

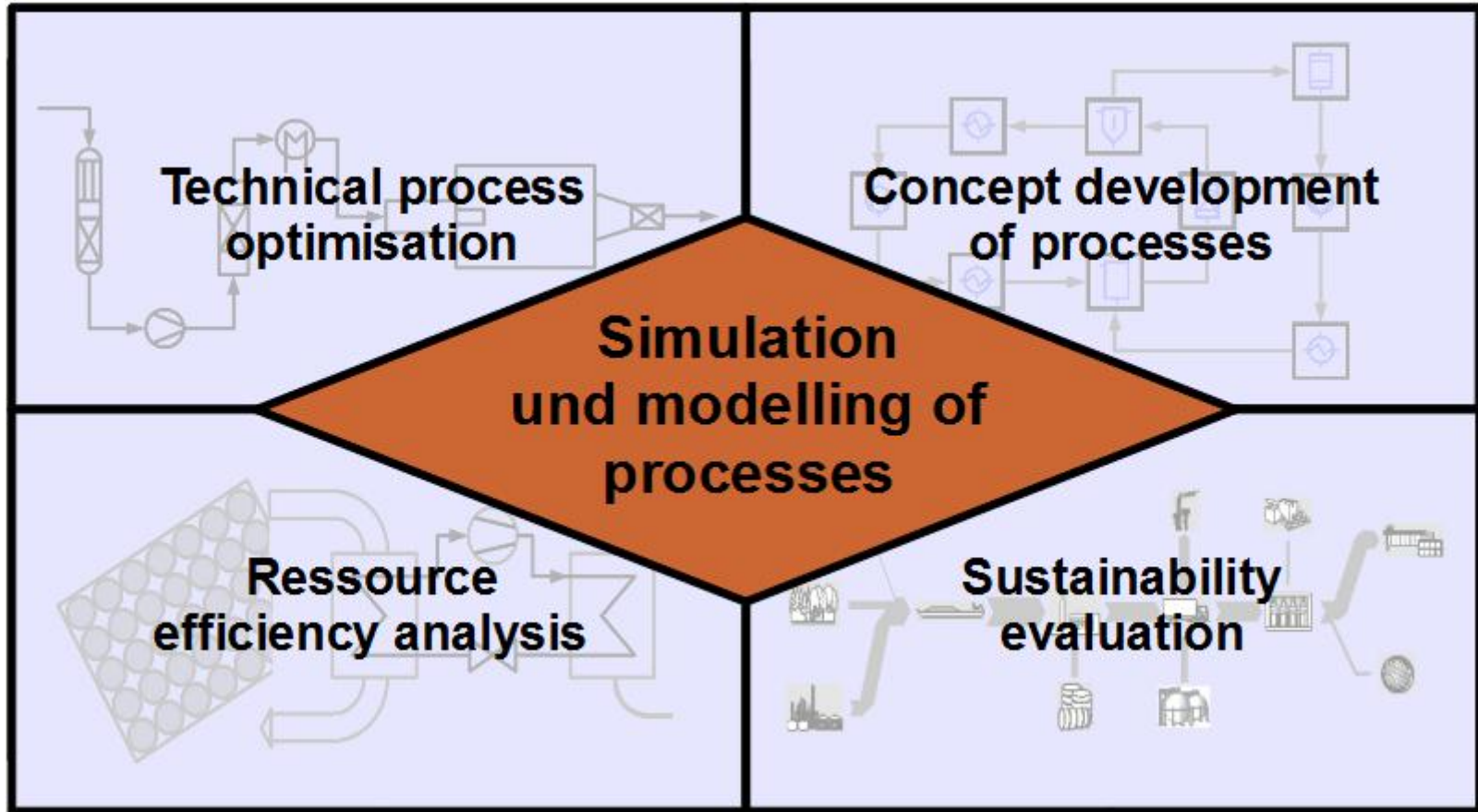
Simulation tools supporting resource efficiency analysis in the processing industry

