Green Engineering: Future Approach Fit to Nature's Engineering

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Abstract- *The consumption and population is continuing to grow while non-renewable fossil fuels and raw materials are decreasing at ever increasing rates. A technical approach to address these issues using engineering design and analysis called the green engineering. Green Engineering transforms existing engineering disciplines and practices to those that lead to sustainability. Green Engineering in corporate development and implementation of products, processes and systems to meet technical and cost objectives while protecting human health and welfare and raises the shield of the biosphere as a standard in engineering solutions. The green engineering must be close to natural engineering system to be sustainable. The use of free energy, prevent waste generation, waste prevention and waste minimization strategies. Waste minimization can be achieved in an efficient way by followed focuses on reduce by reuse, and then recycle and finally energy recovery. Twelve basic principles of green engineering along with ten rules to follow in any of the multidisciplinary have been discussed. A few applications are studies have been presented to corroborate the benefits of green engineering with sustainable development. And issue related to green engineering being discussed.*

Keywords- Natures Intelligence, Waste Prevention and Minimization, Problem in recycling and green engineering principles.

I. INTRODUCTION

It is impossible to imagine modern life without the products manufactured by industries. These products are used in everyday aspects of life, including agriculture, construction, transportation, electronics and well-being. However, their productions generate waste release toxic chemicals increase greenhouse emissions and greatly affect human health and the environment. Engineers and scientists from diverse fields are leading the way to solve these issues and challenges. Thus green engineering has the capability to support this innovation. Green Engineering transforms existing engineering disciplines and practices to those that lead to sustainability. Green Engineering incorporates development and implementation of products, processes, and systems that meet technical and cost objectives while protecting human health and welfare and elevates the protection of the biosphere as a criterion in engineering solutions. The green engineering must meet the present day needs for the optimum yield along with disposal and waste treatment to the environmental regulatory compliance to protect the human health and global welfare of the biosphere.

II. SYSTEM OF NATURE

In essence natural systems largely operate on the free energy of the sun, which interacts with the geochemistry of the earth's surface to sustain productive regenerative biological systems. Nature does not produce any waste because the processes of each organism contribute to the health of the whole ecosystem. The matured fruit of a tree fall on the ground and gets decomposed in to the food for other living things. Bacteria and fungi feed on organic waste of both the trees and the animals, depositing nutrients in the nature's processes cyclic. In contrast to this human designed soil in a form ready for the tree to use for growth i.e. one organism's waste becomes food for another and this makes Production systems (processes) non cyclic due to which there is a continuous generation of wastes and negative impact on the environment.

III. EVOLUTION OF GREEN ENGINEERING

"Necessity is the mother of invention" this proverb best fits here. Human race and all other living things are now facing the serious consequences of ignorance that human beings have done for the development and comfort of their own. There is a continuous depletion in the natural resources since it was never bothered to replenish hence this factor along with continuous discharge of wastes has caused strange diseases and unfavorable climate change. This has compelled the human being to devise means and methods to replenish the natural resources and minimize the waste discharged to environment i.e.to evolve the concept of green engineering Green engineering is necessarily interdisciplinary and therefore can be best considered as a set of concepts which can beapplied across engineering disciplines. The scope of green engineering depends upon one's perspective and discipline but it is broadly defined as "Minimizing environmental impacts across all life cycle phases in the design and engineering of products, processes and systems".

IV. APPROACH TO GREEN ENGINEERING

We observed that whatever is being produced by Nature is recycled without having any negative impact on the environment since waste becomes food for the environment. Analogous to this, the following feasible approach to mirror the human engineering with Nature's engineering, (a) Use free energy- In the simplest sense, FREE ENERGY is any energy that is provided by the Natural World. This may include energy sources, such as solar panels or wind generators, but also could include amazing technologies like a car powered by water-fuel, a battery charger powered by Gravity, or a home heating system powered by the Earth. The best FREE ENERGY systems deliver energy at no on-going cost to the user, with no detrimental effects to the environment, and at extremely low costs for the maintenance and operation of the equipment.(b) Prevent waste generation- Experience has shown that there is no completely safe method of waste disposal. All forms of disposal have negative impacts on environment, public health and local economies. Landfills have contaminated drinking water. Garbage burnt in incinerators poisoned air, soil and water. Hence the only way to avoid environmental harm from waste is to prevent its generation. The purpose of "Reduce" is to save resources and to reduce waste, in other words, to reduce the amount of natural resources input in to the production processes and to reduce the amount of disposed waste. Basically "reduce" to be achieved by following measures.

i. Reducing the amount of raw materials and energy used per product by changing the design of the product or changing the production process.

ii. Reducing the quantity of production by extending the life of products or improving repair and maintenance technologies.

iii. Reducing the amount of disposed waste by selecting recyclable raw materials

"Re-use" is use, for the second or more time, of a product for the same purpose, under the same form and with the same properties of the material as the first use, the material having constantly remained under the same form between several uses. The distinction between re-use and recycling is easy to make referring to its structure and state. If the waste object is going through re-processing during which process its structure or state is going to change, the process is recycling. If between several uses, the structure and state of the object remains the same, the process is re-use. Reconditioning may be necessary before re-use, e.g. washing bottles between uses; however this processing does not change the bottles' structure. Wastes which cannot be materially recycled are incinerated for volume reduction, stabilization and detoxification. In the incineration process much thermal energy is generated and can be utilized for electric power generation or heating public and other facilities near incineration plants. Incineration ash is also used as a raw material for cement production and as a soil conditioner.

