Managing Wastes and Emissions from Manufacturing Industries & Building (Reduce, Reuse, Recycle and Recovery)

GrEEn Technologies: Making Profits-Committing to Sustainability

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3Rs in Manufacturing Industries
Multimedia Waste Emissions from Industries

- Energy Waste
- Air Pollution
- Solid Waste
- Effluent Discharge
Why Sustainable Production?

- Sustainable Production is the creation of goods and services using processes and systems that are:
  - Non-polluting (environmentally responsible)
  - Conserving of energy and natural resources (Energy and resource management)
  - Economically viable
  - Safe and healthful for workers, communities, and consumers
  - Socially and creatively rewarding for all working people

- Sustainable Production is a comprehensive approach to meeting sustainability objectives in all facets of your production, and turn sustainability challenges into business advantages through:
  - **Product design**: using sustainability to guide design approaches to products from the earliest stages of conception and development
  - **Consumer engagement**: influencing what and how people consume
  - **End-of-use**: recapturing products at the end of their useful lives and converting them to serve as raw materials for other purposes
Cleaner Production & Sustainable Manufacturing

- The initial concepts of Cleaner Production were brought together during the mid-1980s, (the establishment of UNEP’s Cleaner Production Programme in 1989)

- Cleaner production is an effective method to achieve business benefits such as lower costs, increase profitability, reduce waste and improve the image of the business environment and social responsibility

- It is intended to minimize waste and emissions and maximize product output

- Cleaner production has been a (green) technology promoter
Implementing Cleaner Production

**Housekeeping:**
better inventory management, better monitoring and scheduling of the production process, reducing loss from leaks, spillage, and drag-out, and making sure equipment is maintained properly.

**Process optimization:**
changing the manufacturing process to minimize waste, conserve raw materials, and capture and reuse waste materials maintained properly.

**Raw material substitution:**
find ways to substitute greener materials for hazardous materials, chemicals with high environmental or health impacts, materials that are non-renewable, or those that are scarce.

**New (Green) Technologies:**
incorporating more environmentally responsible technologies.

**New Product Design:**
Manufacturing green product using recycled and renewable materials, designing for easy disassembly, for recycling, or for remanufacturing, using less packaging and more recycled or recyclable packaging.
Implementing Cleaner Production

POLLUTION PREVENTION IDEAS

- Equipment Change
- Material Substitution
- Process Modification
- Recycle & Reuse
- House Keeping
- Rational Use of Resources

COST vs. POLLUTION PREVENTION IDEAS

<table>
<thead>
<tr>
<th>POTENTIAL OF WASTE MINIMISATION</th>
<th>IMPLEMENTATION PERIOD</th>
<th>RANGE OF OPTIONS</th>
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<tbody>
<tr>
<td>20 - 30%</td>
<td>&lt; 1 year</td>
<td>Good House keeping and Better Process Control</td>
</tr>
<tr>
<td>30 - 50%</td>
<td>1 - 3 years</td>
<td>Equipment Modification and/or technology changes, recycling</td>
</tr>
<tr>
<td>&gt; 50%</td>
<td>&lt; 3 years</td>
<td>Product and/or Process Change</td>
</tr>
</tbody>
</table>

- technological change
- product change
- change in input materials
- good housekeeping
- on-site reuse
CP Approach- Good House Keeping

SOFT OPTIONS: GOOD HOUSEKEEPING

Good housekeeping example:

• repair all leaks and avoid losses by closing water taps
• turning off equipment when not needed
Trivalent Chromium Plating
W Canning Materials Ltd, UK

Problems
Pollution due to Hexavalent Chromium laden wastes

Clean Technology
Electrolyte with lower concentrations of less toxic trivalent chromium ion. Cr (III) oxidisation to Cr (VI), at anode avoided by membrane around the anode. Low deposition rate of Cr (III) was enhanced by specially designed organic additives.

