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Green chemistry: "The need or necessity for environment protection"

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ABSTRACT

Manmade disasters wrap an ample range of events produced largely due to negligence, accidents, or sometimes even by human design and its errors. These also include the threats of nuclear, biological and chemical disasters. This emphasized the regular check and modification in current scientific solutions and to promote the quest of 'Go Green'. Water source can be used for pioneering scientific solutions at laboratory level and to resolve the scientific & environmental issue. It is in abundant source on earth and versatile in nature to behave as a communicator for various chemical/biological reactions. This solvent is best green solvent for various chemical and biological processes the utility ad its superiority over others have been investigated and evaluated.

Introduction

Irrespective of unique geo-climatic conditions which make it vulnerable to natural disaster like floods, draught, cyclones, earthquakes, and outbreak of diseases leading to a sizable number of human casualties' manmade disasters are now on its peak. These are result of imbalance in natural resources which is due to the action of human being and it is worth here to say that this imbalance arrived due to the resources used for the benefit of mankind and humanities but the care taken in using these recourses are kept on the top of negligence. This negligence need a review and the remedies are also supply by the nature but the need is to recognize the solutions.

Water is a divine molecule because it is ubiquitous (about 70% of Earth is covered with water, and the main component of all living things is water: in nearly 80%) and the only substance that no one can fear[1]. Further since the beginning of human civilization water remains the major source of energy and communicating agent (like: propagation of waves and thus energy). In scientific terminology any communication always required some medium and the communication at micro-level is best provided either by air or solution phase, which must contain some transference. Thus water is one of the major concerns as a medium and energy transfer resource. It has already known as a medium for variety of vital functions and reactions at molecular levels.

As water is among the most abandoned (70% earth surface is covered with it) environmental friendly and least expensive liquid thus is very important as solvents, therefore reactions mediated by water should constitute the ideal green chemistry. The term Green Chemistry means: Technologies that are energy efficient, minimize or preferably eliminate the formation of waste, avoid the use of toxic/hazardous solvents and reagents or use of solvent free or Recyclable Environmentally Benign Solvent systems or Green solvents, where possible, utilize renewable raw materials and improved Atom Efficiency. Paul T. Anastas an organic chemist working in the office of pollution prevention and toxins at the EPA and John C. Warner developed the Twelve Principles of Green Chemistry in 1991. These principles can be grouped into reducing risk and minimizing the Environmental Footprint. The 12 principles are as follows:

Prevention: It is better to prevent waste than to treat or clean up waste after it has been created.

Atom Economy: Synthetic methods should be designed to maximise the incorporation of all materials used in the process into the final product.

Less Hazardous Chemical Synthesis: Wherever practicable, synthetic methods should be designed to use and generate substances that possess little or no toxicity to people or the environment.

Designing Safer Chemicals: Chemical products should be designed to affect their desired function while minimising their toxicity.

Safer Solvents and Auxiliaries: The use of auxiliary substances (e.g., solvents or separation agents) should be made unnecessary whenever possible and innocuous when used.

Design for Energy Efficiency: Energy requirements of chemical processes should be recognised for their environmental and economic impacts and should be minimised. If possible, synthetic methods should be conducted at ambient temperature and pressure.

Use of Renewable Feedstock's: A raw material or feedstock should be renewable rather than depleting whenever technically and economically practicable.

Reduce Derivatives: Unnecessary derivatization (use of blocking groups, protection/de-protection, and temporary modification of physical/chemical processes) should be minimised or avoided if possible, because such steps require additional reagents and can generate waste.

Catalysis: Catalytic reagents (as selective as possible) are superior to stoichiometric reagents.

Design for Degradation: Chemical products should be designed so that at the end of their function they break down

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into innocuous degradation products and do not persist in the environment.

Real-time Analysis for 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.

Inherently Safer Chemistry for Accident Prevention: Substances and the form of a substance used in a chemical process should

Why Green Chemistry- its aim and strength: Chemistry is incontrovertibly a very important part of our daily lives. Technological developments in chemistry bring new environmental problems and harmful unexpected side effects, which result in the need for 'greener' chemical products. *Green chemistry* looks at pollution prevention on the molecular scale and is an extremely important area of Chemistry due to the importance of Chemistry in our world today and the implications it can show on our environment. The *Green Chemistry* program which works very closely with the twelve principles of *Green Chemistry* supports the invention of more environmentally friendly chemical processes. One of green chemistry's greatest strengths is the ability to design for reduced hazard. In brief the main aim of the green chemistry is to reduce the harmful impact of chemicals to environment, eliminate the health hazards from human/animal life and virtually eradicate the contamination of the environment through the scientific inputs. Apart from other objectives like cost reduction, improved technology, easy handling, non toxicity the green chemistry searches for alternative environment friendly reaction conditions which will improve the desired product formation with good yield and high reaction rate in cost effective manner and easily manageable reaction conditions: like low reaction temperature and pressure. The technological and scientific advancement in this regards give the most important alternative in the form of green solvent. The use of green solvents will support the requirements of chemistry, socially, environmentally, & economically.

