Green Smart Material: An Overview

Mrs. Bhattad K.S.
Dept of Engineering science
S.K.B.P. Polytechnic, Kopargaon

Abstract- *Green chemistry also called sustainable chemistry- is a philosophy of chemical research & engineering that encourages the design of product and process that minimize the used & generation of hazardous substances. With global warming being accepted as the biggest environmental challenge we face, the chemical industry must develop more energy efficient process & release its reliance on fossil fuel. The Presidential Green Chemistry, five awards are given each year, one in each of five categories: Academic, Small Business, Greener Synthetic Pathways, Greener Reaction Conditions, and Designing Greener Chemicals.*

Keywords- Greener smart chemical, Eco-friendly materials, Bamboo, cotton, glycol.

I. INTRODUCTION

"It's more effective, it's more efficient, it's more elegant, and it's simply better chemistry." Sustainable development and environmental issues are at the forefront of public and Government concern. Chemistry and Chemical Engineering may offer the solution to many of these challenges, but chemicals can also be part of the problem. Green chemistry aims to provide environmentally benign products from sustainable resources, using processes that do not harm people or the environment.

The 12 principles are of green chemistry are:

1. It is better to prevent waste than to treat or clean up waste after it is formed.
2. Synthetic methods should be designed to maximize the incorporation of all materials used in the process into the final product.
3. Wherever practicable, synthetic methodologies should be designed to use and generate substances that possess little or no toxicity to human health and the environment.
4. Chemical products should be designed to preserve efficacy of function while reducing toxicity.
5. The use of auxiliary substances (e.g. solvents, separation agents, etc.) should be made unnecessary wherever possible and innocuous when used.
6. Energy requirements should be recognized for their environmental and economic impacts and should be minimized. Synthetic methods should be conducted at ambient temperature and pressure.
7. A raw material or feedstock should be renewable rather than depleting wherever technically and economically practicable.
8. Reduce derivatives - Unnecessary derivatization (blocking group, protection/deprotection, and temporary modification) should be avoided whenever possible.
9. Catalytic reagents (as selective as possible) are superior to stoichiometric reagents.
10. Chemical products should be designed so that at the end of their function they do not persist in the environment and break down into innocuous degradation products.
11. Analytical methodologies need to be further developed to allow for real-time, in-process monitoring and control prior to the formation of hazardous substances.
12. Substances and the form of a substance used in a chemical process should be chosen to minimize potential for chemical accidents, including releases, explosions, and fires.

II. GREEN MATERIAL

Cotton as green material: Textile is one of the field where we can comfortably and economically go for the ecofriendly materials.

The difference between materials in regards to them being green depends on how the fabrics are made. One factor that really affects how they are made is where the fabric is manufactured in the world. Fabrics are considered more environment friendly that are made under strict regulations and guidelines imposed on manufacturers such as the methods and chemicals used during the dying process when the cotton is turned into different colors, as well as the imprinting of the material, which would include chemicals from the inks. Also, there are always chemicals used for clean-up which can be hazardous for the environment.

Now, to the material. The material is a very large part in consideration of how green a fabric actually is. Cotton fabric is the most ecofriendly material.

Bt Cotton – This plant produces crystal protein those are with insecticidal property.

Glass: Glass cookware provides even heat for baking and boiling. This Eco-friendly cookware alternative is actually quite indestructible in normal circumstances. Glass cookware is thick and difficult to break unless dropped with force. It cleans easily too. Eco-friendly glass cookware is 100% recyclable.

Copper: For number of reasons copper is considered as one of the most Eco-friendly cookware materials. First of all the manufacturing process for copper requires very little heat. Therefore less energy is used to produce it. Secondly, very little heat is required to cook in copper. Copper is also a very long lasting Eco-friendly material. Due to all these factors, copper cookware can be expensive but well worth the investment, since it rarely needs replacing.

Cast Iron: Generally one needs to buy a cast iron frying pan just once in the lifetime. The durability of cast iron makes it an Eco-friendly product. They are often handed down through generations. Cast iron can be seasoned to act as a non-toxic, non-stick pan. Using cast iron in place of toxic non-stick cookware keeps harmful chemicals out of cooking system. Using Eco-friendly cast iron cookware adds iron required for health.

Ceramic: Ceramic cookware lasts just as long as glass cookware, making it an Eco-friendly choice. With an enameled coating these pans distribute heat evenly. They also provide easy clean-up and a fairly non-stick surface. True, they are not as effective as Teflon but have the benefit of being completely non-toxic.

