

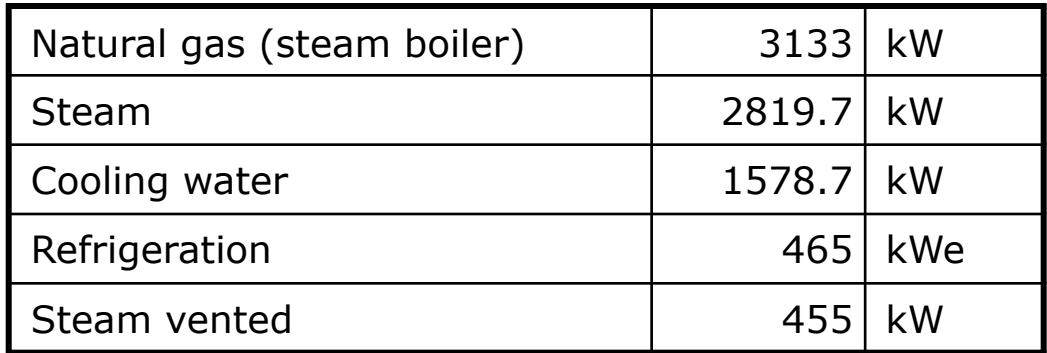
Where are we ?

- ✓ Energy efficiency project evaluation
- ✓ DT min
- ✓ Heat recovery
- ✓ Heat exchanger network design
- Improving the heat recovery
- Integrating the energy conversion units
- Exergy analysis of the energy conversion system
- How can mathematical programming help us
- Evaluate energy efficiency projects

Defining Hot and Cold streams of a process

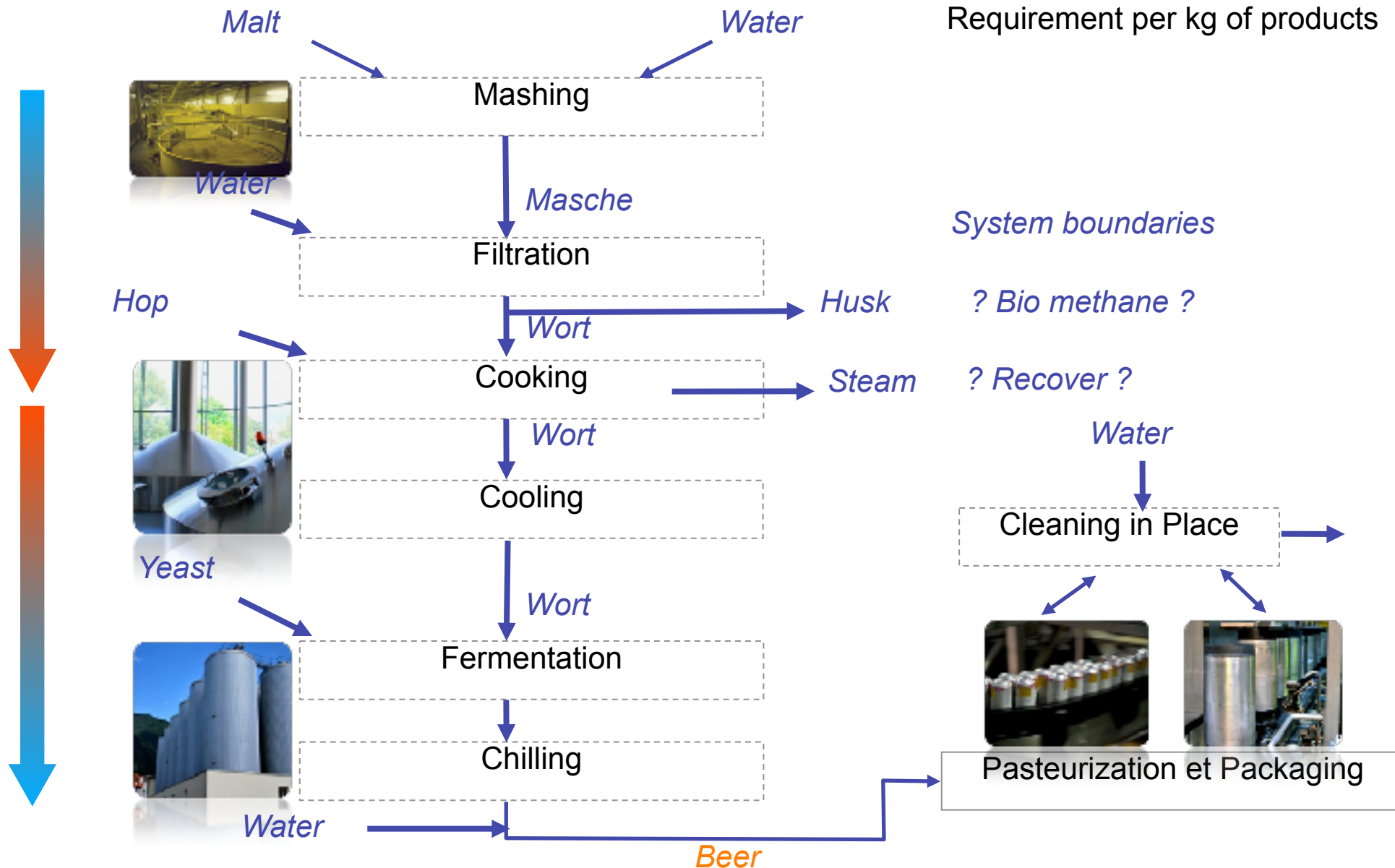
Analysing the process energy requirement
Modifying the process operating conditions
Integrating heat pumps