Advantages
safer working environment
reduced discharges of Cr (VI) from 80 to 3 ppm of Cr (III)
improved quality and uniformity
reduction of energy requirements to half

<table>
<thead>
<tr>
<th></th>
<th>conventional technology</th>
<th>Clean technology</th>
</tr>
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<tbody>
<tr>
<td>Plating plant</td>
<td>£ 175,000</td>
<td>£ 135,000</td>
</tr>
<tr>
<td>Effluent Plant</td>
<td>£ 70,000</td>
<td>£ 52,000</td>
</tr>
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</table>
CP Approach- Raw Material Substitution- Case of Micro plastics in Consumer Products

- Many consumer products sold in around the world contain microplastic particles as abrasives and exfoliants.
Sustainable Alternatives to MicroPlastic

- Over the years, microbeads have replaced traditional, biodegradable alternatives such as ground nut shells, and salt crystals.

- Other natural alternatives, like apricot shells and cocoa beans are being used successfully by many companies.
Changing Packaging

- Changing packaging can be just as important.
- The key word is to minimize the packaging and maintaining the protection of the product.
- One example is to use recycled cardboard instead of plastic foam for protection of fragile items.
Improving the Products

- Replace a painted metal shield with a RECYCLE plastic shield for a certain product, then the environmental problems and costs related to paint finishing could be avoided.
- Improved product design can result in large savings on material consumption and use of hazardous chemicals.
CP Approach: Technological Option - Equipment Modification

Steam Requirements

Simple "Jet Dyeing" machines : 1,480 kg /batch: 396 t CO₂ per/batch

"Advanced Jet dyeing" units: only 980 kg/batch

33% reduction in GHG emission or air pollutants (CO₂ emission = 264 tons per batch).

55% reduction in water consumption
CP Approach: Technological Option- Process Modification

TECHNOLOGICAL OPTIONS:  PROCESS MODIFICATION

Effect on rinse water consumption by use of intermediate static rinse baths to achieve equivalent degree of rinsing.

Q = Total quantity, Cr – Chromium, Co - Cobalt

Qin = 10 m³/h
Q = 10 L/h

Cr Plating Bath
Cr Rinsing

Co
Cr

Cr Plating Bath
Cr Rinsing

Co
Cr
Rs

Cr Plating Bath
Cr Rinsing

Co
Cr

2 Static + Flow Rinsing

Replace 50 L/h

Replace 50 L/h

Replace 50 L/h

Qin = 0.4 m³/h
Qin = 2 m³/h

Qin = 10 m³/h
Q = 10 L/h

Qin = 10 L/h
Q = 10 L/h

Qin = 2 m³/h
Qin = 2 m³/h

Qin = 0.4 m³/h
Qin = 0.4 m³/h

Q = Total quantity, Cr – Chromium, Co - Cobalt
3R... is a cycle

Reduce
choosing things and materials so as to decrease the volume of waste generated

Reuse
putting things back into the system, repeated use of materials

Recycle
structured and systematic use of waste itself as raw material / resource

Raw Material Input

Production

Consumption, Use

Discard

Treatment

Final Disposal
Wastes and Emissions From Buildings
GHG Emissions from Buildings

- The two most common sources of energy for buildings are purchased electricity and direct consumption of natural gas and petroleum for heating and cooking.

- The quantity of greenhouse gas emissions from home depend on the types of fuel the power plant uses to generate the electricity.
**Gaseous Emissions from Buildings**

- **Indoor air pollution**, can be up to 10 times worse than outdoor air pollution because contained areas enable potential pollutants to build up more than open spaces do.
Indoor Environmental Quality Maintenance

- Fresh filtered air, continuously humidified or de-humidified depending on climate conditions
- Year-round heating and cooling controlled by digital programmable thermostats.
- CO₂ monitoring equipment
- Have CO₂ monitoring equipment in central air system, by which it is sent to the individual rooms
- Vapor and air barrier minimizes random air infiltration
- Building materials and paints with low or no off-gassing
- 24/7 exhaust in every bath and kitchen
Water Consumption from Buildings

100 l = 50% of a drum can

Breakdown:
- Kitchen 35%
- Flushing toilets 61.7%
- Hot water 0.6%
- Washing cars 2.3%
- Bathing/cleaning 0.4%

Typical Domestic Water Consumption
Water Use Reduction in Buildings

1. **Water pricing/tariff:**
   - Ex. Water conservation tax (WCT) was introduced in Singapore to encourage water conservation efforts by users
   - As a result of these efforts, there was reduction in per capita water use

