHEMISTRY(4)

(1**) Prevent waste**: Designing chemical synthesis to avoid waste. Reduce the waste production as much as possible. Do not leave the waste to be treated.

(2**) Maximize atomic economy**: Designing the synthesis in such a way that the final product contains the maximum percentage of the initial material. Little or no atom is wasted.

(3) **Design less dangerous chemical synthesis**: Designing the synthesis that either uses, or generate substances with minimal or no toxicity for humans or the environment.

(4) **Designsafer chemicals**: Designing chemicals which are fully effective but have minimal or no toxicity.

(5**) Use safer solvents and reaction conditions**: Avoid use of separating agents, solvents or other auxiliary chemicals. If required, use the safer ones.

(6**) Increase energy efficiency**: Perform chemical reactions at room temperature and pressure whenever and wherever possible.

(7**) Use renewable raw materials**: Use initial materials which are renewable rather than exhaustible ones. Renewable raw material sources are usually agricultural products or other bio-waste or waste from other processes; sources of exhaustible raw materials include the fossil fuels (oil, natural gas or coal) or mining activities.

(8**) Avoid chemical derivatives**: Avoid the use of any temporary changes or protective groups, if possible. These derivatives use additional reagents and generate a lot of, often avoidable, waste.

(9**) Use catalysts, stoichiometric non-reagents**: Minimize the waste by using catalytic reactions. Catalysts are very effective in smaller quantities and can perform a single reaction multiple times. They are preferable over the stoichiometric reagents, which are required in excess and can react only once (5).

(10) **Design chemicals for degradation**: Design those chemicals which reduce harmful substances after their use so that they do not accumulate in the environment.

(11**) Real-time pollution prevention**: Include an in-process control and monitoring, in real time during the synthesis to reduce or eliminate the formation of harmful byproducts.

(12**) Minimize the risk of accidents**: Design such chemicals with their physical forms (solid, liquid or gaseous) to reduce the potentials of chemical accidents and explosions.

USE OF RENEWABLE RESOURCES FOR CIRCULAR ECONOMY

Compared to the "take-made-dispose" linear industrial model, the CE focuses more on reclamation. The circular economy is an economical model that is designed to be recoverable, renewable and to maximize the usability and value of various products, components and material. The use of renewable resources as inputs not only accord with the three aforementioned concepts but also closes the material loop which is the key step for CE. This input can be used in industries, turned into fuel and produced, and released back into the atmosphere in the form of CO_2 via photosynthesis. In turn, the final output from non-renewable resources cannot be reabsorbed, accumulating in the atmosphere instead (6). Consequently, renewable resources satisfy each part of green chemistry and are critical to analyse for their properties, applications and uses. There are three case studies which use renewable input and are introduced below.

BAMBOO PRODUCTION AND CONSUMPTION FOR CIRCULAR ECONOMY

Bamboo is a rapidly-growing grass which has strong potential for integration into the CE through applying GCPs as a material as shown in Figure 1. Bamboo is not only productive, cellulose rich, has little moisture but also tolerates a variety of growing conditions given precipitation (7) .Bamboo reaches peak strength during full maturity, which is only 3 - 5 years depending on the species. Moreover, the natural fibres in bamboo, or cellulose, can form biodegradable composites as a superior alternative to petroleum-based polymers and materials. Considering these characteristics, the versatility of bamboo lends itself to a multitude of applications and incorporation into various industries (8). Particularly, the abundance of biomass in bamboo and many environmental benefits make it a viable material for biorefinery.

In fact, bamboo-based bioethanol is more environmentally friendly than petrol emissions by 45 – 93% .It is also more sustainable than wood biomass, which supplies roughly 13 % of global energy, but is dwindling in supply. Bamboo has a multitude of inherent benefits demonstrating from the aspects of social wellbeing, environmental conservation and economic grow. Bamboo naturally continues to grow after harvesting without the need to replant seeds and does not cause soil depletion or deterioration. As a material, the strength of bamboo is comparable to that of steel and concrete (9). Moreover, every portion of the bamboo can be utilized, including the waste. This lends bamboo to a variety of uses and translates to resource efficiency. The CE can not only help the economy reach a new development node, but also make industry, society and the environment reach a balance toward SDGs.