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Process requirement analysis

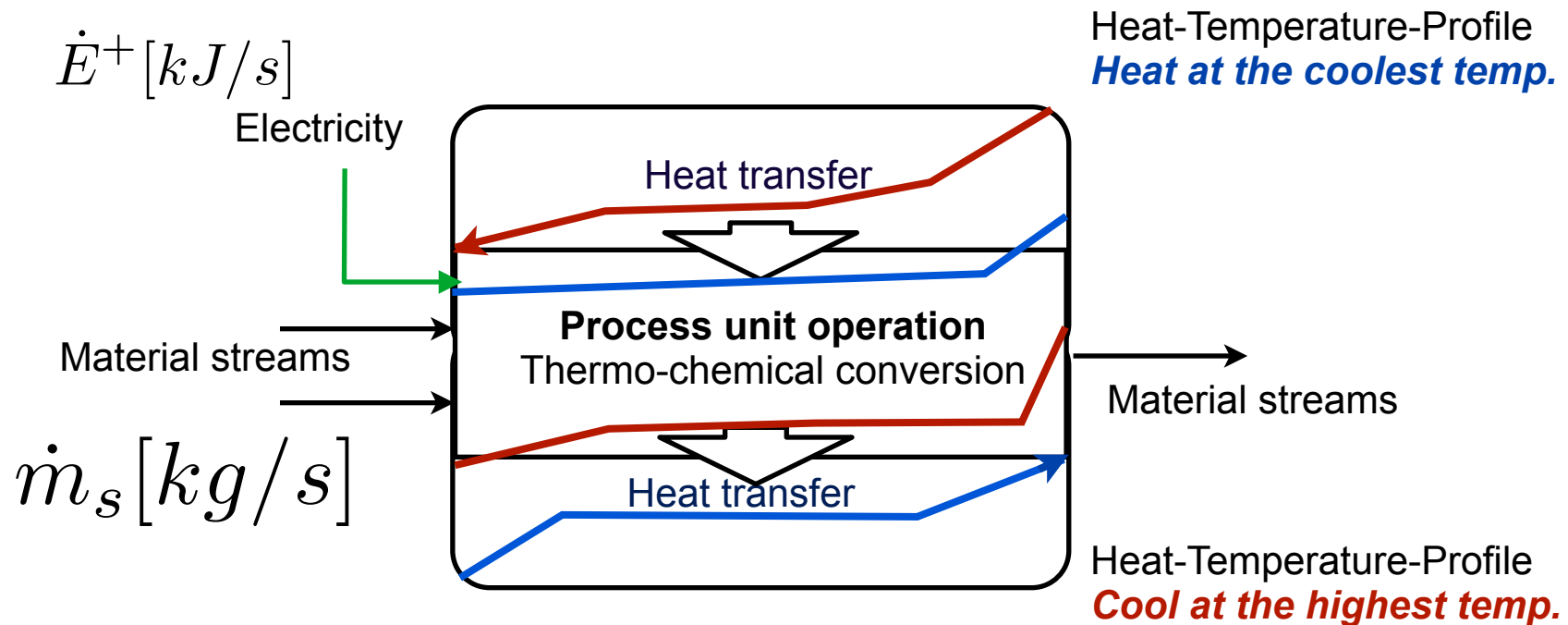


Definition of the process requirements

- **Process streams**
 - Flows are related to the process unit operation
 - Flows are related to the material conversion
 - Raw materials/products
 - Mechanical power/electricity
 - Support of production (water, gases, catalysts)
 - Waste
 - Packaging
 - Offices
- **Utility streams :The way the unit process receives the energy needed.**
“slave streams”
 - Flows calculated to supply the energy requirement
 - Flows that depend on the energy efficiency
 - Flows related to the energy cost
 - Distributed energy (steam, cooling water, glycol water)
 - Related mechanical power or electricity consumption

