Research and Innovations in CHEMICAL SCIENCES

An Approach towards Qualitative and Quantitative Studies and Applications



Edited by Dr. Aruna Kumari Nakkella Dr. Vishnu Kiran Manam





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To,

Abdulrazak Shekhasaheb Bagawan Associate Professor in Chemistry, M.G.V.C. Arts Commerce and Science College Muddebihal Dt: Vijayapur St: Karnataka.

Title of Paper: Green Chemistry, 12 Principles in Practice.

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Research and Innovations in Chemical Sciences

An Approach towards Qualitative and Quantitative Studies and Applications

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Contents

Determination of Silver (I) using the Oxidation of M- Di-Anisidine (mDA) with Peroxydisulfate: By Catalytic Determination	1-5
B.S.A. Andrews, V D N Kumar Abbaraju & Vijayalakshmi Kancharla	
Walking through the Cave of Death with N, N DMT as Flame Gourab Chatterjee	6-11
An Overview of C ₄ Cycle of Plants & How it is Differ from C ₃ Cycles Pragalbh Tiwari, Nidhi Kumari, Aman Prakash & Kumar Shreshtha	12-20
Green Synthesis of Silver Nanoparticles using the Red Seaweed Solieria filiformis (Kützing) Gabrielson	21-29
Murugesan Subbiah, Natarajan Shanthi, Murugesan Kotteswari & Shanmugasundaram Shyamalagowri	
Bio Synthesis of Gold Nano-Particles using Leaf Extract and Flowers with Special Reference to the Locally Available Plants in North Eastern Region of India ; A Mini Review	30-38
Saikatendu Deb Roy, Abhijit Nath, Krishna C Das & Siddhartha S Dhar	
One Step Simple Complexometric Method for the Determination of Thallium in its Alloys and Complexes Using 1-Propanethiol as a Releasing Agent	39-45
Parameshwara Naik P & Prabhaker Walmik	
Carbon Quantum Dots (CQDS): Based Nanomaterials with Versatile Applications in Energy Storage Devices Muthulingam S & Greeshma KP	4 6 -74
Research Experimental Instruments: A Study of Liquid Crystal Dr. N.C. Shobha & Anitha R	75-83
	 Determination of Silver (I) using the Oxidation of M- Di-Anisidine (mDA) with Peroxydisulfate: By Catalytic Determination B.S.A. Andrews, V D N Kumar Abbaraju & Vijayalakshmi Kancharla Walking through the Cave of Death with N, N DMT as Flame Gourab Chatterjee An Overview of C₄ Cycle of Plants & How it is Differ from C₃ Cycles Pragalbh Tiwari, Nidhi Kumari, Aman Prakash & Kumar Shreshtha Green Synthesis of Silver Nanoparticles using the Red Seaweed Solieria filiformis (Kützing) Gabrielson Murugesan Subbiah, Natarajan Shanthi, Murugesan Kotteswari & Shanmugasundaram Shyamalagowri Bio Synthesis of Gold Nano-Particles using Leaf Extract and Flowers with Special Reference to the Locally Available Plants in North Eastern Region of India ; A Mini Review Saikatendu Deb Roy, Abhijit Nath, Krishna C Das & Siddhartha S Dhar One Step Simple Complexometric Method for the Determination of Thallium in its Alloys and Complexes Using 1-Propanethiol as a Releasing Agent Parameshwara Naik P & Prabhaker Walmik Carbon Quantum Dots (CQDS): Based Nanomaterials with Versatile Applications in Energy Storage Devices Mutulingam S & Greeshma KP Research Experimental Instruments: A Study of Liquid Crystal Dr. N.C. Shobha & Anitha R