Search of Good green solvent and superiority of water energy over others: *The important requirements for being a good Green solvent are* Low toxicity, Easy recyclability (no disposal) Further desirable characteristics are: -Easy removal from the product & Low reactivity. Thus the idea of ''green'' solvents is arrived to minimize the environmental impact caused due to the production process in chemical/pharmaceutical industry resulting from the use of solvents in chemical processes. The best known green solvents are: *1. No solvent 2. Water3. Carbon dioxide 4. Ionic liquids 5. Lactate esters 6. Fluorous phase reactions*

All these solvents have some advantages and disadvantages which need to be considered according to the suitability for the process among these top two are the best known till date.

Although Use of no-solvent, i.e. solvent-free reactions is the good option but this may work for only a few reactions as in general, a lack of reaction medium may lead to overheating of the reaction mixture and, yielding a mixture of by-products thus finding environmentally benign green-solvents is a top priority for the organic chemist. Another solution, however the recent researches shown the biphasic technologies, using fluorous and ionic liquids along with aqueous systems and supercritical carbon dioxide, have formed the main thrust of a movement. Ionic liquids are good solvents as they have negligible vapor pressure and will thus not evaporate into environment. However, the cost and toxicity of ionic liquids are big concerns in using them as a solvent. Thus, the last option remains is naturally abundant water as a solvent [1].

Water always remains the first choice for chemist and scientific community as a reaction media due to following reasons [2]: Water as a reaction medium

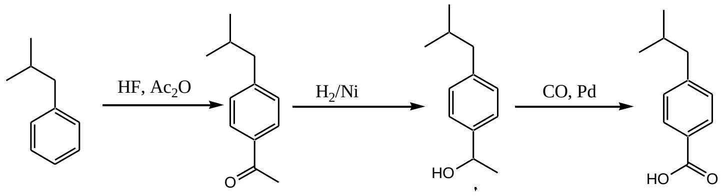
Economically & environmentally attractive

- Inexpensive and abundantly available
- Non-inflammable and non-toxic
- Odorless and colorless

Highly polar reaction medium

- Novel reactivity of organometallic complexes
- Facile product separation/catalyst recycling
- Reduced product contamination

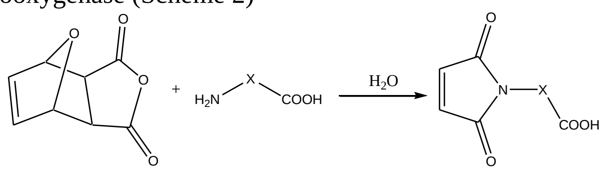
Some of the known applications of water in Synthetic chemistry: Number of reactions is known which can be accomplished in water (solvent) these are oxidation [3a, b], dehydrogenation [3c], hydrogenation [3d], halogenations [3e], dehalogenations [3e], allylations [3f], coupling of acyl chlorides and alkynes [3g] etc. One of the important medicine Ibuprofen (scheme: 1)(nonsteroidal anti-inflammatory drug (NSAID) used for relief of symptoms of arthritis, fever,[4] as an analgesic for pain, especially where there is an inflammatory component, and dysmenorrhea.) could be synthesized by the alternative path using water as solvent in efficient manner.



Hoechst route to Ibuprofen

Scheme: 1[4]

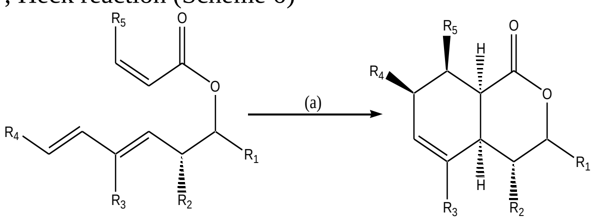
This cheap solvent is used in simple method for the synthesis of maleimides potential new types of inhibitors of cyclooxygenase (Scheme 2)[5]



Maleimide

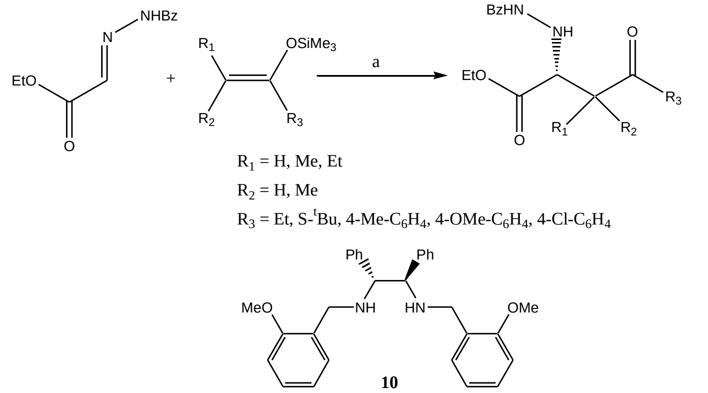
Scheme: 2[5] Inhibitors of Cyclooxygenase