V. PRINCIPALS OF GREEN ENGINEERING

Green engineering focuses on how to achieve sustainability through science and technology Challenges to Achieving Sustainable Systems. The 12 Principles of Green Engineering provide a framework for scientists and engineers to engage in when designing new materials, products, processes, and systems that are benign to Human health and the environment. A design based on the 12 principles moves beyond baseline engineering quality and safety specifications to consider environmental, economic, and social factors. The breadth of the principles' applicability is important. When dealing with design architecture. Whether it is the molecular architecture required to construct chemical compounds, product architecture to create an automobile or urban architecture to build a city the same green engineering principles must be applicable, effective, and appropriate. Otherwise these would not be principles but simply a list of useful techniques that have been successfully demonstrated under specific conditions. We illustrate how these principles can be applied across a range of scales. It is also useful to view the 12 principles as parameters in a complex and integrated system. Just as every parameter in a system cannot be optimized at any one time, especially when they are interdependent, the same is true of these principles. There are cases of synergy in which the successful application of one principle advances one or more of the others. In other cases, a balancing of principles will be required to optimize the overall system solution. There are however two fundamental concepts that designers should strive to integrate at every opportunity life cycle considerations and the first principle of green engineering inherency.

The 12 Principles of Green Engineering provide structure to create and assess the elements of design relevant to maximizing sustainability. Engineer scan use these principles as guidelines to help ensure that designs for products, processes, or systems have the fundamental components, conditions, and circumstances necessary to be more sustainable.

VI. THE 12 PRINCIPLES OF GREEN ENGINEERING

Principle 1: Designers need to strive to ensure that all material and energy inputs and outputs are as inherently non hazardous as possible.

Principle 2: It is better to prevent waste than to treat or clean up waste after it is formed.

Principle 3: Separation and purification operations should be designed to minimize energy consumption and materials use.

Principle 4: Products, processes, and systems should be designed to maximize mass, energy, space, and time efficiency.

Principle 5: Products, processes, and systems should be "output pulled" rather than "input pushed" through the use of energy and materials.

Principle 6: Embedded entropy and complexity must be viewed as an investment when making design choices on recycle reuse or beneficial disposition.

Principle 7: Targeted durability, not immortality, should be a design goal.

Principle 8: Design for unnecessary capacity or capability solutions should be considered a design flaw.

Principle 9: Material diversity in multi component products should be minimized to promote disassembly and value retention.

Principle 10: Design of products, processes, and systems must include integration and interconnectivity with available energy and materials flows.

Principle 11: Products, processes, and systems should be designed for performance in a commercial "afterlife".

Principle 12: Material and energy inputs should be renewable rather than depleting.

VII. THE TEN RULES TO FOLLOW

1. Engineer processes and products holistically, use systems analysis, and integrate environmental impact assessment tools.
2. Conserve and improve natural ecosystems while protecting human health and well-being
3. Use life-cycle thinking in all engineering activities
4. Ensure that all material and energy inputs and outputs are as inherently safe and benign as possible.
5. Minimize depletion of natural resources.
6. Strive to prevent waste.
7. Develop and apply engineering solutions, while being cognizant of local geography, aspirations, and cultures.
8. Create engineering solutions beyond current or dominant technologies improve, innovate and invent (technologies) to achieve sustainability.
9. Actively engage communities and stakeholders in development of engineering solutions
10. Adopt 3R technologies (i.e. reduce, reuse & recycle) are essential tools to promote a sound material cycle society.

VIII.APPLICATION

Green engineering applications span almost every industry and range from monitoring the health of forests, so ecologists can better understand the effects of global warming, to retrofitting aging production facilities and machines with new control systems to make them more efficient. While there are many ways to group these green applications, most fall into the following three categories.

A. Renewable power generation
B. Supercritical Water Oxidation (SCWO) Process
C. Green Process Using Biphasic Catalysis

A. Renewable power generation

Renewable power generation covers a wide range of technologies including wind, solar (photovoltaic and thermal), biofuels, hydro, wave harvesting, geothermal, and even high energy physics. Research and development in these areas are exploding around the world, driven by environmental suitability goals and ever-increasing government legislation. Today more than 50 countries with a variety of political, geographical, and economic conditions have set aggressive targets for the amount of energy generated from renewable sources (see Table 1).