Green bamboo bike an award winning bike: As one of the world's strongest natural materials, bamboo has been used to build houses, boats and furniture, not to mention hats, toys, musical instruments and even clothes. It is now the basis for an ecologically sound mode of ground transportation, the bamboo bike.

California-based bike company Calfee Design sells bamboo bicycle frames suitable for normal use, mountain biking and racing. They are crash tolerant and provide a much smoother and more comfortable ride than their steel counterparts due to the material's excellent shock-absorption quality. Weighing in at a mere four to six pounds, the design has received awards such as Best Road Bike, Best Off-Road Bike, and Peoples' Choice Award at the North American Handmade Bicycle Show.

In addition to deriving from a natural material, the model doesn't require any electricity to be built and produces much less carbon emissions than other model types during its production.

III. GREEN CHEMICAL-

Green chemical supplies are environmentally safe cleaning solutions derived from plants. Unlike conventional chemical detergents, they do not contain harmful ingredients. This natural composition ensures the solution will not harm the environment, the user, or the surface being cleaned. But are green cleaning products as powerful as hazardous, chemical-based alternatives?

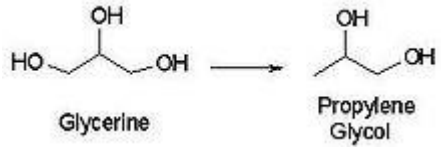
The Power behind Green Chemicals

True green cleaning products are composed of concentrated extracts of plants or vegetables that breakdown dirt deposits and grease as effectively as commercial chemicals do. The unique formulation of these green cleaners includes nano-based particles. Being extremely small, these particles quickly penetrate and break up dirt deposits and stains. These dissolved dirt residues can then be easily wiped away, washed off, or vacuumed up.

Natural cleaners offered by reputable chemical suppliers attack most types of organic matter such as grease, oil, protein, and petroleum derivatives. Green chemicals are notable for their ability to eliminate hydrocarbon deposits that often present problems for cleaning professionals. Perhaps the best reason for using green chemicals from a leading chemical manufacturer is that they protect surfaces from being re-soiled. The encapsulation and emulsification process discourages dirt, dust, and grease molecules from reattaching to cleaned surfaces.

Simpleexample of preparation of green chemical-

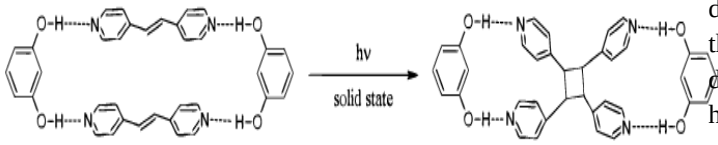
In 2006, Professor Galen J. Suppes, from the University of Missouri in Columbia, Missouri, was awarded the Academic Award for his system of converting waste glycerin from biodiesel production to propylene glycol. Through the use of a copper-chromite catalyst, Professor Suppes was able to lower the required temperature of conversion while raising the efficiency of the distillation reaction. Propylene glycol produced in this way will be cheap enough to replace the more toxic ethylene glycol that is the primary ingredient in automobile antifreeze.



Glycerine to propylene glycol

1) Supramolecular chemistry

Research is currently ongoing in the area of supramolecular chemistry to develop reactions which can proceed in the solid state without the use of solvents. The cycloaddition of *trans*-1,2-bis(4-pyridyl)ethylene is directed by resorcinol in the solid state. This solid-state reaction proceeds in the presence of UV light in 100% yield.



NANO DRY LUBRICANT POWDER

Tungsten Disulfide (WS_2), Molybdenum Disulfide (MoS_2), Hex-Boron Nitride (HBN), Graphite Specially formulated Nano Lubricant Additive Powders to improve lubricity and save energy. Industrial motors and machinery are lubricated to decrease friction between moving parts. The friction causes energy loss due to heat generation and the wearing of the machinery. Because of the massive fuel consumption by the industrial sector, even a reduction of a few percent in fuel consumption rates will significantly reduce the economical and environment costs of industry. Ali Erdemir, Senior Scientist in Argonne, says that by using the new nano based lubricant a reduction of up to five percent in fuel consumption is possible.

Boric acid is formed of stacks of crystalline layers. Each such layer has a very tight bonding within itself, but the bonding between layers is relatively weak. This combination of strong and weak forces enables a relatively easy motion of the molecules, creating the low friction coefficient of the compound.

