

Green Chemistry: Design of Safer Chemical and Process Protocols for Healthy Environment

Satinder Kaur Brar^{1*}, Rama Pulicharla¹ and Mausam Verma²

¹Institut National de la Recherche Scientifique, Centre - Eau Terre Environnement, 490, rue de la Couronne, Québec, Québec G1K 9A9 Canada

²CO₂ Solutions Inc., 2300, rue Jean-Perrin, Québec, Québec G2C 1T9 Canada

Preventing pollution is an important issue in the current world than cleaning up the environment. By tradition, chemists have designed products that are effective and economical. They have not considered the waste generated during processing of the new chemicals and products and its toxicity. Inventing any new products that are of concern to us or ecosystems ultimately goes into the environment at the end of the life of these substances, leading to accumulation, degradation and toxicity. Hence, it is always better to choose the process protocols that generate minimum waste and finished products with few chemicals usage and synthesis steps. Our science builds on great achievements by chemicals and chemists. It's been more than 150 years that we have been finding a way to invent new molecules. And the modern chemistry with its inventions has improved a lot our lives providing an incredible array of products in every field (consumer products, cloths and electronics) and mainly save lives on this earth with new medicines.

During early progress of science, we have only focused to get final products and its benefits. However, at that given time, we have great natural resources, very less polluted environment and less population so we did not consider the waste produced by the inventions and its toxicity. And gradually our needs increased and the inventions also accrued to meet the growing demand. This led to utilization of natural resources and further polluted the environment. Now is the time to prevent environmental pollution, so we have to engage in this great scientific challenge with urgency and focus for giving healthy environment to our next generation.

Green chemistry is the most fundamental approach for preventing pollution. It encourages innovations and promotes products that are environmentally and economically sustainable. The Pollution Prevention Act of 1990 legislation has given birth to today's green chemistry initiatives. In nature, green chemistry is cleaner, cheaper and smarter and it prevents pollution at molecular level. By definition, it is a philosophy of chemical research and engineering that encourages the design of products and processes that minimize the use and generation of hazardous substances. In traditional chemistry, we use large quantity of starting material to get the final product and discard most of it as waste. The theme of green chemistry is to maximize the incorporation of the starting materials or reagents into the final product and also to develop a method that synthesizes a needed product by putting together basic building blocks (at molecular level), rather than by breaking down a larger starting material. For making most of the products (consumer products, cloths, cosmetics and electronics) and chemicals, various chemicals are mixed together in larger quantities which are potentially toxic liquids and solvents to get a final product. And the pharmaceuticals are also made in the same fashion to get a finished chemical product. Hence, most of the waste generated in the chemical industries is solvent related (80-85%). Now, the chemical industry is traditionally viewed more as a cause than a solution to pollution, even though chemistry offers unique solutions in the area of waste prevention.

The term green chemistry was coined by Paul Anastas in 1991. And the concept was initiated by Trevor Kletz [1] where he proposed that chemists should look for alternative processes to those involving more dangerous substances and conditions. Green chemistry is finding innovative solutions to the real world problems and now innovations are moving from the lab to market place. Environmental protection agency (EPA) developed new technology to remove solvent usage in chemical and product synthesizes. This technology reduces chemical waste, cost of production and produces chemical more quickly. Based on molecular designing, EPA developed computer software which gives some estimation of toxicity and best synthesis process involved. This saves time and reduces lot of preliminary studies. Using green chemistry, now we can reinvent every product which is in the market in a sustainable and green way.

Many of these innovations also led to fabrication of tiny wonder nano-materials which do not cause harm to the environment. Education about the green chemistry is essential to communicate the benefits of green chemistry to society and the main objective of this is to give understanding of the molecular mechanisms of how chemicals affect human health and the environment. A central goal of green chemistry is to avoid hazard in the design of new chemicals and developing a technology base that is inherently non-toxic to living things and the environment. It does not normally deal with research associated with remediation issues. Green chemistry guides chemists and gives some guidelines about toxicity to follow early in the new chemical development process. Teufel et al. [2] studied the mechanism of detoxification of chemicals by bacteria and find the way bacteria break down toxic chemicals. These studies at molecular level help us to design new chemicals such that their detoxification can be done by natural microorganisms present in soil or water after entering into the environment. Present major scientific challenge is to design a method to identify which chemical compound is nontoxic after finishing its intended function and enter into environment. The basic problem is that we designed chemicals to be stable to prevent degradation and this stability of compound after entering to the environment makes them difficult to degrade.

***Corresponding author:** Satinder Kaur Brar, Institut National de la Recherche Scientifique, Centre - Eau Terre Environnement, 490, rue de la Couronne, Québec, Québec G1K 9A9 Canada, Tel: 418-6543116; Fax: 418-6542600; E-mail: satinder.brar@ete.inrs.ca

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Green chemistry focuses on the connections between humans, chemistry and environment. The main goal of green chemistry is inventions at molecular and atomic levels so as to increase the chemical efficiency resulting in little or no waste. Thus, green chemistry is the cradle for green processes and green technologies and thus a greener world [3].

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