vi

9.	Alcohol Production from Sugarcane Molasses by Fermentation Process Alok Raj, Raminder Singh & Isha Srivastava	84-88
10.	Biodegradable Microplastic Dharmasoth. Rama Devi & K. Basavaiah	89-94
11.	Green Chemistry: Effectiveness and Multidimensional Applications Tanmoy Dutta, Sandip Mondal, Sudipta Kumar Kundu & Abdul Ashik Khan	95-104
12.	Life Science Engineering: Improving Human Health and Lifestyle Priti Mishra, Neha Behar, Samiksha Sharma, Krishna Kumar Verma, Sangeeta Banjare, Sumit Kumar Dubey & W.B. Curpulo	105-116
13.	Principles of Green Chemistry K. Sowjanya, M. Pharm	117-125
14.	Green Chemistry, 12 Principles in Practice	126-133
	Abdulrazak Shekhasaheb Bagawan	120-155
15.	Application of Green and Environmental Chemistry for Hazardless, Economical and Healthier Sustainable Development in Modern World Dr. Sumanta Bhattacharya	134-137
16 .	Future of Analytical Chemistry Dr. Santosh Karajgi	138-143
17.	Synthesis and Antioxidant Activity of Indoly-Thiazolo-Pyrimidine Derivatives Prabhaker Walmik & Parameshwara Naik P.	144-150
18.	Progress toward Lignin Valorisation beyond Energy use: a 3D Amorphous Network and the Tailoring of Biosynthetic Pathways Uplabdhi Tyagi	151-159
19.	Role of Government Policies and Status of Public Health for Covid-19 Dr. K. Rashi & Divya Susan Rajan	160-164
20.	Efficiency of Fish Visceral Protease Against Inhibitors, Metal Ions and Surfactants Akhil Kumar S	165-169
21.	Introduction to the Enviromental Chemistry & It's Importance in 21 st Century Jyotsna Shukla & Pragalbh Tiwari	170-178
22.	The Therapeutic Potentials Involved in Ovary Cancer Induction: A Review Venkata Satya Harika G, Josthna P & Kodidasu Anusha	179-184
23.	Phytochemical Characterization of Marine Macro Algae in Southern Coastal Regions of Tamilnadu G. Ananthi, Bagyalakshmi and V. Ramesh	185-193

Green Chemistry, 12 Principles in Practice

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Abstract

Green chemistry, which is also known as "sustainable chemistry," which allows Chemists to create stable, green, and non-toxic chemical products and Processes, without harming human health and the environment. It is a greater state-of-the-art Way of doing chemistry, aiming at preventing pollutants and health problems on the chemical layout stage. Green chemistry is primarily based mostly on a hard and fast of 12 Scientific Principles that overlap with the requirements of sustainability and suggest a contemporary- day model of chemistry this is much less toxic, much less risky, highly green, and non-Polluting. The processes of the Green Chemistry which have been superior to this factor embody almost all areas of chemistry, inclusive of natural, inorganic, biochemistry, Polymer, toxicology, environmental, physical, technological, etc. Through the numerous winning developments of the green chemistry including catalysis, bio catalysis and using possibility of renewable feedstock (biomass), reaction media (water, ionic liquids and Supercritical fluids), reaction conditions (microwave irradiation) and new synthetic pathways (photo catalytic reaction), the dual goals – environmental protection and economic benefit may be executed. This article shows examples of the winning trends in methods that Green Chemistry reduces the impact of chemical processes and technology at the environment.

Keywords: Green Chemistry, Bio catalysis, Biomass, Ionic Liquids, Supercritical Fluids, Microwave Irradiation, Photo catalysis.

Introduction

Due to the increasing improvement in technological knowledge and generation in the second half of the 20 th century has brought on huge financial improvement and an increase in living necessities in developed factors of the world. However, such financial development has additionally induced large environmental degradation, that's manifested via way of method of greater recommended climate change, the emergence of ozone holes and the accumulation of non unfavourable natural pollution in all factors of the biosphere. The newly established nation of Affairs required the search for a method to balance the usage of natural resources, financial increase and environmental conservation.