Heat transfer requirement interface

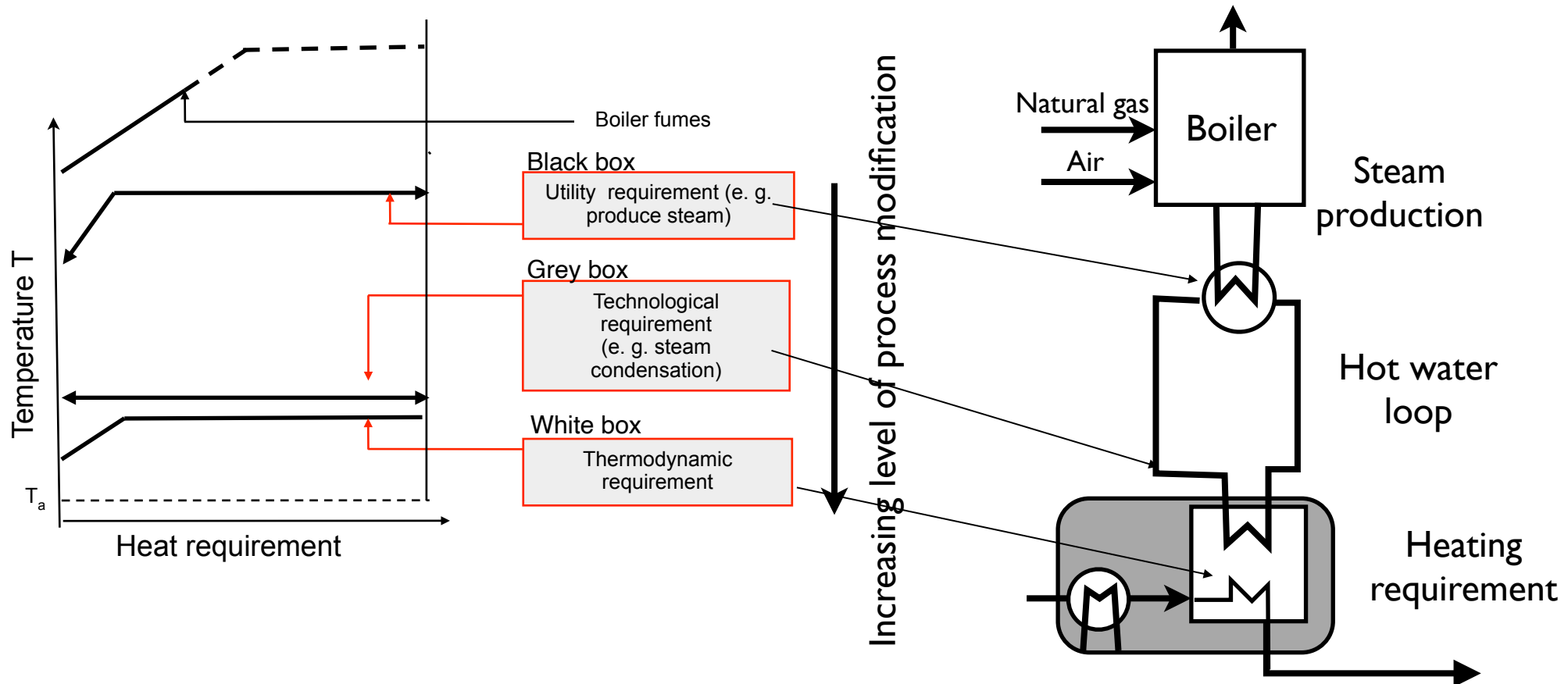
Process unit operation



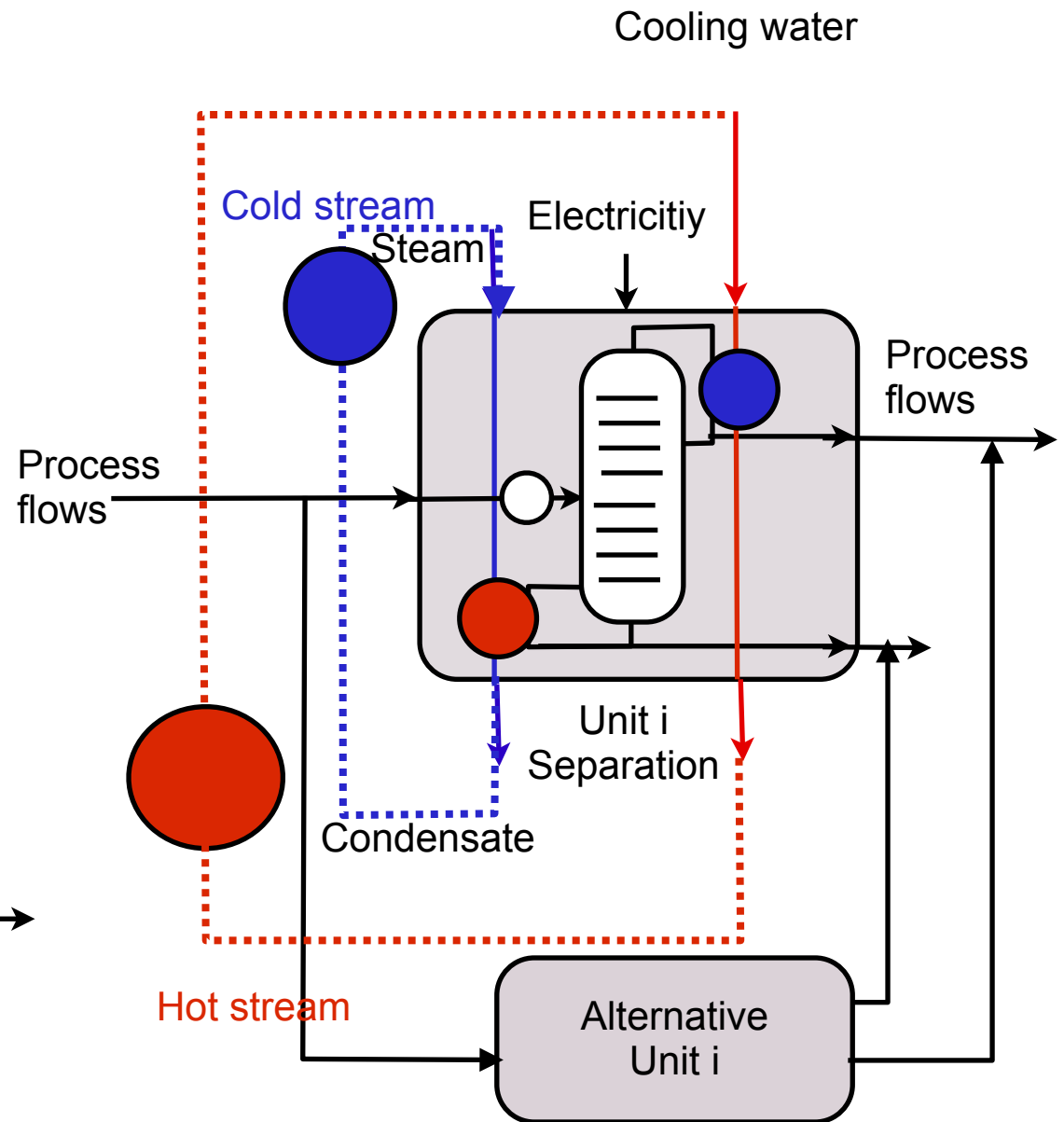
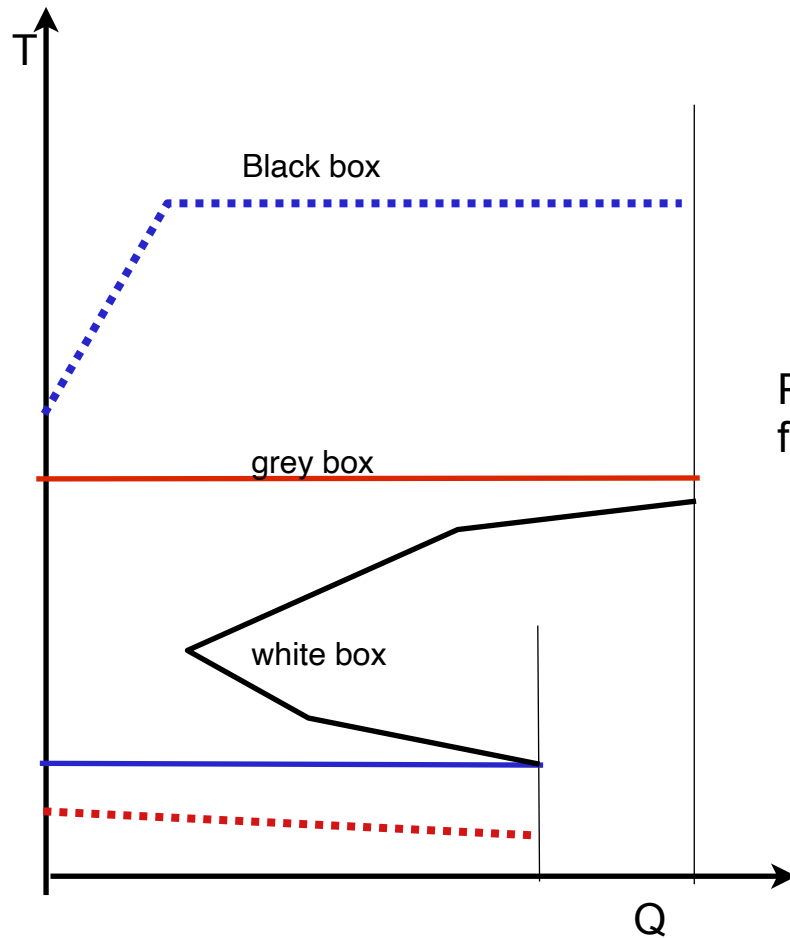
$$\dot{m}_s [kg/s] = m_s [kg/kg\text{product}] \cdot \dot{M}_p [kg\text{product}/s]$$

*What are the streams that do require heat transfer ?
Characterise them with Heat-Temperature profiles*

