**Process System Engineering**

Prof. Davide Manca – Politecnico di Milano

# Summary of HDA plant exercises

Roberto Abbiati – Valentina Depetri

# HDA process

Toluene

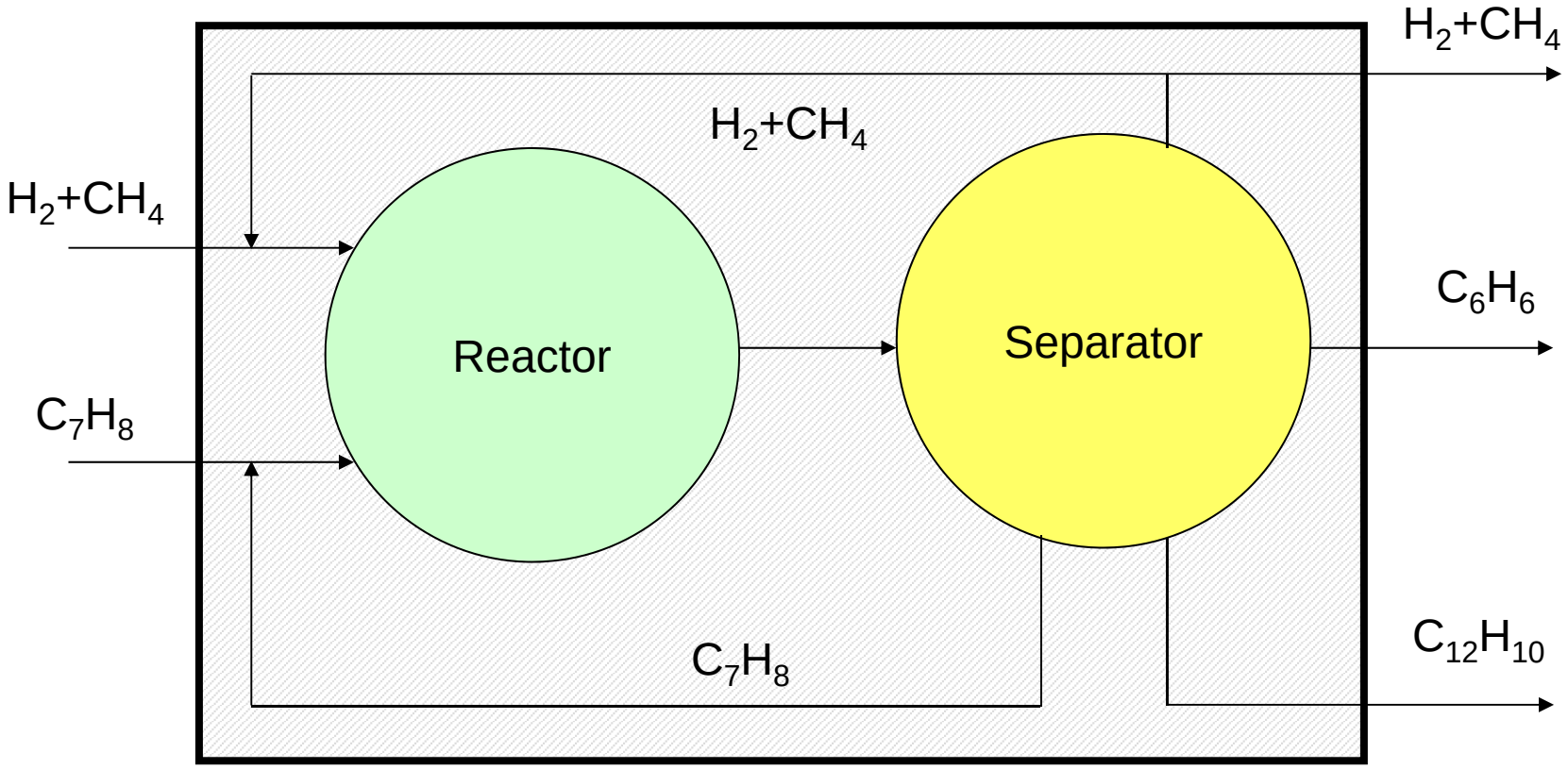
Hydrogen

Light Products

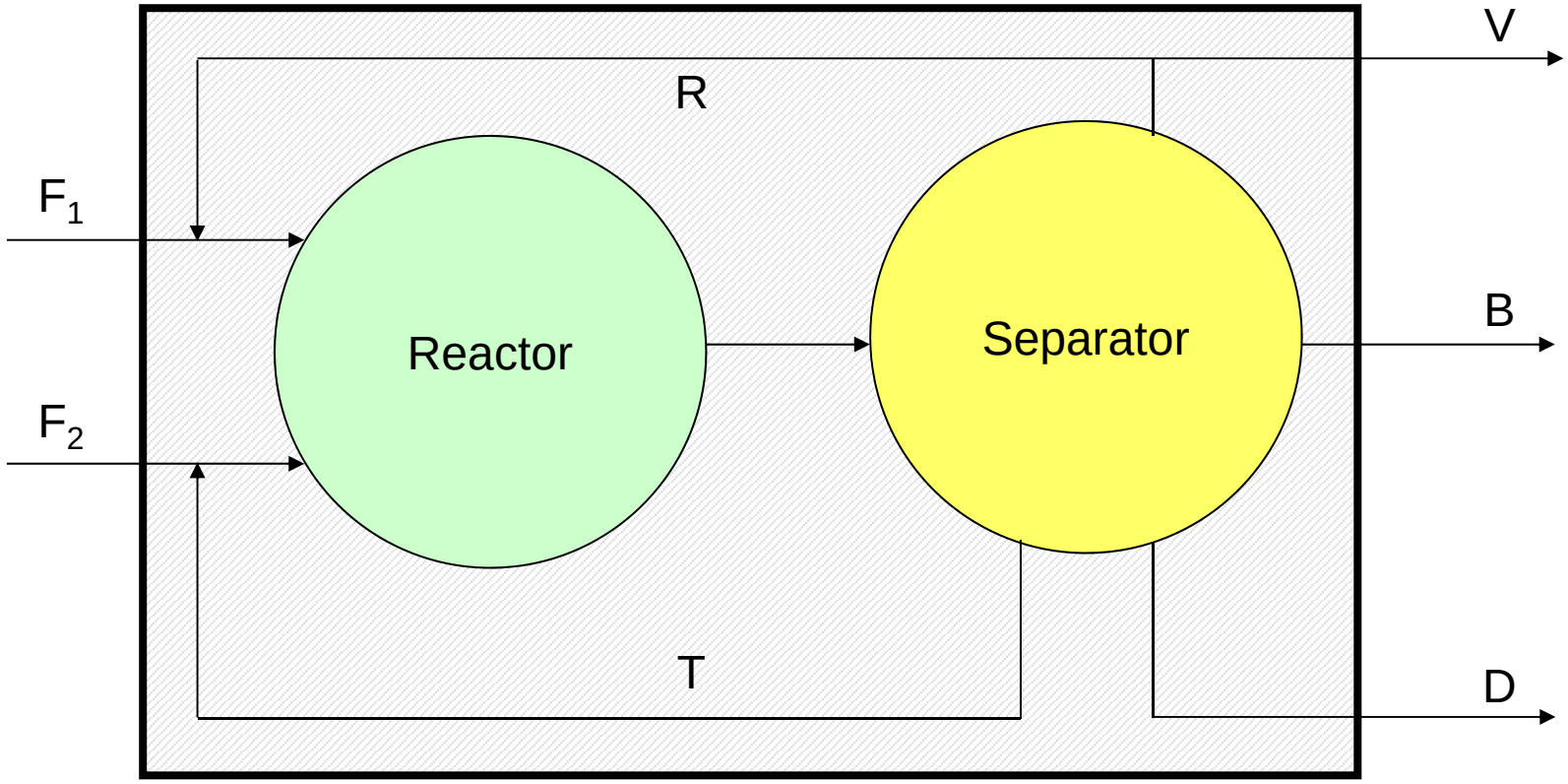
Benzene

Heavy Products

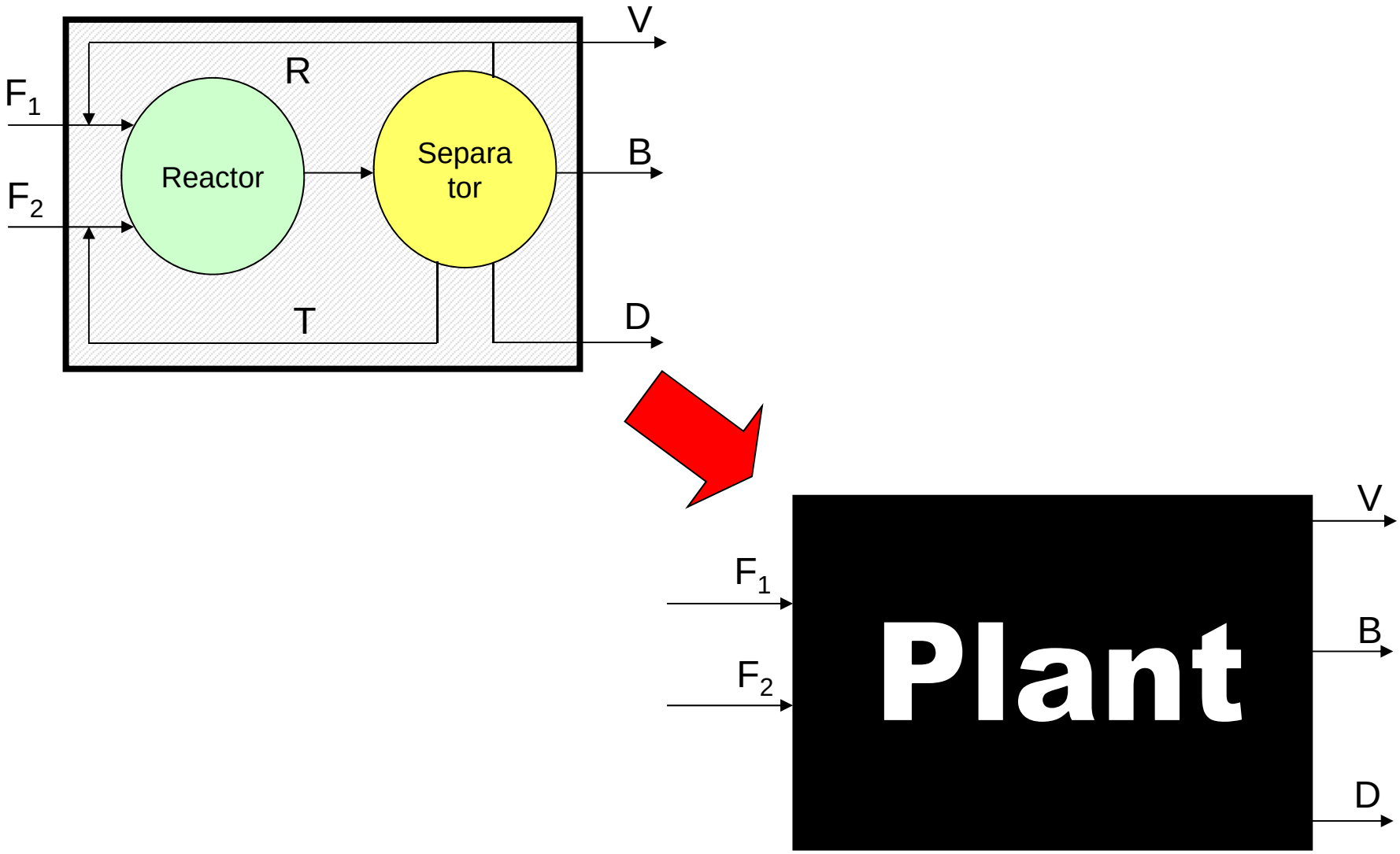
# HDA process: reactants and products



# HDA process: inlet, outlet, and recycle



# HDA process: inlet and outlet streams



# Conceptual Design

## Hierarchy of decisions

- **EP1**: Batch vs Continuous
- **EP2**: Input-Output structure of the flowsheet

$$EP_2 = \sum_{j=1}^{NPRODUCTS} €_{P,j} \cdot \dot{n}_j - \sum_{i=1}^{NREACTANTS} €_{R,i} \cdot \dot{n}_i$$

- **EP3**: Recycle structure of the floowsheet

$$EP_3 = EP_2 - €_{reatt} - €_{compr}$$