As a end result of such reflections within side the remaining decades, awareness of the Need for environmental protection has increased, so notable interest is paid to the so-called "Green And possible technologies. The new legal suggestions and suggestions purpose to protect the Environment from dangerous chemicals, at the same time as the chemical network through the Procedures of green chemistry is geared in the course of developing new compounds And procedures which might be much less risky to human health and the environment. Green or Sustainable Chemistry is a time period related to the appearance of chemical Products and techniques that reduce or remove the use and manufacturing of dangerous Substances. As a modern department of chemistry with ecological processes it involves lowering Or disposing of using dangerous substances in chemical techniques in addition to decreasing Dangerous and poisonous intermediates and products. To be called "green," every Reaction have to have 3 green components: solvent, reagent / catalyst and energy Consumption. Green chemistry is primarily based mostly on twelve principles that may be used to create or Recreate molecules, substances, reactions and procedures which might be more secure for Human health and the environment, and the procedures of green chemistry developed to This point embody mainly all areas of chemistry, which includes Organic, inorganic, Biochemical, polymeric, toxicological, environmental, physical, technological, etc. Basic Principles of green chemistry cover a large spectrum of synthetic natural synthesis: Designing procedures in natural synthesis to reduce byproduct /waste generation, reduce the Utilization of dangerous chemicals/raw substances and decorate the usage of more secure or Greater environmentally-secure solvents and (bio) catalysts, renewable raw substances and The manner Would enhance strength efficiency. In addition, green chemistry is interested By the excellent shape of waste disposal and designing the method of degradation of chemical Products after use, all in accordance with pollutants prevention and sustainable development Measures [1]. The goals of green chemistry in environmental safety and financial Profits are finished thru numerous dominant suggestions including catalysis, bio catalysis, Using opportunity renewable raw substances (biomass), opportunity reaction Media (water, ionic liquids, supercritical fluids), possibility reaction conditions (microwave Activation , Mechanic chemistry and ultrasound) further to new picture catalytic reactions [2, 3]. This paper objectives to make contributions to a higher knowledge of the principles and Procedures underlying green chemistry, and through examples and dominant Trends to aspect to the procedures in which green chemistry reduces the impact Of chemical methods and era at the environment.

Definition of Green Chemistry

The U.S. Environmental Protection Agency (EPA) defines Green chemistry due to the fact the format of chemical products and methods that Reduce or remove the era of risky substances. The idea of green chemistry includes Renewable raw substances, eliminating waste, and avoiding risky use of toxic Reagents and solvents within side the chemical industry (Gupta

128 Research and Innovations in Chemical Sciences: An Approach towards Qualitative and Quantitative Studies and Applications

and Paul, 2014). Anastas and Warner (Anastas, 1998) have stated 12 requirements that draw the frame of green chemistry Definition. These requirements are • Preventing waste era • Increasing conversion of reactions • Designing much less risky chemical syntheses • Designing more secure chemical substances And products • Using more secure solvents and reaction conditions • Increasing energy Efficiency • Using renewable feedstock's • Avoiding chemical derivatives • Using catalysts in Place of stoichiometric reagents • Designing chemical substances and products to degrade After use • Analyzing in real-time to prevent pollution • Minimizing the capability for Accidents (EPA, 2018) A form of studies regions related to green chemistry had Been comprehensively reviewed via way of means of Erythropel et al. (2018). Green Chemistry Objectives to take away dangers proper on the layout stage. The exercise of removing dangers from The begin of the chemical format technique has advantages for our health and the environment, for The duration of the format, manufacturing, use/reuse and disposal methods. 29 Practitioners Of Green Chemistry try to shield the environment via way of means of cleaning up Toxic waste webweb sites and through way of means of inventing new chemical techniques

That do not pollute and that reduce the intake of strength and natural resources. In 1998, USChemists, Dr. Paul Anastas and Dr. John Warner mentioned Twelve Principles of Green Chemistry to illustrate how chemical manufacturing may want to recognize human health and the Environment at the same time as additionally being green and profitable. 30 Guidelines for Growing Green Chemistry technology are summarized withinside the "Twelve Principles of Green Chemistry."



The Twelve Principles of Green Chemistry:

- It is better to prevent waste than to deal with or easy up waste after it is formed : It is
 maximum appropriate to carry out a synthesis through following a pathway in order That
 formation of waste is minimum or absent. One kind of waste product not Unusualplace
 and frequently avoidable is the start fabric or reagent that remains un Reacted. The widely
 identified saying "Prevention is better than treatment have to be Followed".
- Synthetic methods have to be designed to maximise the incorporation of all Substances used withinside the method into the final product: If one mole of The start One mole of the product, the yield is 100 %. However, this kind of Synthesis can also additionally generate

huge quantity of waste or through way of means Of product which isn't seen withinside the above calculation. Such a synthesis, despite The fact that offers 100% yield, is not taken into consideration to be green Synthesis. The method have to be so redesigned to offer most yield and most Efficiency. In order to find, if a selected response is green, the idea of atom Financial system become advanced through way of method of Berry Trost of Stanford University. This considers the quantity of pointing out substances included into the Favored final product. Thus through way of method of incorporation of extra quantities Of the atoms of the atoms contained withinside the beginning substances (reactants) in To the common products, fewer waste through way of method of products are Obtained. In this way,the usage of the idea of atom financial system at the aspect of Thoughts of selectivity and yield, greener extra green synthesis may be advanced. The Atom financial system for a response may be calculated the usage of the subsequent Equation



E = 40 (40 kgs of solid waste per kg of product)

Diels – Alder reaction is 100% Atom Economy reaction as all of the atoms of the Reactants are included within side the cyclo adduct.

