CHEMICAL FLOWS

November 2017
LEARNING OUTCOMES & RESOURCES

Learning Outcomes

• Introduction to NPOs and how these can be managed and identified.
• Analysis and documentation of chemical material flows in your company.

Resources

• REMC Company Handbook.

Workbook

Refer to complimentary exercises in your workbook.
ZDHC REQUIREMENTS

**ZDHC CMS 2.1.2 - Facility Plan and Walk Through**
- Factory Plan.

**ZDHC CMS 2.1.3 - Chemical Material Flow Diagrams**
- Chemical Material Flow Diagrams.

THE PROBLEM

What problems can occur if you do not know the chemical flow in your facility?

Brainstorm as a group and make notes in your workbook, exercise (4-1).
Identifying Non-product Outputs (NPO)
EXAMPLES OF NON-PRODUCT OUTPUTS

• Unqualified raw materials.
• Consumables.
• Rejects, off-specification products (any type) and reprocessing costs.
• Waste (solid, liquid, toxic, non-toxic).
• Wastewater (amount, degree of contamination = all water not contained in the final product).
• Energy (not contained in the final product), e.g. coal, steam, electricity, oil, diesel, fuel, waste heat).
• Emissions (including noise and odours).
• Losses in storage.
• Losses during handling and transport (internal, external).
• Packaging material (unless for perfumes or similar products).
• Client reclamations and trade returns.
• Losses due to lack of maintenance.
• Losses or health and environmental problems.
• Capacities occupied by reprocessing (opportunity costs).
• Machine downtimes.
NON-PRODUCT OUTPUT (NPO)

Input

- Raw Material
- Energy
- Water
- Chemicals

Process

Output

- Desired Final Product
- Non-Product Output (NPO)

Reference: GTZ, 2005
POTENTIAL FOR EXTRA PROFITS FROM MANAGING NON-PRODUCT OUTPUTS (NPOs)

NPO = All material, energy and water which is used in the production process but does not end up in the final product.

Reference: GTZ, 2005
APPROACH TO NPO IDENTIFICATION FROM HIGH LEVEL TO SINGLE PROCESS (1/3)

Supplier
- Grey Fabric
- Dyes
- Chemicals

Utility
- Natural Gas
- Water

Main Process
- Warehouse
- Pre-mixing
- Dyeing Process
- Finishing Process

Wastewater
- Waste Heat, Emissions
- Solid Waste, Rejects

Municipal Sewer
Air
Landfill

Consumer
- Coloured Clothes

Reference: UNEP RP
APPROACH TO NPO IDENTIFICATION
FROM HIGH LEVEL TO SINGLE PROCESS (2/3)

Grey Fabric +
Dyes
Chemicals
Water
Steam

Dyeing Process
(5 vessels)

Coloured fabric +
Dyes
Chemicals in cloth
Moisture in cloth

Wastewater +
Dyes / Chemicals in wastewater
Heat / Energy in wastewater

Reference: UNEP RP
**APPROACH TO NPO IDENTIFICATION FROM HIGH LEVEL TO SINGLE PROCESS (3/3)**

- **Natural Gas**
- **Steam Generation**
  - 10% of heat
  - **Combustion**
  - 50% of heat
  - 40% of heat

- **Grey Fabric**
- **Dyes** 3500 kg
- **Chemicals** 5000 kg
- **Water** 50000 m3

- **Pre-mixing**
  - 20% of dyes
  - 95% of chemicals
  - 90% of water

- **Dyeing Process**
  - 40% of heat
  - 10% water

- **Finishing Process**
  - 20% of white cloth
  - 16% of dyes
  - 1% of chemicals

- **Coloured Fabric**
- **Wastewater**
- **Waste Heat**
- **Rejects**

Source: UNEP RP
ACTIVITY

REFLECTION

Workbook, exercise (4-2).

Work in pairs and identify potential cost savings from the NPO examples shown on the pictures.

Present your results to the group.
Analysis and Documentation of Chemical Material Flows In Your Company
PURPOSE OF PROCESS FLOW MAPPING

- To lay ground work for inventory of chemicals.
- Establish chemical management system framework.
- Promoting responsible usage and prevention of adverse impacts on the environment, health and safety.
- To support the identification and documentation of hazard/risks related to entire range of production processes, products and non-product outputs (NPO).
BENEFITS FROM PROCESS FLOW MAPPING

• Gain a general overview of production processes.
• Identify all relevant process steps, intermediary products, most important and/or critical materials.
• Create basis for:
  • Systematic analysing of inputs and outputs, (both desired products and NPOs/wastes).
  • Visualising quantities and costs (for mass balancing).
  • Documenting hazards/risks and areas with chemicals and process of concern.
• Localise optimisation potentials and areas.
• Improve process communication inside your company.
• Establish reference for planning, monitoring and reporting.
CONCEPT OF PROCESS FLOW MAPPING

- **Systematic step-by-step approach** towards understanding process and chemical flows.

- **Understand where chemicals and chemical (containing) waste are present and stored** within your site.

- **Set boundaries regarding external operations** that your company can/should/wants to influence, e.g.:
  - Procurement of chemicals and products containing chemicals.
  - Transport/shipment and delivery of products and chemicals to/from the company.
  - Disposal of waste products (air emissions, solid waste, wastewater).
RELEVANT INFORMATION TO BE REFLECTED IN PROCESS FLOW

• Inputs (raw materials, chemicals, water and energy).
• Product and non-product outputs.
• Sources of non-product outputs.
• Intermediary products considered.
• Inputs and outputs are quantifiable.
• Costs are assigned to different types of waste.

Chemical material flow diagrams should be reviewed annually and updated as needed due to operational changes.