Different process heat transfer interfaces



Defining Unit Operation Interfaces



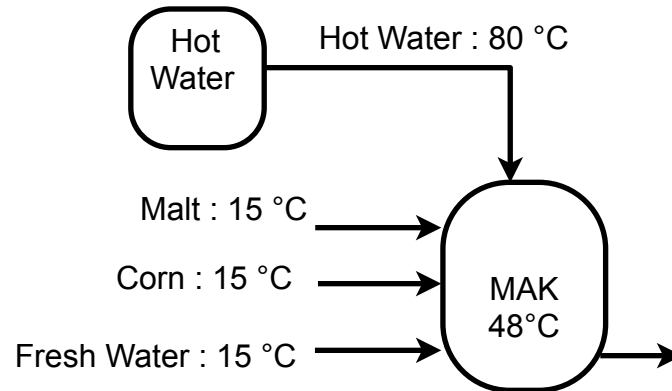
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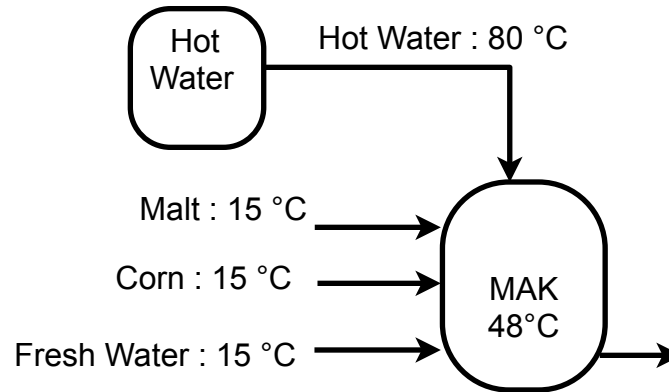
Unit operation MAK

Actual process representation

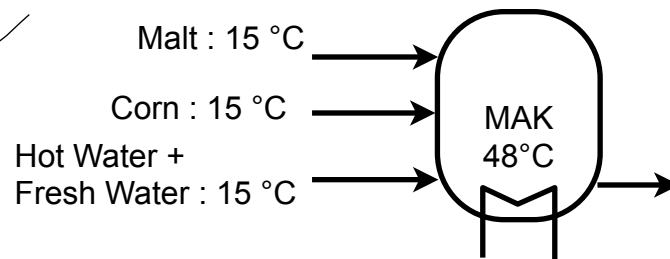


Unit operation MAK

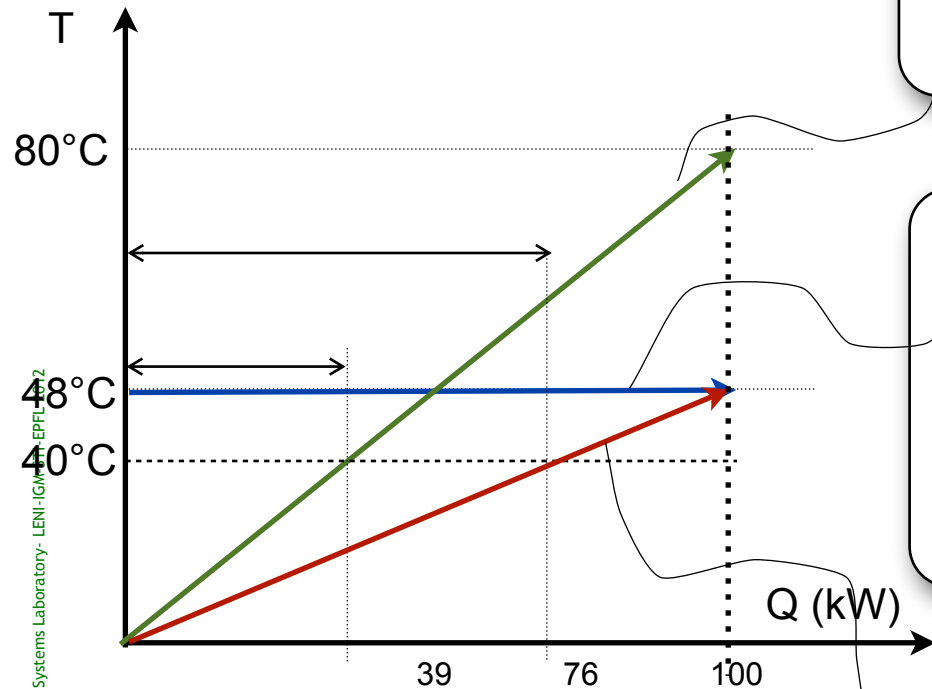
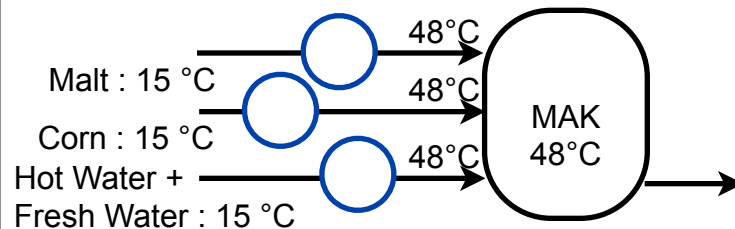
Actual process representation