3. Wherever practicable, synthetic methodologies must be designed to apply and Generate materials that own very little toxicity to human health and the Environment: Synthetic methodologies must be designed to apply and generate Materials that pose very little toxicity to human health and the environment. Redesigning current changes to contain much less dangerous substances is on the Coronary heart of Green Chemistry. For example, withinside the manufacture of poly Styrene foam sheet packing material, CFC's which contribute to ozone layer Depletion, global warming and ground degree smog, have now been changed through Way of means of C0, due to the fact the blooming agent.

130 Research and Innovations in Chemical Sciences: An Approach towards Qualitative and Quantitative Studies and Applications

- 4. Chemical products must be designed to hold efficacy of feature at the same Time as reducing toxicity: The designing of more stable chemical is now possible Considering there have been extremely good advances withinside the information of chemical Toxicity. It is now quite understood that a correlation exist among chemical form e.g. Presence of useful agencies and the life of toxic effects. The concept is to Avoid the capability associated with the toxic effect. Chemical Residences of a molecule, which include water solubility, polarity etc. so one can control Molecules to the preferred effects.
- 5. The use of auxiliary substances (e.g. solvents, separation agents, etc.) must be made Unnecessary everywhere possible and danger free at the same time as used: An auxiliary substance is one Which permits in manufacture of a substance, but does now not turn out to Be an indispensable a part of the chemical. Such substances are used withinside the Manufacture, processing at every step. Major problem with many solvents is their Volatility that can harm human health and the environment. The problem of solvents Has been overcome through way of means of using such solvents which do now no Longer pollute the environment. Such solvents are referred to as green solvents. Examples include carbon dioxide (supercritical Co2). Ionic liquid water. Even Reactions were carried out in strong state. For example the condensation reaction of Orthoesters with o phenylenediamines in presence of KSF clay below solvent Free conditions the usage of microwave.
- 6. Energy necessities have to be diagnosed for his or her environmental and Monetary influences and have to be minimized. Synthetic strategies have to be Carried out at ambient temperature and pressure : Energy generation, as we Understand has a main environmental effect. The requirement of electricity may be Stored to a base minimum in positive instances through way of means of the usage of a Catalyst. For example in conversion of benzyl chloride into benzyl cyanide if we use Section switch catalyst, the conversion is going to finishing touch in a totally brief time.





Conventionally, we were carrying response through way of means of heating on twine Gauze, in oil tubtub or heating mantels. It is now feasible that the electricity to a Response may be furnished through way of means of the use of microwaves, through way of Means of picturegraph chemically. Simple examples are,

C,H,CONHC,H,---->C,H,COOH

RCOOH-----> RCOOR [Esterification]

7. A raw fabric or feedstock need to be renewable as opposed to depleting Anywhere technically and economically practicable : Non reversible or depleting Reassets can exhausted through way of means of their persistent use. So those are not appeared As sustainable from environmental aspect of view. The beginning substances which can Be acquired agricultural or organic approaches are called renewable beginning Substances. Substances like carbon dioxide (generated from natural reassets or synthetic Routes like fermentation etc.) and methane fueloline (received from natural reassets Which incorporates

marsh fueloline, natural fueloline etc.) are available in affordable Quantities and so are taken into consideration as renewable beginning fabric. Methane, A constituent of biogas and natural fueloline can without problems be converted into Acetylene through way of means of partial combustion. Acetylene is a capacity supply of Quantity of chemical compounds which includes ethyl alcohol, acetaldehyde, vinyl Acetate etc.