MAPPING YOUR PROCESSES AND CHEMICAL FLOWS: BOUNDARIES

Procurement
Delivery
Reception/unloading
Storage
Packing/repacking
Laboratory testing

Product warehouse
Product loading
Product transport/shipment and distribution
Product use and final disposal

Internal transfer
Formulation/Mixing
Dosing
Production

Internal waste collection and removal
Maintenance

Emission control
Treatment and disposal of waste
Other…
PRACTICAL MAPPING TOOLS: PROCESS FLOW DIAGRAM

Process steps (in black)

Other inputs on the left (in yellow)

Main input (in yellow)
Raw Material

...........kg
...........m³

Non-product outputs on the right (in blue)

Step 1

Intermediary Product 1

Step 2

Intermediary Product 2

Step....

The final product is shown at the end of the process
Final Product

...........kg
...........m³

Water..........m³
Energy.......kW/h
Auxiliaries......kg
Chemical.........kg

Water..........m³
Energy.......kW/h
Auxiliaries......kg
Chemical.........kg

Water..........m³
Energy.......kW/h
Auxiliaries......kg
Chemical.........kg

Water..........m³
Energy.......kW/h
Auxiliaries......kg
Chemical.........kg

Step...

Reference
EXAMPLE: USING YOUR FLOWCHART INFORMATION (1/2)

Coffee Beans

- Coffee Beans: 10g
- Total: 10g
- Costs
  - Coffee Beans: 51 cents

Grinding

- Coffee Powder: 10g
- Total: 10g
- Costs
  - Coffee Powder: 51 cents

Boiling Water

- Water: 250g
- Coffee Powder: 10g
- Filter: 2g
- Total: 262g
- Costs
  - Water: 2 cents
  - Coffee Powder: 52 cents
  - Filter: 15 cents
  - Total: 68 cents

Making Coffee

- Coffee: 220g
- Residual Powder: 1g
- Used Filters: 7g
- Coffee Grounds: 34g
- Total: 262g
- Costs
  - Product: 56 cents
  - Residual Powder: 5 cents
  - Used Filter: 1 cent
  - Coffee Grounds: 7 cents
  - Disposal Cost: 0.02 cents
  - Total: 68.002 cents

Finished Coffee
EXAMPLE: USING YOUR FLOWCHART INFORMATION (2/2)

Dyes → Chemicals → Mixing

- Process Water: 30%
- Electricity: 30%
- Steam: 30%

Colouring Process → White Cloth

- Water: 60%
- Steam: 40%

Drying and Printing Process → Quality Control and Packaging

- Water: 10%
- Steam: 40%

Quality Control and Packaging → Solid Waste

- 80% cloth
- 64% dyes
- 4% chemicals

Reacts → Wastewater

- 90% process water
- 20% dyes
- 95% chemicals
- 60% steam energy

Emissions

- 5% cloth
- 4% dyes
- 0.25% chemicals

NOTES:
A.) Ignores steam losses in the steam system.
B.) Assume all electricity is transformed into mechanical energy or heat as emissions.
C.) For simplicity, printing materials have been left out of the process.

The percentages are related to the total input figures.
IDENTIFYING OPPORTUNITIES FOR SUBSTITUTION BASED ON IDENTIFICATION OF NPO (1/2)

1) TYPE OF NPO

Fabric showing contamination of fluorescent colour under UV light

2) ROOT CAUSE

Contamination observed from powder Optical Brightening Agent (OBA) used in the store

3) ACTION

- Replace powder Optical Brightening Agent by a liquid Optical Brightening Agent.
- Installation of a powder dispenser system.
IDENTIFYING OPPORTUNITIES FOR SUBSTITUTION BASED ON IDENTIFICATION OF NPO (2/2)

1) TYPE OF NPO

Frequent failure of garment materials’ pH.

2) ROOT CAUSE

- Use of volatile acid such as Acetic Acid in the final neutralisation step.

3) ACTION

- Substitute volatile acid with Formic Acid or Oxalic Acid in the final neutralisation step.
- Use volume instead of weight in case of working with high density liquids.
- Use lid for storage and transportation of volatile acids.
PRACTICAL MAPPING TOOL – ECO MAPPING

• Simple, practical tool for visualisation of process flows.
• Good to use in resource efficiency, OSH and/or chemical management for:
  • Identifying and documenting the prevalent situation and issues.
  • Identifying and analysing common issues and priority.
  • Selecting and planning areas for improvement.
  • Monitoring progress of implementation.
  • Auditing and reporting.
EXAMPLE ECO MAP: TEXTILE UNIT, NARAYANGANJ, BANGLADESH
GET STARTED

• Use existing ground and floor plans to facilitate identification and visualisation of environmental problems (“critical situations/ hot spots”) within a company.

• Consider using different maps to create a useful multi layer set of graphical information (e.g. for chemicals, water, energy, air, wastes).

• Prepare or verify during an initial company/site walk-through.

• Collect and fill in additional information, using guiding questions and observations on site.

• Decide and agree on your own standard symbols beforehand and use consistently in all maps.

• Indicate gravity of observed “hotspots”:
  • Hatched lines: small problem (area to be monitored, problem to be studied).
  • Circle: large problem (stop, corrective action).
  • The more serious the problem, the thicker or larger the circle or symbol.
In groups of 6, review information provided to you and:

- Identify the location and flows of chemicals and chemical (containing) waste.
- Document the process flow.
- Identify possible NPOs.
- Present your findings to the management team – one process flow diagram, one eco-map.
Open To Questions
Every participant to feedback one key learning from this session.

Take notes in your workbook, exercise (4-4).