GREEN ENGINEERING

WHAT IS IT AND WHY DO WE NEED IT?

Most people would agree that **climate change** is real and that we are literally burning our way through the earth's natural resources at an unprecedented and unsustainable rate - **sustainability** being defined as development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

However, even if you are not a 'believer' in these positions, there are still plenty of reasons for embracing the benefits of '***green engineering***', defined by the US Environmental Protection Agency as:

The design, commercialization, and use of processes and products that minimize pollution, promote sustainability, and protect human health without sacrificing economic viability and efficiency.

Green engineering is a holistic approach to process and product design that aims to protect people and the environment from the direct and indirect potentially adverse impacts of a company's activities, whilst facilitating efficient and cost-effective project delivery and conduct of operations.

For a production facility it typically works by reducing energy and/or raw material consumption or perhaps by intensifying production - all of which directly benefits the bottom line - and by eliminating or minimizing hazards (to people and the environment) at source, which reduces the likelihood of major accidents and the burden of waste disposal or clean-up costs.

The concept of green engineering in not new. It has been around for almost 20 years and was debated at length during a conference in Sandestin, US, in 2003 that was attended by industry leaders, academics and regulators . This resulted in the Declaration of 9 Principles of Green Engineering [1]:

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

The American Chemical Society provides a number of examples of green engineering of products on its website: www.acs.org/content/acs/en/greenchemistry

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Examples of how green engineering of processes, plant and equipment has demonstrably yielded significant safety, environmental and economic benefits would include:

Reduction of energy consumption and water and hydrogen usage by the application of pinch technology [2] - integrating heat exchanger networks and optimizing water and hydrogen consumption within a production facility (minimize depletion of resources and improve economic performance).

Elimination of hazards at source or attenuation of risk by application of inherently safer design (ISD) principles [3] during project development and execution (protect people, the environment, the asset and corporate reputation).

Process intensification [4] (do more with less e.g. smaller inventories of hazardous materials, reactive distillation instead of discreet reaction and distillation stages - minimize resource depletion, protect people and the environment and improve economic performance).

Reduction of pollutant emissions by application of waste minimization techniques [5] (conserve ecosystems, prevent waste, minimize resource depletion, protect people & the environment).

Integrated, life-cycle approach to project development, with green engineering principles built into the project execution plan (PEP) and stage gate reviews (improved project execution, overall optimization of sustainable development goals and enhanced protection of people and the environment).

In summary, green engineering addresses product development, better systems of manufacturing, better overall utilization, reuse, recycling and ultimate disposal of scarce resources, and minimization of impacts on people and the environment, whilst potentially improving economic performance.
As such, green engineering is more a way of thinking than a specific tool.
Applied systematically, green engineering can help you achieve your risk, commercial and sustainability targets.

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References

1. Abraham, M.; Nguyen, N. “Green engineering: Defining principles” – Results from the Sandestin conference. *Environmental Progress* 2004.
2. Kemp, I.C. “Pinch Analysis and Process Integration”, 2nd Edition, IChemE, 2007.
3. Kletz, T.; Amyotte, P. “Process Plants - A Handbook for Inherently Safer Design”, 2nd Edition, IChemE, 2010.
4. Reay, D.; Ramshaw, C.; Harvey, A. “Process Intensification - Engineering for Efficiency, Sustainability and Flexibility”, IChemE, 2007.
5. Crittenden, B.D; Kolaczkowski, S.T. “Waste Minimization Guide”. IChemE, 1992.