- 8. Reduce derivatives Unnecessary derivatization (blocking off group, safety/ Deprotection, brief modification) have to be avoided every time possible: A usually Used approach in natural synthesis is the use of protective or blocking off group. These groups are used to protect a sensitive moiety from the conditions of the reaction, Which might also additionally make the response to go in an unwanted manner if It is left unprotected. This system provides to the problem of waste disposal.
- 9. Catalytic reagents (as selective as possible) are advanced to stoichiometric reagents: The catalyst as we recognize allows transformation without being consumed or with out Being included into the final product. Catalysts are selective of their movement in That the diploma of response that takes region is controlled, e.g mono addition v/s more Than one addition. A conventional example is that discount of triple bond to a double bond Or single bond. In addition to the advantages of yield and atom economy, the Catalysts are beneficial in lowering intake of energy. Catalysts perform lots of variations Earlier than being exhausted.
- 10. Chemical products have to be designed in order that at the end in their Function they do now no longer persist withinside the environment and damage down Into harmless degradation products: It is extraordinarily important that the goods Designed to be synthesized need to be biodegradable. They need to now no longer be Chronic chemical compounds or chronic bio accumulators. It is now possible to region Practical agencies in a molecule in order to lacilitate its biodegradation. Functional Groups which can be liable to hydrolysis, photolysis or different cleavage had Been used to make sure that products may be biodegradable. It is also critical that Degradation products do now no longer own any toxicity and unfavorable results to The surroundings. Plastic, Pesticides (natural halogen based) are examples which pose To environment.
- 11. Analytical methodologies need to be similarly advanced to permit for real-time, Insystem tracking and manage earlier materials to the formation of dangerous: Methods and technology have to be advanced in order that the prevention or Minimization of technology of dangerous waste is achieved. It is essential accurate and To have reliable reasons, video display units and different analytical methodologies The harmful to evaluate that can be gift withinside the system stream. These can Accidents which might also additionally arise save you any in chemical plants.
- 12. Substances and the shape of a substance utilized in a chemical selected to decrease System have to be capacity for chemical accidents, explosions, and fires: The Incidence which includes releases, of accidents in chemical avoided. It is widely known Enterprise should be that the incidents in Bhopal (India) and Seveso many others have Resulted withinside the (Italy) and lack of lots of life. It is possible from time to time to Increase accidents capacity inadvertently to be able to decrease the technology of waste so That it will save you pollution. It has been decided that during an attempt to recycle Solvents from a system (for monetary reasons) will increase the capacity for a chemical Twist of fate or fire.

Disadvantages of Green Chemistry

The primary challenge of green chemistry is Designing such chemical products and techniques that reduce or absolutely remove the use Or introduction of dangerous and threatening

132 Research and Innovations in Chemical Sciences: An Approach towards Qualitative and Quantitative Studies and Applications

substances. This aim is likewise the largest handicap-loss Of green chemistry this is meditated in time, expenses and absence of information. More specifically, switching from an old, traditional product or method to a brand new "green" product or method calls for lots of time, format or remodel of a latest Product and method is frequently tough and quite expensive, and there may be additionally a Loss of team spirit on what's taken into consideration safe. With the excessive price of Implementation and the shortage of information, the shortage of green chemistry is also The truth that there may be no recognised opportunity to used chemical raw substances Or opportunity technology for green techniques. In addition, there may be additionally

A loss of human sources and skills. The dangers of switching to green products and Techniques aren't divided in the deliver chain, and there may be a loss of sources for similarly Research. Ionic liquids are taken into consideration to be the future of green chemistry. Although there may be absolute confidence that the ones are beneficial in chemical synthesis, The question is an increasing number of raised whether or not they meet expectations. When Making use of 12 standards that describe green chemicals, ionic liquids do now no Longer appearance in particular green. There is an opinion that on the present level of Technological know-how development it's miles unrealistic to expect that withinside the Next ten years a large software of ionic liquids may be seen. Although, as is properly Known, ionic liquids are slightly risky because of the low vapor pressure, but it's miles best One of the many things that make a substance truly green. For example, ionbased, Imidazole-primarily based totally and fluoro-anion-primarily based completely liquids are probable To be toxic however cannot attain the environment through way of means of evaporation. The problem Is that maximum ionic liquids are watersoluble and might without difficulty attain the biosphere Through that pathway [24].