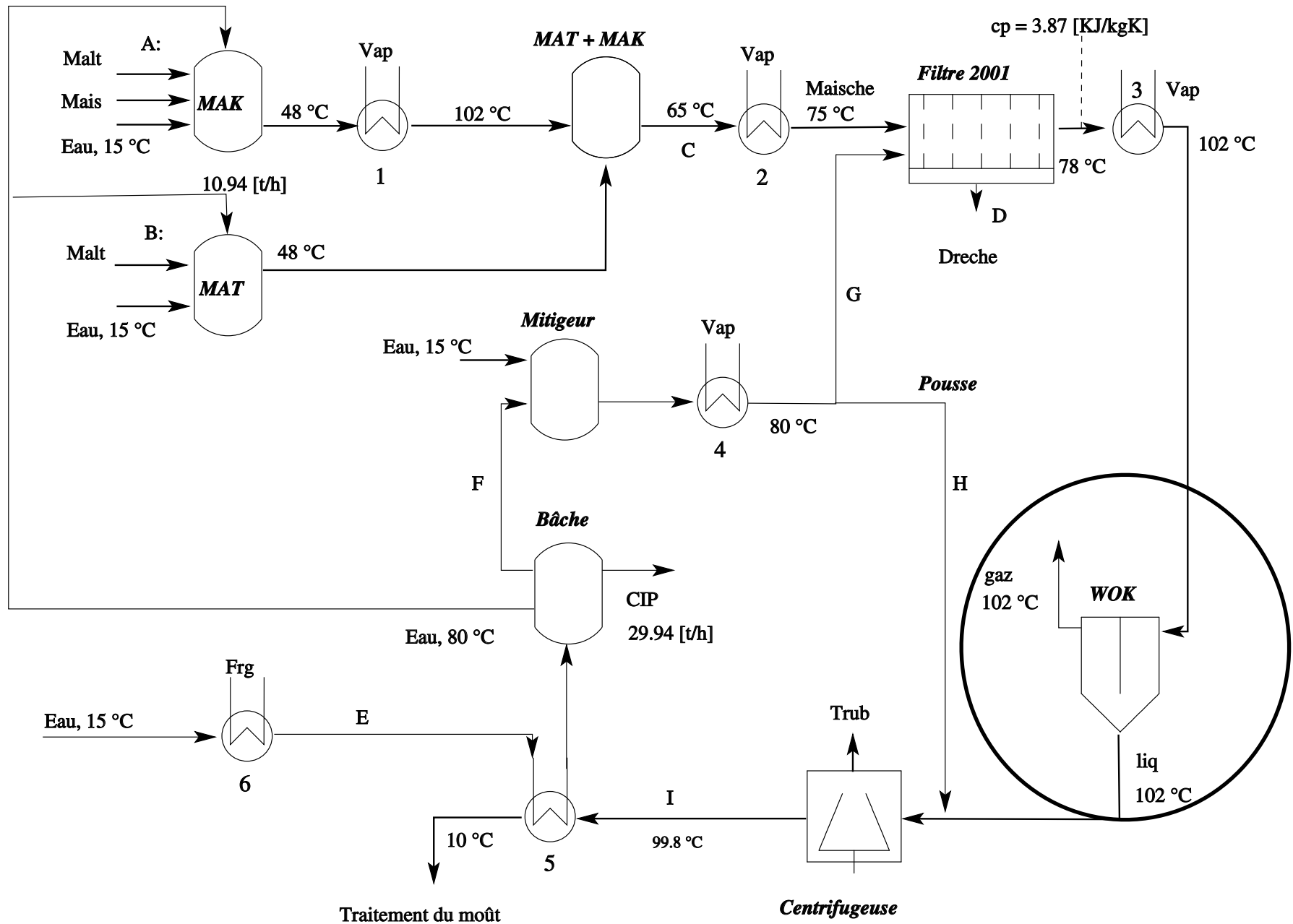
Vessel heating



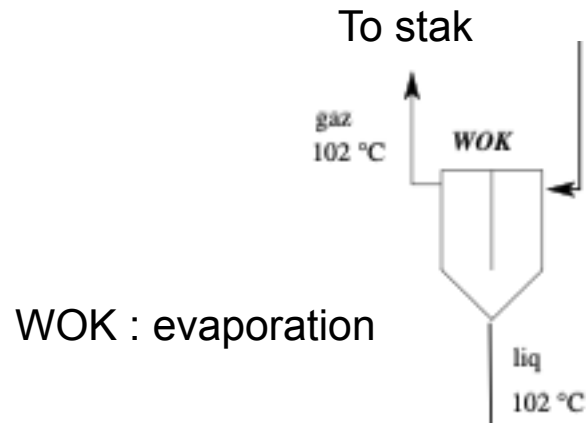
Heat transfer requirement



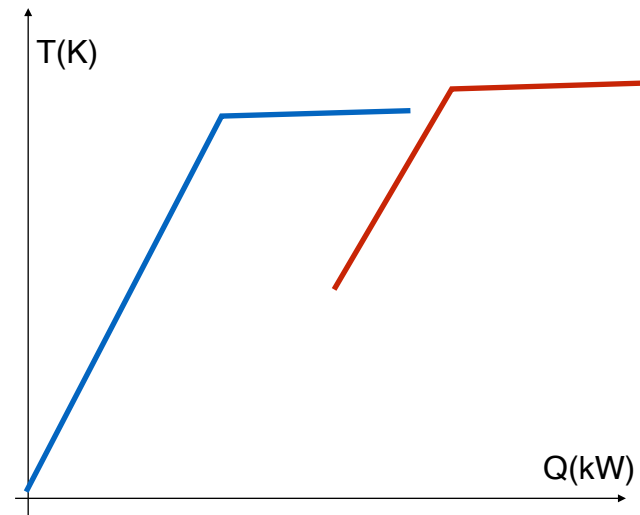
