

What is Green Chemistry?



Summary

Chemical industry products usage is widespread in modern society and they have greatly improved our quality of life. In spite of these achievements, Chemical Industry is perceived as a polluting industry because of its operations environmental impact and concerns on human health. Green Chemistry (refers to design of Chemical products and processes which reduce or eliminate the use and generation of hazardous substances) provide an opportunity to Chemical Industry to show its commitment to limit harmful impacts in their operations.

SAP Solutions (like SAP EHS Management) enable Chemical companies to go beyond compliance and implement a scalable, integrated approach to manage operational risks related to environment, health, and safety issues in their operations.

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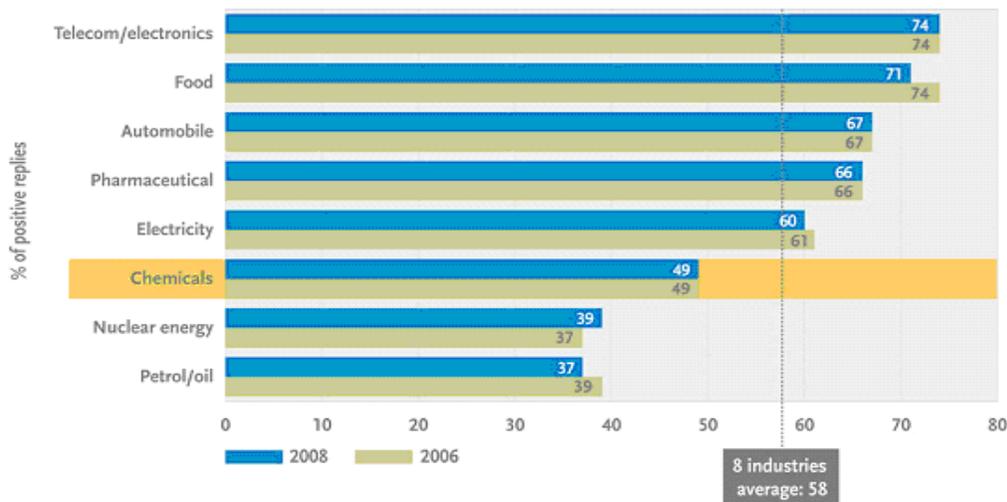
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Chemical Industry: Image Problem

It is well-known fact that Chemical Industry suffers from image problem in spite of improvement in our lives it has brought about. CEFIC (European Chemical Industry Council) carried out a survey (in 2008) to gauge Public image of the European chemical industry. The survey placed Chemical industry at 6th position out of 8 benchmark industries and its rank was also below the average.



Source: Cefic Pan European Survey on the image of the chemical industry 2008

This image problem is actually an opportunity for the Chemical Industry to introspect and ensure that its manufacturing processes are sustainable in the long run.

Chemical Industry by following Green Chemistry principles can re-address its image problem and show its caring face to the society.

Green Chemistry: Definition

As the world becomes more conscious about Global warming and rapidly depleting energy sources, Chemical Industry has to become more aware of its responsibility to pursue and ensure Efficient, Economical and Environmentally sound Chemical processing.

Green Chemistry is the design of Chemical products and processes that reduce or eliminate the use and generation of hazardous substances. It can also be defined as Sustainable Chemistry or Environmentally benign Chemical Processing.

Chemical companies attempting to pursue Green Chemistry initiatives are driven by following business incentives:

- Reduce Risk of non-compliance – from legislations and regulations
- Take care of concerns from shareholders, customers and employees
- Build Brand value and improve public perception