BIO-PULPING PROCESS FOR CIRCULAR ECONOMY

Circular economy is an appropriate way for development of pulp and paper industry which have intensive resources consumption and environmental pollution. The concept of CE emphasizes effective management of resources from cradle to grave.

Straw was used as input in bio-pulping process where enzyme was used and paper products were produced after thermal and mechanical process. Then the pulp waste was utilized

in the production of biogas or it can be burnt for energy production. The generated power and biogas can be applied for paper products again. The fly ash from power plant can be effectively utilized as fertilizer for crops. After harvesting crops, grain and straw can be obtained where straw can be used as the input of the bio-pulping process to close the loop. On the other hand, crops and straw as bio-feedstock can convert into energy by combustion to CO_2 in atmosphere. Finally, the emitted CO_2 will be consumed via photosynthesis of crops.

Recycling 1 t of straw can reduce 0.9 t of CO_2 emission, produce 0.55 t of pulp (is equivalent to reducing 0.5 t of CO_2 emission) and produce 0.325 t of organic fertilizer (is equivalent to reducing 0.4 t of CO_2 emission). CE can contribute to the development of science and biotechnology cooperating with other social sectors including ecological sciences, construction engineering, sociology, financial economics, territorial and urban planning.

CARBON NEUTRALITY FOR CIRCULAR ECONOMY

The energy structure now a days is highly relying on petroleum feed stocks. Although the emergence of renewable energy brings light to the solution shortage of resources, energy storage is the bottleneck of low-carbon energy application and development. In the sustainable organic fuel for transportation (Figure 3) concept the overflowed or off-peak electricity produced from solar, wind, hydro and nuclear energy are used to avoid waste in energy in carbon neutrality cycle The electricity was introduced for hydrogen production: $H_2O \rightarrow H_2 + 1/2\ O_2$. Then the hydrogen reacts with CO_2 through $CO_2 + 3H_2 \rightarrow CH_3OH + H_2O$ to synthesize methanol which is a bio-derived fuel. The consumption of CO_2 in this process is a good commitment for being carbon-neutral. In addition, specific catalyst is essential in the hydrogen production process to overcome the reaction energy barrier.

Methanol as an alternative of petrol is able to provide energy for transportation via $CH_3OH + O_2 \rightarrow CO_2 + H_2O$. The CO_2 from transportation sector was emitted into atmosphere, which can take part in photosynthesis to give oxygen under the sunlight and biomass. Following by gasification of biomass to give syngas which is a mixture of CO and H_2, it can be converted into liquid fuel or further transformed to hydrocarbons (such as Dimethyl Ether (DME) and olefins). CO_2 from transportation and other emission source (power plants and industry) can also be collected via carbon capture and utilization (CCSU) process. The captured CO_2 is recycled for further usage or directly used back in synthetic fuel processes where to close the loop of circular economy cycle. CE can minimize natural disasters caused by energy consumption and excessive carbon emissions while reducingthe cost consumption of enterprises and increase their revenue through additional products which contributes to the development of green economy and green business.

Green solvents

Environmental health and conservation become an important issue for healthy future.The demand for ecologically conscious products increases. Some traditional solvents can have undesirable effects on the environment and as a result, green solvents are quickly rising in popularity as an eco-friendly alternative. Green solvents are the product of green chemistry. Green chemistry states that, among other things, not even the production of green solvents should harm the environment. There is a focus on solvent recyclability using ecologically effective methods and biodegradability under normal conditions.

Green solvents, sometimes called Bio solvents, are eco-conscious solvents that are derived from plant matter. Green solvents work to replace petrochemical solvents like propylene, butadiene, benzene, toluene, and methanol. While petroleum solvents have low levels of toxicity when compared to other solvents, they can still cause negative health effects in people if inhaled in large quantities or if there is long-term exposure.

Examples of Green Solvents

Ionic Liquids (ILs) are an example of green solvents. They are desirable due to their low vapor pressure, versatility, and their lack of flammability. Ionic Liquids are recognized as “designer solvents” while also being eco-conscious. Their downside is that they are not easily biodegradable.