Conclusions

The primary aim of every enterprise is to generate cash from available Raw substances and primary capital inside sustainable business sports. Sustainable Business sports have to meet modern desires with out jeopardizing the dreams of future Generations, which means that chemical techniques want to apply raw substances, water And energy in a manner that doesn't damage the environment and be economically possible. Establishing a balance withinside the use of natural sources, financial increase and Environmental conservation is possible via the advent of a green chemistry method Whose project is to layout such chemical techniques and products which are harmless to Human health and the environment. The software of the concept of green chemistry that Introduces chemical safety implies ok prison help through the prison law of positive processes And sports which are unavoidable for the implementation of one of these idea. The idea of Green chemistry is primarily based totally on twelve requirements that talk of reducing Or removing risky or dangerous substances from the synthesis, manufacturing and alertness Of chemical products and as a result using substances which are risky to human health And the environment is reduced or eliminated. When designing a green chemistry Technique, it's miles not possible to satisfy the requirements of all twelve standards of the technique On the identical time, however it tries to use as many requirements as possible throughout positive Degrees of synthesis. The goals of green chemistry in environmental protection and Financial benefit are performed via numerous dominant directions. Some of them are: Biocatalysis, catalysis, use of opportunity renewable raw substances (biomass), Opportunity response media (water, ionic drinks, supercritical fluids), opportunity response Conditions (microwave activation) in addition to new photocatalytic reactions. Catalysis as the Muse of green chemistry with new catalytic reactions and forms of new catalysts gives Some of advantages in terms of method utilization, selectivity, strength discount and the usage Of opportunity response media. The huge capability of microorganisms and enzymes Withinside the transformation of artificial materials with selectivity offers biocatalyst a Dominant role withinside the "green" program. Photocatalytic reactions that constitute New techniques of cleaning infected air and water additionally make contributions to Green chemistry growing situations for carrying out sustainability.

References

- Valavanidis, A., Vlachogianni, T., Fiotakis, K., (2009): Laboratory Experiments of Organic Synthesis and Decomposition of Hazardous Environmental Chemicals Following Green Chemistry Principles. International Conference "Green Chemistry and Sustainable development", Thessaloniki, 25-26/9/2009. Paper for Conference Proceedings.
- Jukić, M., Djaković, S., Filipović-Kovačević, Ž., Kovač, V. and Vorkapić-Furač, J. (2005): Dominant trends of green chemistry. Kem Ind 54 (5): 255-272, In Croatian.
- Margetić, D. (2005): Mechanic-chemical organic reactions without the use of solvents. Kem Ind 54 (7-8): 351-358, In Croatian.
- 4. Ritter, S. K. (2001): Green Chemistry. Chem. Eng. News, 79 (29), 27-34.
- Vojvodić, V. (2009): Environmental Protection: Green Manufacturing in the Pharmaceutical Industry and Cost Reduction, Kem Ind 58 (1): 32-33, In Croatian.
- Riđanović, L., Ćatović, F., Riđanović, S. (2013): The Green Chemistry-Ecological Revolution in the Classroom. 8thResearch/Expert Conference with International Participations "QUALITY 2013", Neum, B&H, June 06 – 08, 447-452., In Bosnian.
- Jukić, M., Djaković, S., Filipović-Kovačević, Ž., and Vorkapić-Furač, J. (2004): The "green" chemistry opens up the Path ecologically acceptable chemical processes. Kem Ind 53 (5) 217-224. In Croatian.
- Sheldon, R. A. Utilisation of biomass for sustainable fuels and chemicals: Molecules, Methods and metrics. Catal Today 167, 3, 2011.
- Mijin, D., Stanković, M. I., Petrović, S. (2003): Ibuprofen: Gain and Properties, Hem. Ind. 57 (5) 199-214, In Serbian.
- Anastas, P. T., Warner, J. C. (1998): Green Chemistry Theory and Practice. New York: Oxford University Press, 10-55.
- Anastas, P. T., Kirchhoff, M. M., Williamson, T. C. (2001): Catalysis as a foundational Pillar of green chemistry. Appl Catal A: General, 221: 3-13.
- Sheldon, R. A. (2007). "The E Factor: Fifteen years on". Green Chemistry. 9 (12): 1273. Doi:10.1039/ B713736M
- Welton, T. (2015): Solvents and sustainable chemistry, Proceedings of the Royal Society Of London A: Mathematical, Physical and Engineering Sciences, November 11, 2015, DOI: 10.1098/rspa.0502
- Wayne Hill, H. and Brady, D. G. (1976): Properties, environmental stability, and molding Characteristics of Polyphenylene sulfide, Polymer Engineering & Science, Vol 16, Iss 12, pp 831–835.
- Samori, C. (2010). Use of solvents and environmental friendly materials for applications. In Green Chemistry, University of Bologna, Faculty of Mathematical, Physical and Natural Science.
- Kärkkäinen, J. (2007): Preparation and characterization of some ionic liquids and their use In the dimerization reaction of 2-methylpropene. Dissertation, University of Oulu.