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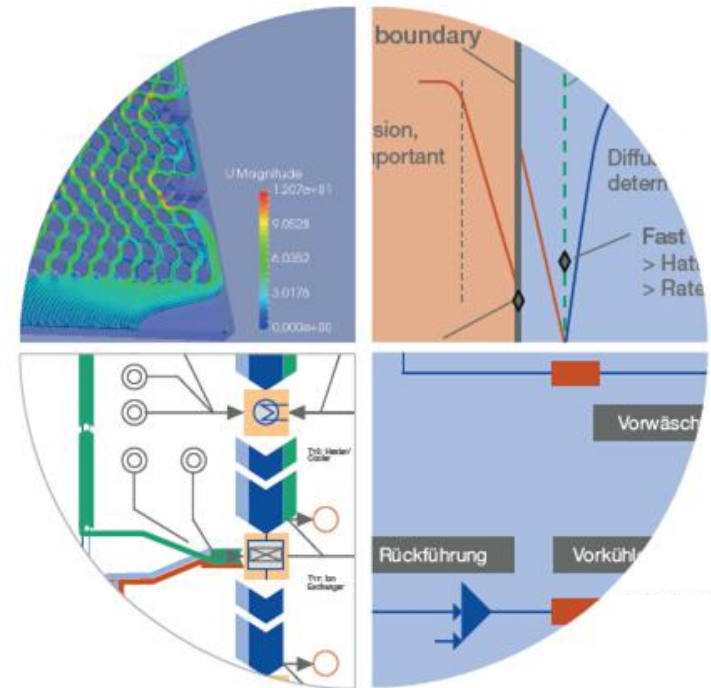
Schwartze id.vt – Fields of activities



AVEREM Verfahrenstechnik GmbH – Fields of activities

AVEREM process engineering is a German Ltd. focused on engineering services, mainly consulting and basic design.

- Air and water purification
- Flow simulation by computational fluid dynamics
- Thermodynamic flowsheet simulations
- Sankey analysis and optimization
- Industrial building facilities, cleanrooms, Hi-Tec industries



Goals of the presentation

- In general, the intention of resource efficiency analysis is the same in all industries: *increase of resource efficiency*
- But, in particular, resource efficiency analysis tasks in the processing industry can be very different from other industries

Goals of this presentation

- Show resource efficiency tasks in the processing industry in a structured way
- Assign simulation tools to resource efficiency tasks
- Give some examples on the use of simulation tools for resource efficiency analysis in the processing industry

Overview on resource efficiency tasks in the processing industry

	Task	Example
Analysis phase	Analysis of specific aspect	<ul style="list-style-type: none"> • Compressed air supply • Pumps
	Analysis of production line	<ul style="list-style-type: none"> • Production of a resin • Ultra-pure water supply for semiconductor production
	Analysis of total production facility	<ul style="list-style-type: none"> • Coatings production facility • Semiconductor production facility
Implementation phase	Plan of concept for improved resource efficiency	<ul style="list-style-type: none"> • Comparison of different scenarios to find the best solution
	Dimensioning / layout of production unit	<ul style="list-style-type: none"> • Implementation of heat recovery • Substitution / design of a pump
	Replacement of total production process	<ul style="list-style-type: none"> • New way of production for resin manufacturing