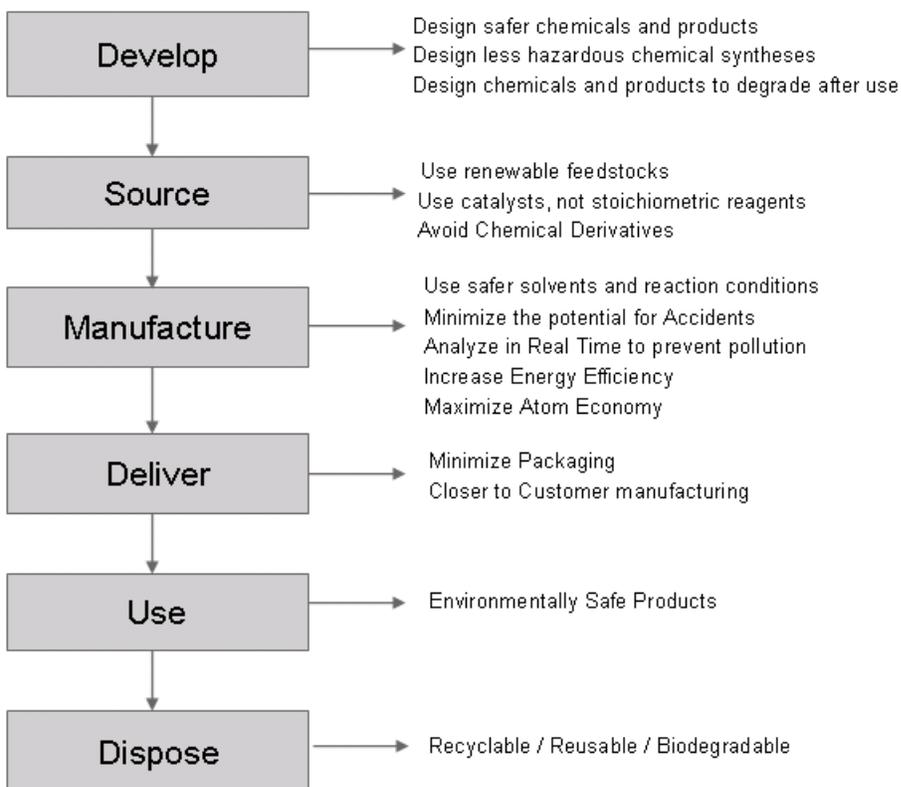
Paul Anastas and John Warner in their book: Green Chemistry: Theory and Practice (New York, NY: Oxford University Press Inc., 1998) formulated 12 principles of Green Chemistry, which are regarded as fundamental guidelines for this philosophy.

12 Principles of Green Chemistry are as follows:

- Prevent waste
- Design safer chemicals and products
- Design less hazardous chemical syntheses
- Use renewable feedstocks
- Use catalysts, not stoichiometric reagents
- Avoid chemical derivatives
- Maximize atom economy
- Use safer solvents and reaction conditions
- Increase energy efficiency
- Design chemicals and products to degrade after use
- Analyze in real time to prevent pollution
- Minimize the potential for accidents

The focus of Green Chemistry is towards development of environmentally friendly chemical processes and products. The heart of Green Chemistry is in reduction – reduction in waste production, energy consumption, non-renewable production and hazardous incidents.

Green Chemistry principles as applied to a Product Lifecycle can be represented as:



Green Chemistry Metrics

Yield is generally used as a metric to measure the efficiency of the chemical processing / synthesis. But Yield cannot be used as a Green Chemistry metric since it fails to account for:

- Solvents and Catalysts that are not fully recovered
- Production of non- renewable byproducts
- Energy intensive unit operations like Solvent Separation, Distillation etc.

Green Chemistry metrics attempt to add environmental impact to cost and production factors which can then help to ascertain environmentally benign chemical processing route. These metrics should be simple, measurable, and objective and support environmentally benign chemical processing. An example of commonly used Green Chemistry metrics is:

- Environmental (E) Factor
 - Defined as the ratio of the mass of waste per unit of product
 - $E\text{-Factor} = \text{Total Waste (kg)} / \text{Product (kg)}$
 - Smaller the E factor, lesser amount of waste being produced

Key Issues and Challenges of Green Chemistry

Green Chemistry faces **technological challenges** to ensure economical viability. Technological challenges manifest in the form of flexible chemical manufacturing facilities, use of alternative feedstocks and formalization of operational processes and systems to support and ensure green chemical synthesis.

Chemical Manufacturing facilities should be designed to ensure mass, energy and time efficiency in the synthesis. These need to be supported through streamlined Operational processes which will help to enhance visibility, control, monitoring and safe chemical synthesis.

Overall, **Economic and regulatory environment** need to support investment in Green Chemistry technologies that demonstrate sustainable advantage but carry higher technical risk than conventional operations. Also, **appreciation from society** for undertaking Green Chemistry initiatives can boost resolve of Chemical Industry to further green their Chemical synthesis.

What Does It Take to Execute Green Chemistry

A Chemical company can start their journey towards Sustainable Chemical Synthesis by ensuring **Energy tracking and control**. Energy cost forms a major portion of chemicals production cost (e.g. Energy accounts for 25 % of production cost in Naphtha Cracking). Energy tracking requires capture and visualization of real-time energy data from the shop-floor.

As a next step, Chemical Manufacturers need to ensure **real-time visibility of operational data** so that their responses to any unforeseen events can be more proactive. This will ensure that manufacturing is executed in a safe working environment, within cost, with greater efficiency and productivity.

