Green Chemistry

Description

Green chemistry is the practice of designing chemical products or processes that reduce or eliminate the use or generation of hazardous substances. One example of this is using lower hazard chemicals in place of chemicals with higher hazards that are more expensive to dispose of. This practice can often be cheaper and safer for labs in addition to being far cheaper when it comes to hazardous waste disposal. Substitution of hazards is the second most effective most effective method of hazard control after elimination. The 12 Principles of Green Chemistry provides a framework for implementing sustainable and environmentally-friendly processes and behaviors:
[su_spoiler style="fancy" icon="chevron" title=" Waste Prevention "] It is better to prevent waste than to treat or clean up waste after it has been created.[/su_spoiler] [su_spoiler style="fancy" icon="chevron" title=" Atom Economy "] Synthetic methods should be designed to maximize the incorporation of all materials used in the process into the final product.
Conventionally, reaction efficacy is dictated by percent yield. However, atom economy delineates the mass of the reactant atoms that are incorporated in the desired product and that which yields waste by-products.

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% Atom Economy = (FW of atoms utilized/FW of all reactants) X 100
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[/su_spoiler] [su_spoiler style="fancy" icon="chevron" title=" Less Hazardous Chemical Synthesis "] Wherever practicable, synthetic methods should be designed to use and generate substances that possess little or no toxicity to human health and the environment.
Although toxic substances are routinely utilized as reactive chemicals afford reactions that are kinetically and thermodynamically favorable, efforts should be made to mitigate the overall toxicity profile of a product or process.
[/su_spoiler] [su_spoiler style="fancy" icon="chevron" title=" Designing Safer Chemicals "] Chemical products should be designed to effect their desired function while minimizing their toxicity.
Highly reactive chemicals are often used by chemists to manufacture products because they are quite valuable at affecting molecular transformations. However, they are also more likely to react with unintended biological targets, human and ecological, resulting in unwanted adverse effects.
[/su_spoiler] [su_spoiler style="fancy" icon="chevron" title=" Safer Solvents & Auxiliaries "] The use of auxiliary substances (e.g., solvents, separation agents, etc.) should be made unnecessary wherever possible and innocuous when used.
The linked Greener Solvent Guide in an excellent resource for selecting less-hazardous alternative solvents.
[/su_spoiler] [su_spoiler style="fancy" icon="chevron" title=" Energy Efficient Design "] Energy requirements of chemical processes should be recognized for their environmental and economic impacts and should be minimized. As opposed to solely focusing upon parameters needed to facilitate a given reaction, it is important to consider where the energy comes. Whenever possible, synthetic methods should be conducted at ambient temperature and pressure.
[/su_spoiler] [su_spoiler style="fancy" icon="chevron" title=" Use of Renewable Feedstocks "] A raw material or feedstock should be renewable rather than depleting whenever technically and economically practicable. Strive to use renewable feedstocks to develop low energy, non-toxic pathways that convert biomass to useful chemicals in a manner that does not generate more carbon

than is being removed from the environment. In essence, this principle aims to implement positive carbon footprints.
[/su_spoiler] [su_spoiler style=”fancy” icon=”chevron” title=” Reduce Derivatives “] Unnecessary derivatization (use of blocking groups, protection/ deprotection, temporary modification of physical/chemical processes) should be minimized or avoided if possible, because such steps require additional reagents and can generate waste.
One of the best approaches to reduce the use of derivatives and protecting groups in the synthesis of target molecules is through the use of enzymes.
[/su_spoiler] [su_spoiler style=”fancy” icon=”chevron” title=” Catalysis (versus Stoichiometric) “] Catalytic reagents (as selective as possible) are superior to stoichiometric reagents.
[/su_spoiler] [su_spoiler style=”fancy” icon=”chevron” title=” Design for Degradation “] Chemical products should be designed so that at the end of their function they break down into innocuous degradation products and do not persist in the environment.
[/su_spoiler] [su_spoiler style=”fancy” icon=”chevron” title=” Real-Time Pollution Prevention “] Analytical methodologies need to be further developed to allow for real-time, in-process monitoring and control prior to the formation of hazardous substances.
[/su_spoiler] [su_spoiler style=”fancy” icon=”chevron” title=” Inherently Benign Chemistry for Accident Prevention “] Substances and the form of a substance used in a chemical process should be chosen to minimize the potential for chemical accidents, including releases, explosions, and fires.
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