Deep Eutectic Solvents (DESs) are green solvents that are similar to ILs. Both solvent types are viscous, have low volatility, aren’t inflammable, and are thermally stable. Natural Deep Eutectic Solvents, which are a subset of DESs, have the added benefit of being biodegradable, which makes them ideal for use in the cosmetic and food industry.

Bio-based Solvents are green solvents in various categories and can fall into esters, terpenes, ethers, and alcohols. They come from a number of biological sources. One of these green solvents is ethyl lactate. Ethyl lactate comes from corn and is environmentally neutral, monetarily economical, and has an effectiveness similar to petrochemical solvents. Another bio-based green solvent's production, 2-methyltetrahydrofuran (2-MeTHF), involves furfuran, which is derived from corn stalks, corn cobs, and the husks of oats and peanuts.

Green Solvent Usages

When it comes to green solvents, the applications are numerous. Green solvents aim to replace petroleum solvents that are used widely in many industries like the cosmetic, perfumery, food, and pharmaceutical industries. Green solvents can be used to extract colours from raw material, or fats and oils. Some solvents are used to extract scents and antioxidants. DESs in particular have used extracting proteins, volatile compounds, flavonoids, and sugars.

Biocatalysis

Biocatalysis is "the use of natural substances to speed up (catalyze) chemical reactions". In most cases, a group of proteins called enzymes will be carrying out the catalysis, but a combination of enzymes as well as cells can be used. These enzymes can be taken from the cell, either from the original cell or from a different cell that was modified to produce the enzyme.

Enzymes are involved in life processes, including digestion and getting energy from digested food. Therefore, a lot of chemical reactions catalysed by enzymes have a biologically-related function. Possibly the oldest example of biocatalysis is brewing, where microorganisms are used to convert sugars into alcohol; historical records date back 6,000 years.

Biocatalysts can also be used to replace chemical catalysts, and this has the advantage that toxic by-products of chemical catalysis are bypassed. This makes it cleaner and removes the need to clean up the toxins.

Another advantage of using enzymes is their specificity and ability to function in mild conditions. Enzymes are larger than traditional chemical catalysts, therefore there are more contact points between the substrate and the enzyme. Being a biological molecule, enzymes are able to function in milder conditions; this means that the substrate and the newly formed molecules do not need to be protected during the reaction. Also, modifications can easily be made to the enzyme via protein engineering, so that it can work with a different substrate.

Application of Biocatalysts in the Pharmaceutical Industry

Despite the advantages that enzymes can bring, their use in the pharmaceutical industry has not been wide-spread. This was mainly down to the fact that it took time to identify and optimize enzymes for reactions. Improvements in access to enzymes and protein engineering have led to the possibility of using enzymes in pharmaceutical industry.

From Whole Cells to Isolated Enzymes

Traditionally, when whole cells were used, it would be extremely time consuming as well as complex to fully optimize. Therefore, this method was only really used at the end of a drug production, if at all. However, once enzymes were stably isolated, it gave the opportunity for the enzyme to be used at any stage of drug preparation.

To expand the repertoire of enzymes available, genome sequences can be used; due to improvements in DNA sequencing, there are now many genome sequences available to the public. Using the DNA sequence of known enzymes, it is possible to search for sequences which are similar. Once these similar sequences are found, it can then be placed into a different organism and then made to see if the sequence does in fact, code for an enzyme.

Protein Engineering

Initially, enzymes were not "engineered" and used in its natural state; once screening had shown that an enzyme yielded the desired reaction, it was used. In the 1980s to 1990s, the structures of enzymes were used to drive the modification of enzymes to be able to use a wider range of substrates, including using non-natural substrate.

Following this, a directed evolution approached was applied; by using selection pressures, the enzymes were forced to change, and by applying different pressures it is possible to try and force the enzyme to change in adesirable way. The problem with this is that it can take time; in one example, it took one year of directed evolution to optimize a transaminase used in drug production

Considering that the final enzyme can be as much as 10-20% different from the original, this means that there is a huge number of variants that need to be screened. Therefore, new approaches may be needed. Truppo suggests a design-test-make cycle, where computational tools are used to design enzymes which would most likely be optimal, then making and testing these. In this way, the potential function of the modified enzyme can be tested during the design phase and only those that potentially function in a desirable manner need to be made and tested.