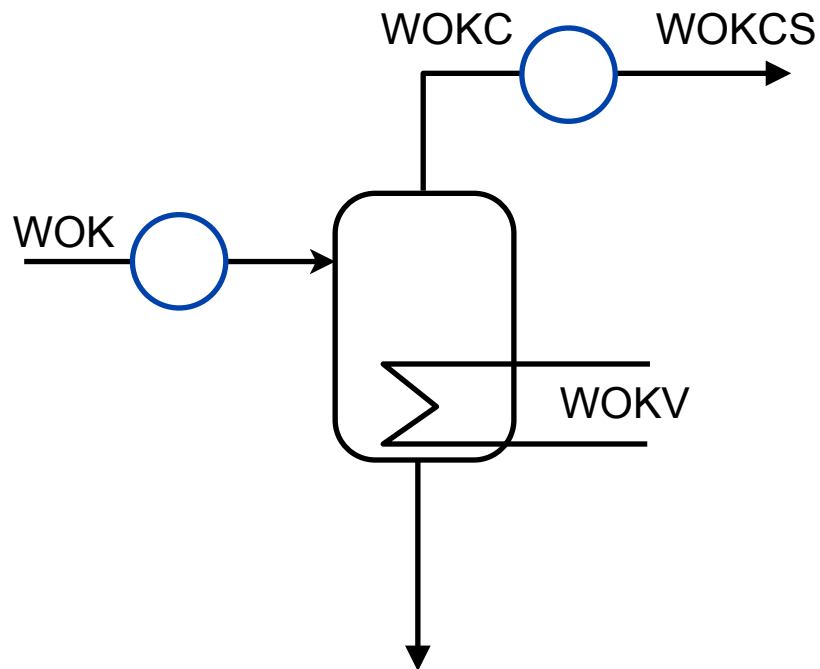
Hot Section of Brewery : definition of streams



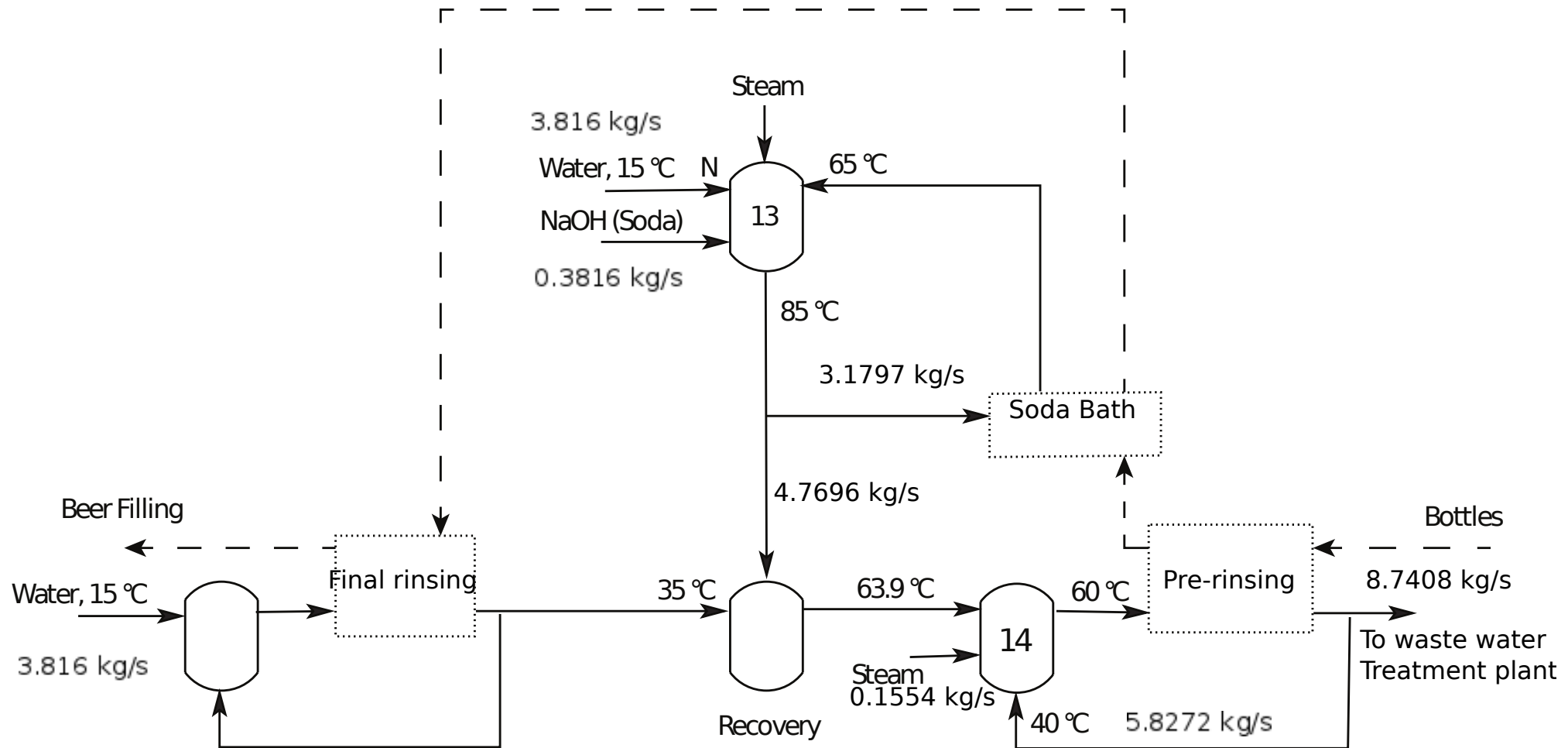
Recover waste heat lost in the environment