Ali Erdemir added that there are more economical and environmental benefits to the lubricant. The new lubricant is safer and more environmentally friendly than conventional lubricants that usually contain special chemicals. Also, boron is a plentiful resource, lowering production costs. Before the new lubricant can be mass produced and sold it still needs to undergo rigorous environmental and safety tests.

In 2004, the Israeli company ApNano Materials revealed the first ever solid lubricant based on nanotechnology. ApNano's material called NanoLub is made out of nano-spheres of inorganic compounds that were discovered at the Weizmann Institute of Science, Israel. One of the most important advantages of the NanoLub is the ability to stay effective even on non-polished surfaces. Usually, parts must be mechanically polished to achieve the smoothest possible surface in order to reduce friction. However, because of its nano ball bearing-like structure NanoLub can reduce friction very efficiently even for rough contacting surfaces.

HEALTH

Companies like Smith & Nephew and De Puy are developing smart orthopedic implants such as fracture plates that can sense whether bones are healing and communicate data to the surgeon. Small scale clinical trials of such implants have been successful and they could be available within the next five years. Other possible devices include replacement joints that communicate when they become loose or if there is an infection. Current technology limits the response of these devices to transmitting data but in the future, they could respond directly by self-tightening or releasing antibiotics. This could reduce the need for invasive surgery. Biosensors made from smart materials can be used to monitor blood sugar levels in diabetics and communicate with a pump that administers insulin as required. However, the human body is a hostile environment and sensors are easily damaged. Researchers at Queen Mary, University of London are working on barrier materials to protect sensors.

THE AGEING POPULATION

There are now more people aged over 60 in the UK than there are children, creating a new market for products that make life easier for the elderly. Many of these could use smart materials and systems to include added functionality. For example, shape memory materials could be used in food packaging that automatically opens on heating for people with arthritis. Researchers at the University of Bath have developed a smart home for people with dementia that uses sensors to monitor behavior and to ensure that the resident is safe.

REDUCING WASTE

Legislation is forcing producers to consider the entire life of a product at the design stage and customers are increasingly demanding more environmentally sensitive products. Innovative use of smart materials has the potential to reduce waste and to simplify recycling.

ELECTRONIC WASTE

Electronic waste is the fastest growing component of domestic waste in the UK. The EU Directive on waste electronic and electrical equipment (WEEE) requires that it be processed before disposal to remove hazardous and recyclable

materials. Manual disassembly is expensive and time consuming but the use of smart materials could help to automate the process. Research in this new area of 'active disassembly' has been carried out by UK Company, Active Disassembly Research Ltd. One example uses fasteners constructed from shape memory materials that can self-release on heating. Once the fasteners have been released, components can be separated simply by shaking the product. By using fasteners that react to different temperatures, products could be disassembled hierarchically so that materials can be sorted automatically. The company has collaborated with Nokia and believes that this technology could be in use in the next two years.

ENGINEERING

Structures such as buildings, bridges, pipelines, ships and aircraft must be robustly designed and regularly inspected to prevent 'wear and tear' damage from causing catastrophic failures. Inspection is expensive and time consuming, while designing to prevent damage can compromise performance. With some modern materials, damage can be internally serious but leave very little surface evidence. Researchers at institutes such as the Universities of Bristol and Sheffield are working on systems that can diagnose and repair this type of damage automatically in both defense and civil applications.

STRUCTURAL HEALTH MONITORING

Embedding sensors within structures to monitor stress and damage can reduce maintenance costs and increase lifespan. This is already used in over forty bridges worldwide.

SELF REPAIR

One method in development involves embedding thin tubes containing uncured resin into materials. When damage occurs, these tubes break, exposing the resin which fills any damage and sets. Self-repair could be important in inaccessible environments such as underwater or in space. The European Space Agency is collaborating on work in this area.

THERMOCHROMIC

These materials change colour in response to changes in temperature. They have been used in bath plugs that change colour when the water is too hot.

PHOTOCHROMIC

These materials change colour in response to changes in light conditions. Uses include security inks and dolls that 'tan' in the sun.