<table>
<thead>
<tr>
<th>Year</th>
<th>per capita water consumption reduction (Liter/day)</th>
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<tbody>
<tr>
<td>2012</td>
<td>155</td>
</tr>
<tr>
<td>2020</td>
<td>147</td>
</tr>
<tr>
<td>2030</td>
<td>140</td>
</tr>
</tbody>
</table>

2. **Water Saving Techniques:**
   Installment of water saving devices such as mandatory flow regulators
Water Reuse: Rain Water Harvesting

- Rain Water harvesting in Buildings
  - Used for non potable purposes such as toilet flush, watering in gardens, car wash etc
  - Also used as replenishing/recharging ground water resources
Wastewater from Buildings

• Wastewater from building can be classified into two categories:
  • Gray water: from kitchen, shower
  • Black water: toilet flush

• Many developing countries with least treatment faculties, release the wastewater into open sewerage and local water bodies.

• Some municipalities mix all domestic and industrial wastewater through a single sewerage network

• Domestic wastewater is collected by municipal sewerage line and treated in a centralized wastewater treatment plant, and some cities have plans for reuse of the treated wastewater.
Domestic Wastewater Recycling and Reuse

Domestic wastewater is treated and recycled into high-grade reclaimed water using advanced membrane technologies and ultra-violet disinfection, making it ultra-clean and safe to drink.

Example: 30% of Singapore’s (potable) water requirements is met by recycled water called NEWater.

- Recycled water which is not fit for drinking purposes are also reuse in buildings through distributed through Dual water systems which features two separate distribution systems for potable and non-potable water/recycled.

- Usually, the purple pipeline and tap as “non-potable” water.
Domestic Wastewater Treatment into Biogas
Green Building: Reducing the Wastes and Emissions

- Green buildings are designed to reduce the overall impact of the built environment on human health and the natural environment by:
  - Efficiently using energy, water, and other resources
  - Protecting occupant health and improving employee productivity
  - Reducing waste, pollution and environment degradation
Water Savings at Solaire Apartment, USA

- Central water filtration system for entire building
- Refrigerators contain double filtered drinking water and ice dispensers with secondary filtration

Wastewater and storm water reuse system

- Wastewater recycling facility treat ~ 94.63 m$^3$/day
- Treatment plant uses an industry-leading filtration technology to separate waste from the water, providing a high-quality effluent.
- Recycling plant process includes,
  - Further treatment with hollow fiber micro-filtration membranes
  - Treatment with ultraviolet light to kill bacteria
  - Both oxygen-based and non-oxygen-based treatment to remove nitrogen to comply with New York’s direct reuse standards.

50% reduction in potable water use vs. a traditional building of comparable size
Water Savings at Solaire Apartment, USA

- Treated water is reused,
  - ~ 34 m³/day used to flush toilets, in the 293-unit apartment building
  - ~ 43.5 m³/day for the cooling tower
  - ~ 22.7 m³/day are used for landscape

- Sludge is filtered off and piped to a New York City wastewater treatment plant.
Solid Waste Generation from Buildings

- Usually households generate **Wet wastes** (food waste, vegetable and fruit scraps etc), and **Dry waste** (paper, plastic, glass etc)

- Waste segregation at source is important but is mostly neglected in buildings

- Wastes generated by residents are usually collected and handled by municipality

- Waste reduction and reuse practices are less in urban modern lifestyles

“Designing in” efficient waste management systems that take into account the program, building type, geography, occupancy, and any other special circumstances of each individual building and its occupants
Waste Reduction

- “Pay as you throw”, South Korea, EU
- Per Bag Trash Collection Fee (2000) Taiwan
- Mandatory Garbage Separation rule (2006), Taiwan
- On and off-site waste recycling facilities
Designing for Waste Management During Occupancy

• “Designing in” efficient waste management systems that take into account the program, building type, geography, occupancy, and any other special circumstances of each individual building and its occupants

• Establish baseline data by performing periodic waste assessments on all waste and recycling outputs of the building

• Design a program which allows for process improvement input from the maintenance, engineering and janitorial staff

• Identify methods for engaging with the building occupants and tenants to
  • obtain program “buy in”, sharing of ideas and feedback
  • participate in waste recycling activities
  • Multi-colored bins for waste segregation
THANK YOU...