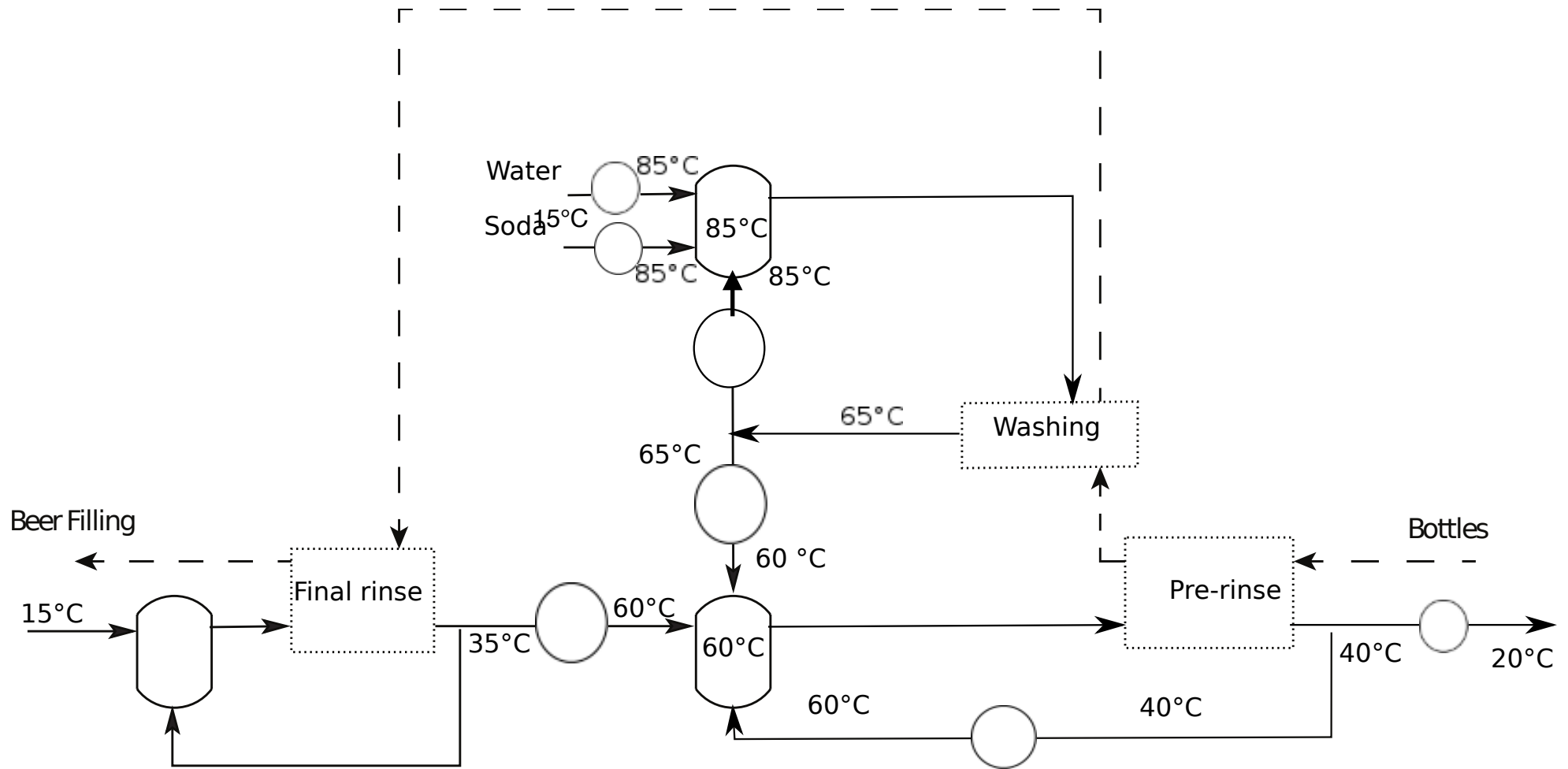
Nom	T _{in} [°C]	T _{out} [°C]	$\dot{M}$ [kg/s]	$\dot{Q}$ [kW]
WOK	78	102	16.2	1504
WOKV	102	102	-	4513
WOKC	95	95	2.3	4513
WOKCS	95	25	2.3	674



Example : Cleaning in place system



cleaning in place requirements



Conclusions on streams definition

- Forget utility streams
- Analyse process unit operations
 - define the needs
- Injection
 - go back to the origin
- Isothermal mixing
 - a priori no non isothermal mixing before knowing the pinch location
- Streams leaving/entering the system in equilibrium with the environment