Table No I: Lists a few examples of the targets various governments have set for renewable energy goals.

State/Country	Renewable Energy Goal (As a Percent of Total Energy)	Target Year
Texas	10%	2025
California	10%	2020
United Kingdom	10%	2010
France	20%	2020
Sweden	60%	2020
China (Phase I)	10%	2010
China (Phase II)	15%	2020
European Union	20%	2020

B. Supercritical Water Oxidation (SCWO) Process

Supercritical water oxidation utilizes the unique properties of sc-H2O, such as the high diffusivity, low density and remarkable mass transport properties, for the destruction of various toxic and hazardous wastes streams, such as paints, oils, pharmaceutical wastes, chemical warfare agents and contaminated soil The addition of an oxidant, such as hydrogen peroxide or oxygen, is often required. The destruction efficiencies of supercritical water oxidation (SCWO) are reported to be very high (99.99%). At supercritical conditions, various organic compounds, such as chlorinated organic compounds or nitro-compounds, are destroyed to more environmentally friendly compounds, such as chloride ions and nitrates, However, this process is associated with technical drawbacks, such as corrosion and salt precipitation and as such is limited to the selection of a suitable wastewater and correctly designed reactors that satisfy a selection of criteria for successful operation, including an energy recovery system for the economically feasible implementation of this technology.

C. Green Process Using Biphasic Catalysis

Most of the industrial processes rely on catalysis, such as chemical, pharmaceutics, materials, polymers and energy. In the case of homogeneous catalysts, where the catalyst is in the same phase as the reactants, they offer numerous advantages for optimizing catalytic systems However; homogeneous catalysts suffer from many drawbacks, including difficulty in separating the catalyst particles after the reaction, which could increase the overall product cost. The concept of biphasic catalysis, which could possess high activity and reusability, has attracted considerable One such example of the biphasic catalytic process is the Ruhrchemie/Rhone-Poulenc commercial process In a biphasic catalysis system, a homogenous catalyst is modified to dissolve in a particular solvent, e.g., Solvent A, and the reactants are dissolved in another solvent, e.g., Solvent B. During the course of the reaction, the reactants, catalyst and Solvents A and B are vigorously stirred to form a single phase in which the reaction can take place. As soon as the reaction is completed, the reaction mixture is cooled down, resulting in phase separation and can be easily separated by simple decantation. Since the catalyst and product are in separate phases, this helps in removing the catalyst from the reaction mixture, and it could be recycled several times without any problems.

IX. ISSUES AND CHALLENGES OF GREEN PROCESS ENGINEERING

As we move to 2025, our society is faced with challenges in the sustainability of our current technological and lifestyle systems. There are enormous global environmental concerns, including energy and fuels, food, transportation, construction, water access and use, pollution and ecological destruction. The current and future goals of process engineering are therefore not only to sustain and reduce the cost of products, but simultaneously reduce the impact on the environment and on human health. In other words, today's process engineering has moved towards green process engineering (GPE). As such, the biggest challenge is to find innovative solutions that are based on environmentally benign design and manufacturing to avoid the generation of waste or pollutants, to keep the product cost affordable with growing demands, to increase the capability of products to be recycled or reused and with the ultimate goal of introducing significant environmental improvements. Most companies are on a sustainability mission, where parameters, such as the utilization of non depletable resources the reduction of global-equivalent greenhouse gases emissions and the reduction of energy costs (by utilizing renewable energy resources), are considered important environmental and social However, in terms of fully adopting a sustainable process, there are other factors to be considered, including suitable market conditions, effective economical regulations and social acceptance defined by product demands. To improve industrial sustainability at the process level, the principles of green engineering provide a tangible framework to address the growing concern of human health and the environment and also provide a suitable guide for green process engineering. Its emphasis is on process, system and product optimization.

X. CONCLUSION

The reuse, reduction, recycles tools to promote a Green Engineering. The basic concept is to reduce the amount of raw material input, the final disposal of waste and the energy consumed in the production and the transportation systems of products. “Reduce” should be considered as the first priority as it has the most direct effect on the reduction of wastes. It can directly reduce the scale of production process, energy consumption and the amount of waste produced by reducing the amount of input in the production process. “Reuse is regarded as second priority. “Recycle” is also important, however it cannot be denied that environmental burdens such as energy conservation are brought by the intermediate treatment and manufacturing processes of recycled products. By using the 12 Principles and 10 rules of Green Engineering as a framework, the conversation that must take place between designers of molecules, materials, components, products, and complex systems can occur using a common language and a universal method of approach. The principles are not Simple, but rather a set of methodologies to accomplish the goals of green design and sustainability.

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