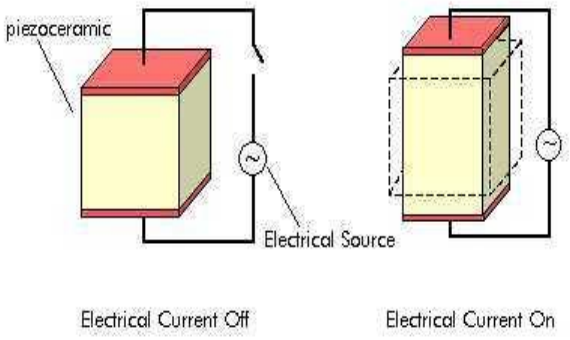
MAGNETORHEOLOGICAL

These fluids become solid when placed in a magnetic field. They can be used to construct dampers that suppress vibrations. These can be fitted to buildings and bridges to suppress the damaging effects of, for example, high winds or earthquakes.

PIEZOELECTRIC MATERIALS

Applying a mechanical stress to these materials generates an electric current. Piezoelectric microphones transform changes in pressure caused by sound waves into an electrical signal.

Piezoelectric materials have two unique properties which are interrelated. When a piezoelectric material is deformed, it gives off a small but measurable electrical discharge. Alternately, when an electrical current is passed through a piezoelectric material it experiences a significant increase in size (up to a 4% change in volume) Piezoelectric materials are most widely used as sensors in different environments. They are often used to measure fluid compositions, fluid density, fluid viscosity, or the force of an impact. An example of a piezoelectric material in everyday life is the airbag sensor in your car. The material senses the force of an impact on the car and sends and electric charge deploying the airbag.



FUTURE

The future of smart material and structures is wide open. The use of smart material in a product and the type of smart structures that one can design is only limited to one's talents, capabilities, and ability to ''think out of the box.''

In an early work and as part of the short courses taught there were discussions pertaining to future considerations. A lot of the brainstorming that resulted from these efforts is now being explored. And there are some that were in the conceptual stage are moving forward. Look at the advances made with the automobile and what information and comforts it provides through smart material and structures. We can take automobiles to a garage for service and it is hooked up to a diagnostic computer and the mechanic is told what is wrong with the car. Or we have a light on the dashboard that signals ‘‘maintenance required.’’ Would it not be better for the light to inform us as to the exact nature of the problem and the severity of it? This approach mimics a cartoon that appeared several years ago of an air mechanic near a plane in a hanger. The plane says ‘‘Ouch’’ and the mechanic says ‘‘Where do you hurt?’’

The potential of this concept is enormous. This sounds wonderful as long as we learn how to work Smarter not longer.

The major uses of GREEN CHEMISTRY

- **Energy**

The vast majority of the energy generated in the World today is from nonrenewable sources that damage the environment.

- Carbon dioxide
- Depletion of Ozone layer
- Effects of mining, drilling, etc
- Toxics

- **Energy**

- **Green Chemistry** will be essential in developing the alternatives for energy generation (photovoltaic, hydrogen, fuel cells, bio based fuels, etc.) as well as continue the path toward energy efficiency with catalysis and product design at the forefront.

- **Bio based fuel**

1. Gasohol or power alcohol:
Mixture of petrol and ethanol 10:90 proportion {BRAZIL}
2. Petro plants: Gives milky latex which can be cracked into petrol. E.g. Euphorbia
3. Petro or Energy crops- Plants from sunflower family produce oil and terpenoids, those are substitute for diesel in engine.

All above examples are good alternatives for fossil fuel.

- **Food Supply**
- **Green chemistry** is developing:

* Fertilizers and fertilizer adjuvant that are designed to minimize usage while maximizing effectiveness. E.g. Bio compost, rhizoetc
* Pesticides which only affect target organisms and degrade to innocuous by-products. E.g. Neem oil.
* Methods of using agricultural wastes for beneficial and profitable uses.

Increasing Greenness Means Prevention & Reduction, Recycling & Reuse.

REFERENCES

[1] Stevens ES. Green plastics, Princeton: Princeton University Press; 2002..
[2] Green chemistry- An introductory text by Mike Lancaster
[3] Kylma J, Seppala JV. “Synthesis and characterization of a biodegradable thermoplastic poly elastomer”. Macromolecules 1997; 30: 2876-82.
[4] Kazuya Okubo, , Toru Fuji and Yuzo Yamamoto, “Development of bamboo-based polymer composites and their mechanical properties”, Composites Part A: Applied Science and Manufacturing, Volume 35, Issue 3, March 2004, Pages 377-383
[5] Rick Johnson, “Use Of Eco-Friendly Bamboo Products On The Rise”, Home Improvement, Environment Published 05/18/2006.