# Conceptual Design

**Hierarchy of decisions**

- **EP4**: General structure of the separation system

$$EP_4 = EP_3 - \left(CAPEX + OPEX\right)_{separation\ section}$$

- **EP5**: Heat Exchange Network (not discussed for HDA plant)

If the potential of the *i*-level is greater than zero, the process may be economically attractive; *vice versa*, the process is not economically interesting and the procedure must be interrupted.

# Report structure: guidelines

- A general overview of the HDA process/plant
- Material balances and plant specifications
- Reactor design

✓ *Component molar flows at each temperatures*

✓ *Selectivity vs residence time*

✓ *Conversion vs residence time*

✓ *Conversion vs selectivity*

✓ *Conversion vs temperature*

✓ *Residence time vs temperature*

# Report structure: guidelines

- Adiabatic temperature calculation: Matlab and UniSim
- Assessing the level-1 economic potential ($EP_1$)
- Assessing the level-2 economic potential ($EP_2$):

✓ *$EP_2$ vs $x_v$ (comparison between the alternative uses of biphenyl)*

✓ *$EP_2$ vs temperature*

✓ *$EP_2$ vs conversion*

✓ *$EP_2$ vs splitting factor*

✓ *Recycle fraction vs $x_v$*

# Report structure: guidelines

- Assessing the level-3 economic potential (EP3)

✓ *Reactor diameter vs* $x_v$

✓ *Reactor volume vs* $x_v$

✓ *Reactor CAPEX vs* $x_v$

✓ *Recycle flow rate vs* $x_v$

✓ *Compressor CAPEX vs* $x_v$

✓ *Compressor OPEX vs* $x_v$

✓ $EP_3$ *vs* $x_v$

- Plant layout in Unisim® and Adjust functions

- Assessing the level-4 economic potential ($EP_4$)

✓ $EP_4$ *vs* $x_v$