INDUSTRIAL WASTE SIMULATIONS AND ANALYTICS

PROCESS FLOW DIAGRAM

- A PFD is a graphical representation of a process to show the primary process flow path.
- It focuses on the equipment used, control valves, and other instruments that are present.
- Illustrates how the major components of a process plant interact with each other to bring about the desired effect.
- Trace the primary flow of chemicals through the unit.

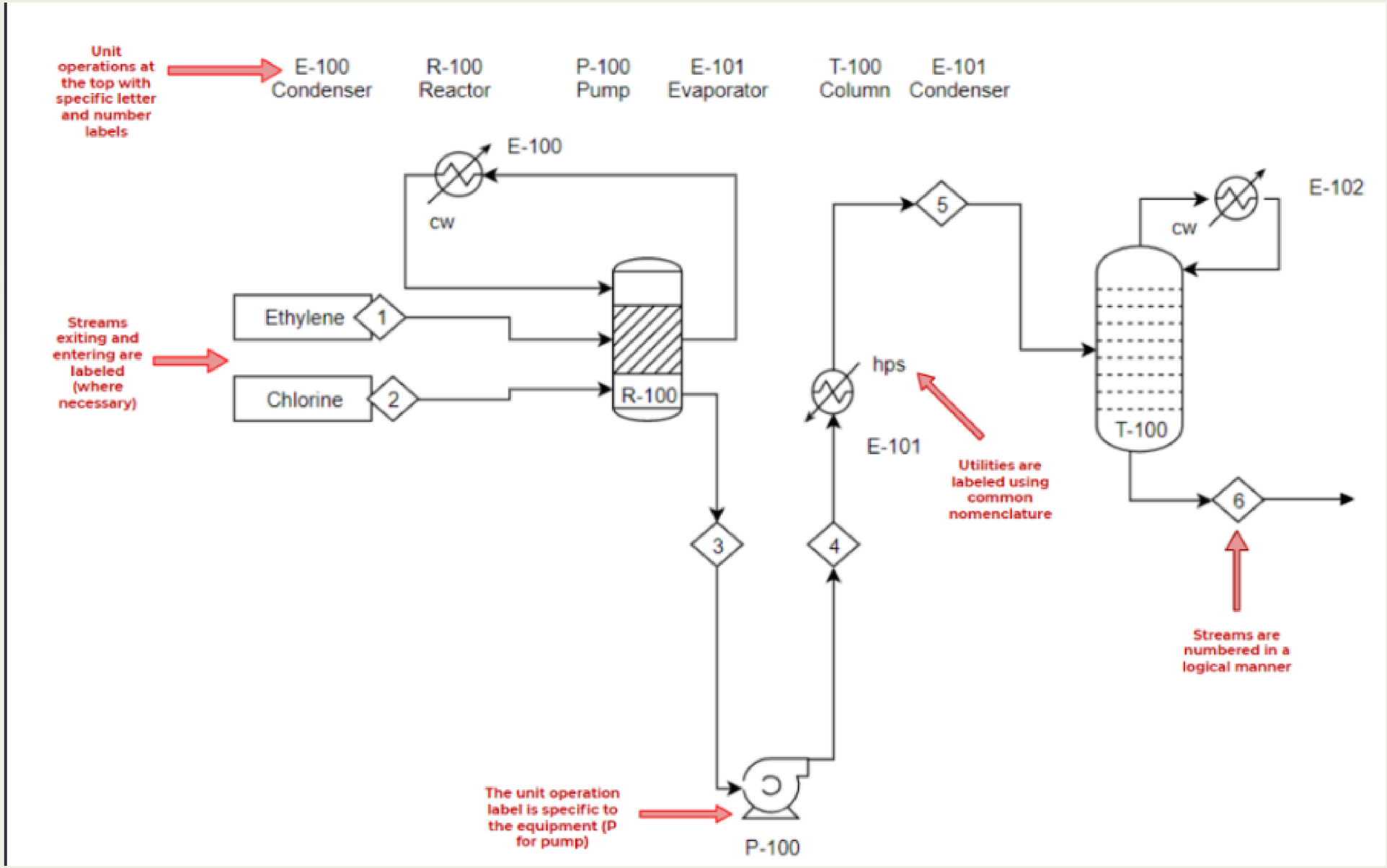
WHAT INFORMATION DOES PFD PROVIDE?

- All major equipment
- Process flow stream and direction of the process
- Control valves and connections with other systems
- Operational data such as temperature, pressure and mass flow rates.