Complexity of resource efficiency tasks in the processing industry

Analysis of specific aspect

Analysis of production line

Analysis of total production facility

Plan of concept for improved resource efficiency

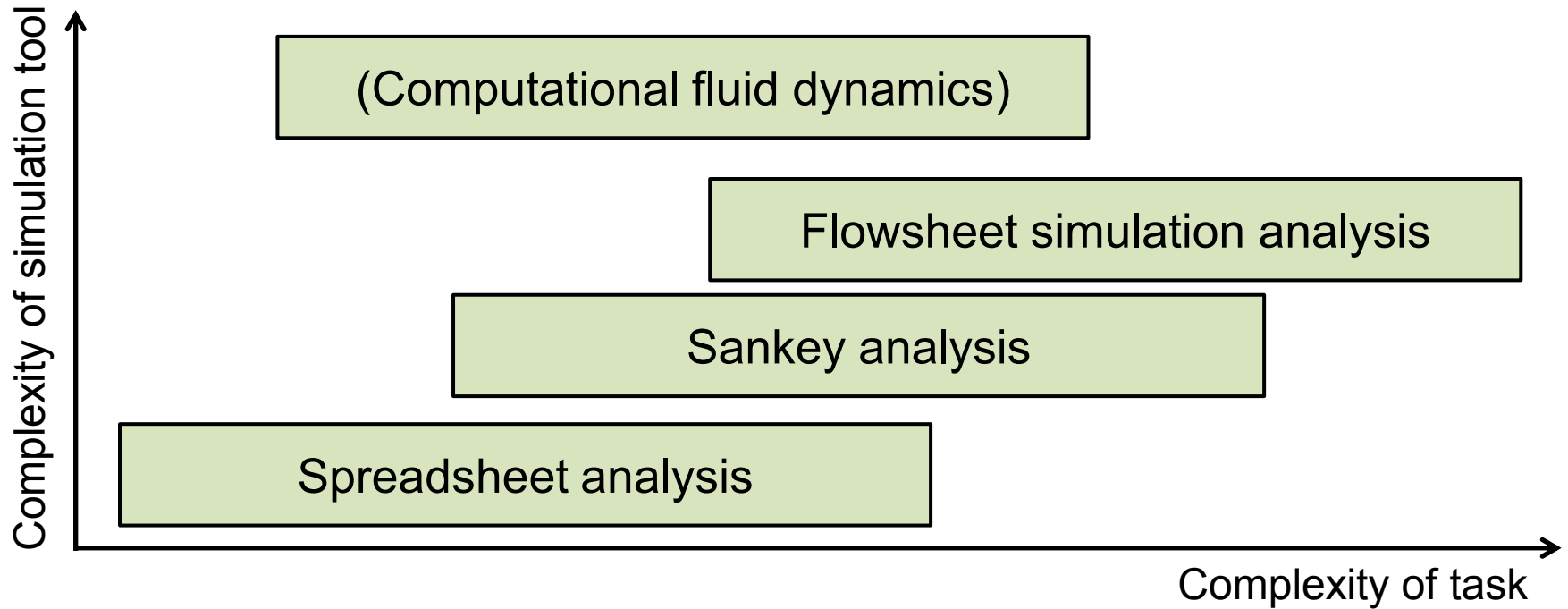
Dimensioning / layout of production unit

Replacement of total production process

Complexity of task



Simulation tools for resource efficiency tasks in the processing industry



Internal simulation tool Can be of all complexity ranges



Examples of resource efficiency tasks in the processing industry

Analysis of specific aspect

Spreadsheet analysis

Example 1:

Calculation of heat exchange

	A	B	C
1	Wärmeübertragung einfach. cp = const.		
2			
3	Eingaben		
4	Berechnung		
5			
6	Stoff	Luft	
7	Wärmekapazität cp	1,012 kJ/(kg K)	
8	Massenstrom	700 kg/h	
9		0,19 kg/s	
10			
11	Temperatur ein	120 °C	
12	Temperatur aus	80 °C	
13			
14	Übertragene Wärme	-28336 kJ/h	
15		-7,871 kW	
16			



Examples of resource efficiency tasks in the processing industry

Analysis of specific aspect

Spreadsheet analysis

Example 2: Calculation of specific heat capacity

	A	B	C	D	E	F	G	H	I						
1	Berechnung der spez. Wärmekapazität von Gasen														
2	nach VDI-Wärmeatlas 10. Auflage 2006, Absch. Dca 1														
3															
4	Eingabe														
5	Berechnung														
6															
7	Stoff	Luft													
8	Temperatur T	80 °C													
9		353,15 K													
10	Koeffizient A	1070,3													
11	Koeffizient B	-0,564000													
12	Koeffizient C	0,001507													
13	Koeffizient D	-0,000001102													
14	Koeffizient E	-0,000000014													
15															
16	Wärmekapazität	1010,53 J/(kg K)													
17		1,0105 kJ/(kg K)													
18															
19	Tabelle 6. Spezifische Wärmekapazität c_p der idealen Gase bei konstantem Druck in J/g K														
20	Stoff	Formel	Temperatur [°C]							Gleichung 10					
21			-50	0	25	100	200	300	400	500	A	B	C	$10^3 D$	$10^3 E$
22	Luft		1,007	1,006	1,007	1,012					1070,30	-0,564	0,001507	-0,001102	-0,000014

Spezifische Wärmekapazität des idealen Gases:

$$\frac{c_p^{id}}{J/kg K} = A + B \frac{T}{K} + C \left(\frac{T}{K}\right)^2 + D \left(\frac{T}{K}\right)^3 + E \left(\frac{T}{K}\right)^{-2} \quad (10)$$



Spreadsheet analysis for resource efficiency tasks in the processing industry

Spreadsheet analysis

e.g. MS Excel, Open Office Calc

- Useful for high frequency tasks
- Tasks shall not be too complex

Else: Keeping track of system of equations may be a challenge....