Green Chemical Synthesis also requires **Proactive maintenance**. Chemical Manufacturers should maintain and operate their assets to achieve high levels of equipment reliability / effectiveness. A chemical company should aim to ascertain what the right maintenance strategy for its assets is and ensure capturing assets operational data (like vibration readings) for reducing risks (of plant shutdown and unsafe operations) and executing proactive / reliability centric maintenance.

A Chemicals Manufacturing company attempting to follow Green Chemistry principles needs to ensure **Product Safety, Process Safety and Worker Safety** in their operations. Product Safety will aim to mitigate risks associated with product handling. Process Safety will help to prevent unsafe operating conditions (e.g. caused by unintentional releases of chemicals) during chemical synthesis. Worker Safety will ensure the safety, health and welfare of people engaged in chemical synthesis on the Shopfloor. These initiatives (on Safety) will help to reduce accidents and ensure safe chemical manufacturing operations.

Green Chemistry principles further require a Chemical Manufacture to build systems and processes which can help them to **develop and test new products and processing methods upfront** (in the product development cycle). This helps to ensure design of less hazardous chemical synthesis process and prevention of waste byproducts production.

SAP Solutions Enable Green Chemistry

For more than 35 years, SAP has been helping Chemical companies around the globe manage resources efficiently by optimizing and transforming their business processes. SAP Solutions support execution of Sustainable Chemical synthesis through following solutions:

1. Product Safety, Process Safety and Worker Safety

SAP helps Chemical Companies to achieve comprehensive and sustainable regulatory compliance in the areas of health, safety, environment and in chemical and product stewardship through **SAP Environment, Health, and Safety Management** (SAP EHS Management) Application. SAP EHS Management capabilities cover following areas:

- **Health and safety** – SAP EHS Management supports the establishment of preventive health and safety management processes to ensure the well-being of employees and gain higher productivity through fewer incidents and absences.
- **Environmental performance** – SAP EHS Management ensures minimization of the environmental impact of Chemical processing operations, plants, and the supply chain so as to comply with regulations affecting air, water, and land.
- **Product safety and stewardship** – SAP EHS Management supports the development, production, Sale and distribution of products that are safe and healthy to the consumer, and have a minimal environmental impact. SAP EHS Management also ensures compliance to regulations like REACH, RoHS, WEEE, TSCA etc.

2. Real-Time Visibility of Operational Data

SAP Manufacturing Integration and Intelligence (SAP MII) ensures direct connection between shop-floor systems and business operations. This helps to ascertain and visualize all data that affects manufacturing in real time – including information about orders, materials, equipment status, costs, and product quality.

3. Proactive Maintenance

The **SAP Service and Asset Management (SAP SAM)** solution provides complete, end-to-end, integrated functionality for efficient Enterprise Asset Management. SAP SAM provides real-time visibility of asset performance and maintenance issues which help to ensure proactive response to and rapid correction of concerns or problems. SAP SAM helps to manage assets over their entire life cycle (from Planning to Procurement to Commissioning to Operations to Decommissioning and Disposal).

4. Develop and Test New Products and Processing Methods Upfront

SAP Recipe Management and Trials provides a workbench that enables a Chemical Manufacturer to manage the new product development process starting from the initial recipe up to the final master recipe for production.

A Chemical Manufacturer can also use Trial Management (included in SAP Recipe Management and Trials) to manage scale-up activities from lab scale to production volume.

5. Energy Tracking and Control

SAP Manufacturing Integration and Intelligence (SAP MII) helps to ascertain real-time energy consumption figures by ensuring direct linkage from shop-floor process control systems to enterprise applications. This energy data can be visualized in dashboards etc for better tracking and control.

Summary and Next Steps

A Chemicals Manufacturing company can initiate a comprehensive program to pursue and practice Green Chemistry principles by:

- Involving Top Management in driving Green Chemistry initiatives
- Including Green Chemistry principles in corporate policies like Quality Policy, Mission and Vision Statement etc.
- Undertaking analysis of existing products synthesis processes to ascertain areas of improvement (like reduction in Energy usage or less production of hazardous byproducts)

SAP is best positioned to help Chemical Industry in their pursuit of Sustainable Chemical synthesis by its commitment to provide solutions (like SAP EHS Management) which help Chemical companies to execute Efficient, Economical and Environmentally sound Chemical Processing.

Related Content

1. [2008 SAP Sustainability Report](#)
2. [SAP Solutions for Sustainability](#)
3. [SAP Environment, Health and Safety Management](#)
4. [SAP Manufacturing Integration and Intelligence](#)
5. [SAP Service and Asset Management](#)

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