In many organic name reactions water can be used as a solvent these reactions are involved in many Industrial applications for synthesis of important active precursors/pharmaceutically important molecules these reactions are Intramolecular Diels-Alder reaction (Scheme 3) [6], Mannich-type reactions (Scheme 4) [7], Wittig reaction (Scheme 5) [8], Heck reaction (Scheme 6) [9]



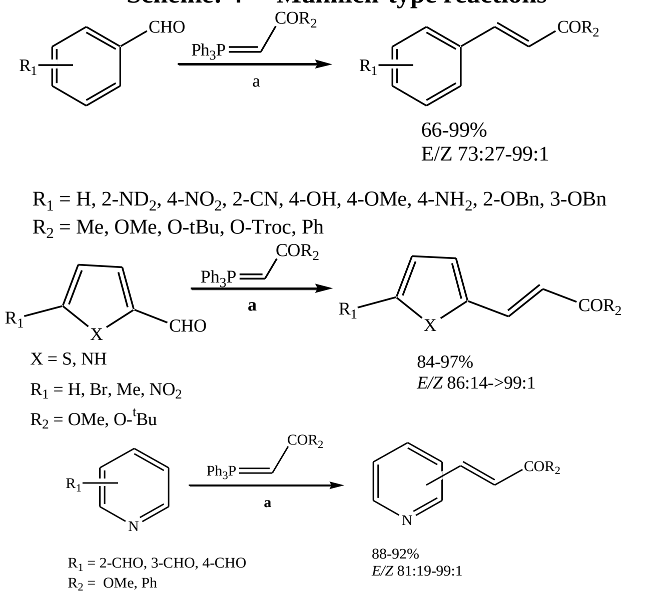
a) Alkene (0.5 mmol), In(OTf)$_3$ (20 mmol%), H_2O (6 mL), *i*PrOH (1 mL), 70-80ºC, 8-24 h[6] .

Scheme: 3 [7] Intramolecular Diels-Alder reaction



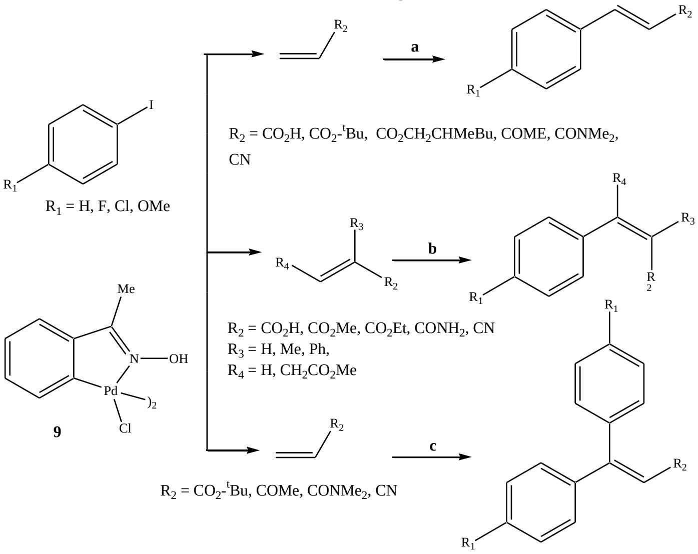
Acyl hydrazono ester (0.4 mmol), silyl enol ether (1.2 mmol), ZnF_2 (100 mol%), 10 (10 mol%), CTAB (0.02 mmol), H_2O (1.95 mL), 0 ºC, 20 h. CTAB= cetyltrimethylammonium bromide [7].

Scheme: 4 [7] Mannich-type reactions



aldehyde (1 mmol), ylide (1.2-1.5 mmol), H_2O (5 mL), 20-90 ºC, 5 min - 4 h. Troc= 2,2,2-trichloroethoxycarbonyl[8].

Scheme: 5 [8] Wittig reaction



ArI (2 mmol), alkene (3 mmol), Cy_2NMe (3 mmol), 9 (0.02-1 mol% Pd), H_2O (3 mL), 120 ºC, pressure tube, 3-23 h; b) ArI (1 mmol), alkene (1.5 mmol), Cy_2NMe (1.5 mmol), 9 (0.1-1 mol% Pd), H_2O (2 mL) 120 ºC, pressure tube, 7-38 h; c) ArI (1 mmol), alkene (0.5 mmol), Cy_2NMe (1.5 mmol), 9 (0.1-1 mol% Pd), H_2O (2 mL), 120 ºC, pressure tube, 8-22 h. Cy= cyclohexyl [9].

Scheme: 6[9] Heck Reactions

Conclusion:

Green chemistry not a solution to all environmental problems but the most fundamental approach to preventing pollution. These basics have power to save our environment and water resource plays a major role in the prevention of hazardous impact on environment. Development of environmentally benign reactions has been of central importance in recent synthetic organic chemistry. Since many organic compounds have limited solubility in water, efficient water-mediated reactions with high selectivity's and reactivities are still relatively limited, and hence there is a need for close examination of such research area

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