$F31 * D28 / (C1 + C2) \dots$ Not easy to validate.

- Visualisation of flows has to be created manually
- Advantage: Widely spread as it is available on almost everybodies computer and almost everybody is able to work with spreadsheets

Examples of resource efficiency tasks in the processing industry

Analysis of production line

Sankey analysis

What is Sankey analysis?

In Sankey analysis,

- mass and energy balances are calculated as the basis for the analysis
- according to the project definition, further variables can be flexibly investigated (e.g. costs, but as well variables like capacities)

The results are visualized in Sankey diagrams.

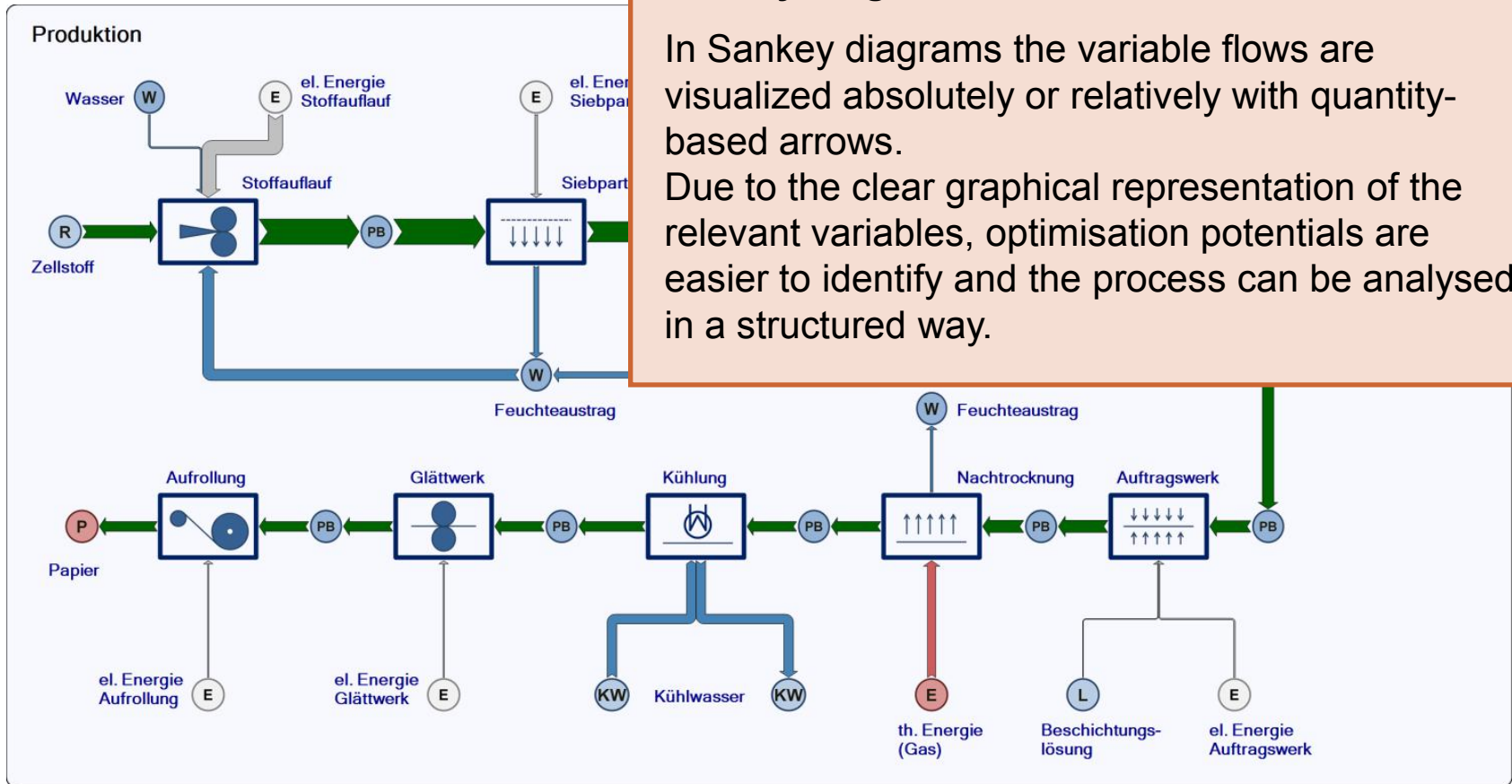


What are Sankey diagrams?