Biodegradable Plastics

The use of plastics is increasing the amount of pollution in the environment. Plastics particles & other plastics pollutant have been discovered in our environment and food chain, posing a health risk. Biodegradable plastics materials focuses on producing a more sustainable and greater world with a less environment foot print from this stand point.This assessment should take into account the objectives and priorities for generating a wide range of biodegradable polymers across their full life cycle. Biodegradable plastics can have features similar to standard plastics while also providing additional benefits due to their reduced carbon dioxide impact on the environment, as long as proper waste management, such as composting, is implemented.

Optimisation of lactic acid production

Lactic acid is the starting material for poly-lactic acid. The goal of this study was to make lactic acid from agro-industrial wastes as a low-cost, renewable substrate while also lowering pollution levels in the environment. Agro-industrial wastes produced sixteen bacterial isolates. Hydrochloric acid, sulfuric acid, and sodium hydroxide were used to chemically hydrolyse agricultural and industrial wastes.

Bio-Diesel

Bio-diesel (a mixture of methyl esters and fatty acids) is an alternativediesel fuel extracted from renewable resources like edible and non-ediblevegetable oils and animal fats. The basic similarity between diesel derivedfrom petroleum and these natural oils and fats is that they are made up oftriglycerides. Due to this reason, the idea of 'Bio-diesel' came forward. InIndia, it is extracted from the transesterification of oil obtained from the*Jatropha curcas* plant.

CONCLUSION

Green chemistry is not a brand-new field of study. It is a new philosophical approach that, if implemented and expanded upon, might result in significant advancements in chemistry, the chemical industry, and environmental protection**.** Green chemistry concepts should have knowledge and habits that can be put into practice. Currently, one can readily discover fairly fascinating instances of the application of green chemistry laws in the literature. These concepts might be applied not just to chemical production, but also to their processing and utilisation.Several novel analytical procedures have been established, all of which are carried out in accordance with green chemistry guidelines. These methods are especially useful for executing chemical operations and measuring their environmental effect.

ACKNOWLEDGEMENT

The authors NT and SP are thankful to **Miss Pooja Khatana**(Department of Chemistry) for her valuable support. The authors also thank **Dr Purnima Verma & Dr Annu Kalra** (Department of Chemistry, K.L. Mehta Dayanand College for women) for providing guidance for writing this review article. We are also thankful to e-library facilities of our college in making of this review.

REFERENCES

1- Karli M Newcity, Highlights of the impacts of green and sustainable chemistry on industry, Academia and society in the USA, Johnson Matthey Techol. Rev. vol 61 issue 3 207, 2017

2- Ji Chen, Scott K Spear, Polyethylene glycol & solutions of polyethylene glycol as green reaction media, Green Chemistry, Issue 2 , 2005

3- MeseluEsezulaAyalew, ThevabakthiSiluvai, The technology of green chemistry and its function in redox response and environmentally friendly technology for sustainable development: assessment of recent findings, Advances in chemical engineering and science , Vol 12 Issue 3 2022

4- Ashley DeviemoKreuder, Tamara house knight, A method for assessing greener alternatives between chemical products following the 12 principles of green chemistry, Sustainable chemistry & engineering, Vol 4 , issue 4, 2927-2935, 2017

5- Mohit Mishra, Mansi Sharma, Green synthesis interventions of pharmaceutical industries for sustainable development, Current research in green and sustainable chemistry, Vol 4, 2021

6- Ziyang Guo, Alison Wang, Implementing green chemistry principles for circular economy towards sustainable development goals, Chemical engineering transactions, Vol 88, 2021

7- Rosulu, H.O., Balongun E.O., Hassan, Exploring the Neglected Potential of Bamboo Cultivation and Utilization in Nigeria for Sustainable Development: An Overview, International Journal of Research and Scientific Innovation, Vol 6, Issue 11 2019

8- M R Snjay, G R Arpita, Applications of Natural Fibers and Its Composites: An Overview, Natural Resources, Vol 7 issue 3 2016

9- Rahmirathour, Hemant kumar , Multifunctional applications of bamboo crop beyond environment management an Indian propectives, Bioengineered Vol 13 , issue 4 , 8893-8914, 2022