WHAT INFORMATION DOES PFD NOT PROVIDE?

- Process control instruments
- Relief and safety valves
- Pipe line numbers
- Minor bypass values

CONSIDER CHLORINATION OF ETHYLENE:



CLASS 2

WHAT IS OPTIMISATION ?

- Definition: Selecting the best solution among many possible choices using efficient quantitative methods.
- Goal: Maximize performance criteria (e.g., minimum cost, maximum yield).
- Key Elements: Process models, performance criteria, trade-offs.
- Role of Computers: Use of software and engineering judgment to make informed decisions.

WHY OPTIMISATION ?

- Improves efficiency: Enhances production, reduces costs, and minimizes energy use.
- Benefits operations: Increases yields, reduces downtime, and optimizes resources.
- Predictive Analysis: Helps in decision-making by systematically identifying constraints and objectives.
- Economic Impact: Small efficiency improvements can lead to significant cost savings.

HOW ITS DONE?

- Define the problem: Identify the system, objectives, and constraints.
- Use predictive models: Mathematical equations describe system behavior.
- Adjust key variables: Find the best combination while satisfying constraints.
- Optimization tools: Algorithms and software (e.g., MATLAB, ASPEN, HySyS).

APPLICATIONS IN CHEMICAL ENGINEERING

- Process Design: Heat exchanger networks, equipment sizing.
- Plant Operations: Distillation column optimization, predictive control.
- Scheduling & Planning: Maintenance scheduling, operations planning.
- Industry Tools: Optimization in software like ASPEN, CHEMCAD, Pro/II.

CLASS 3

REAL-WORLD CONTEXT

Industrial Waste & Environmental Impact

- Industries generate large amounts of solid, liquid, and gaseous waste.
- Improper waste disposal leads to pollution, resource depletion, and climate change.
- Regulatory frameworks (e.g., PCF, LCA) help assess and reduce environmental impact.

PRODUCT CARBON FOOTPRINT

A Product Carbon Footprint (PCF) measures the total greenhouse gas (GHG) emissions produced throughout a product's life cycle. This includes all five stages:

- **Raw Material Extraction:** Sources include activities like logging and mining.
- **Manufacturing:** Sources include factory operations like energy consumption.
- **Transportation:** This includes transportation at all stages like raw materials to manufacturing, manufacturing to storage and distribution centers, and distribution centers to retail stores and consumers.
- **Usage:** Related to product usage like energy consumption during operation.
- **End-Of-Life Disposal:** Emissions from composting, recycling, or landfilling.

HOW ARE GREENHOUSE GAS EMISSIONS MEASURED

It is measured as Global Warming Potential (GWP), and it normalizes multiple GHGs, such as methane and nitrous oxide, to understand the impact compared to carbon dioxide (CO2). GWP takes into account three important factors:

- **Time Horizon:** The time horizon includes several different ranges, often 20, 100, and 500 years because gasses remain in the atmosphere for different lengths of time.

- **Heat-trapping ability**: Gasses like methane trap more heat than carbon dioxide, making it more potent. This must be considered or the impact will be miscalculated.

- **Atmospheric Lifetime:** Some gasses stay in the atmosphere for longer periods of time than others which varies the impact gasses.

LIFE CYCLE ASSESSMENT (LCA)

- A Life Cycle Assessment or Life Cycle Analysis (LCA) evaluates a product's environmental impact throughout its life cycle.
- Unlike PCF, which focuses exclusively on GHG emissions, an LCA provides a multi-dimensional analysis of a product's environmental footprint, offering businesses a broader view of potential environmental impact areas.
- This includes GHG emissions, but it also incorporates other metrics such as eutrophication, acidification, ozone depletion, water usage, and more.
- This provides a more comprehensive understanding of the full environmental impact of a product beyond GHG emissions.
- It analyzes a product's environmental impact across multiple areas throughout its entire life cycle.

HOW TO CHOOSE BETWEEN PCF AND LCA

- Choosing between a PCF and an LCA will be dependent on what your company's goals are. If your company only needs to know GWP or GHG emissions, then a PCF may be sufficient. This may be the case for a company whose only goal is to reduce GHG emissions and communicate these efforts to stakeholders.

- However, if your company needs a more comprehensive understanding of a product's environmental impact, an LCA will include GHG emissions along with other environmental metrics.

- Companies with goals to reduce environmental impact across multiple areas, or those seeking opportunities for improvement beyond GHG emissions, may find an LCA more suitable.