Sankey diagrams

In Sankey diagrams the variable flows are visualized absolutely or relatively with quantity-based arrows.

Due to the clear graphical representation of the relevant variables, optimisation potentials are easier to identify and the process can be analysed in a structured way.

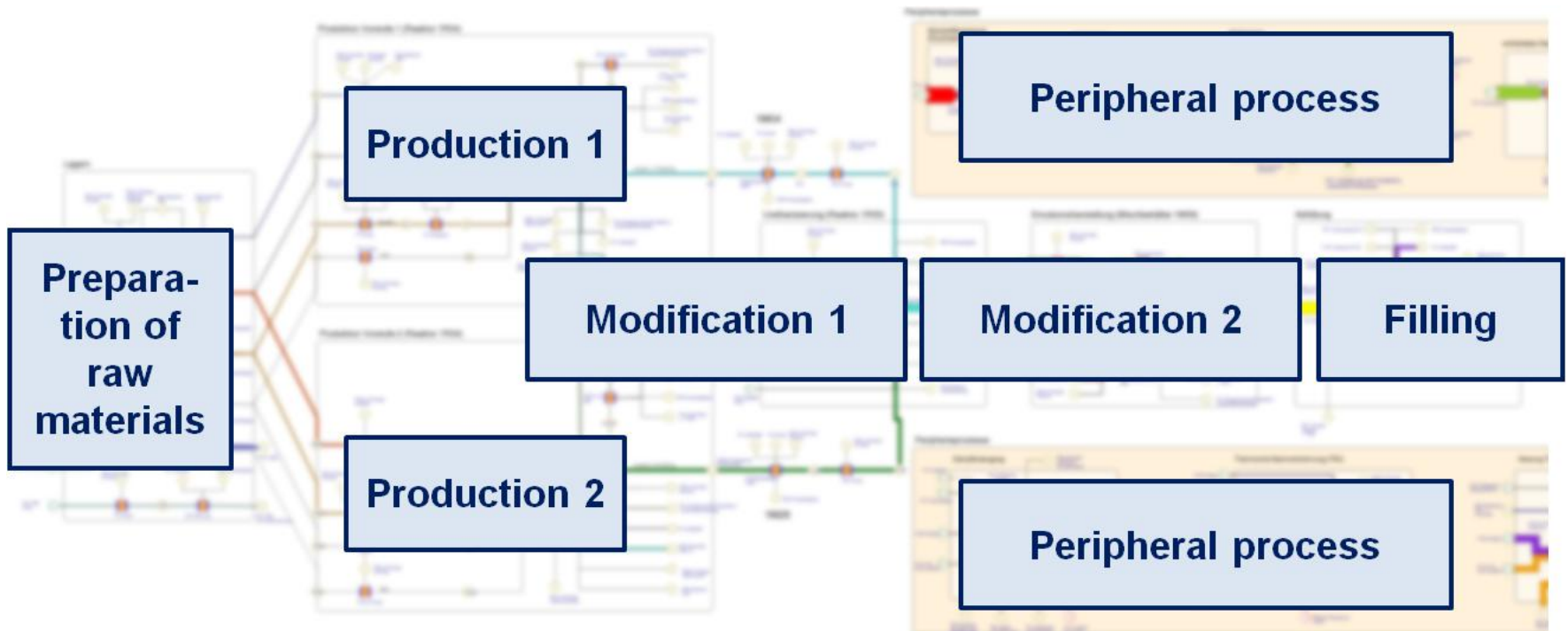


Examples of resource efficiency tasks in the processing industry

Analysis of production line

Sankey analysis

Example: Resource efficiency analysis of the production of a resin



Sankey analysis for resource efficiency tasks in the processing industry

Sankey analysis

e.g. Umberto NXT

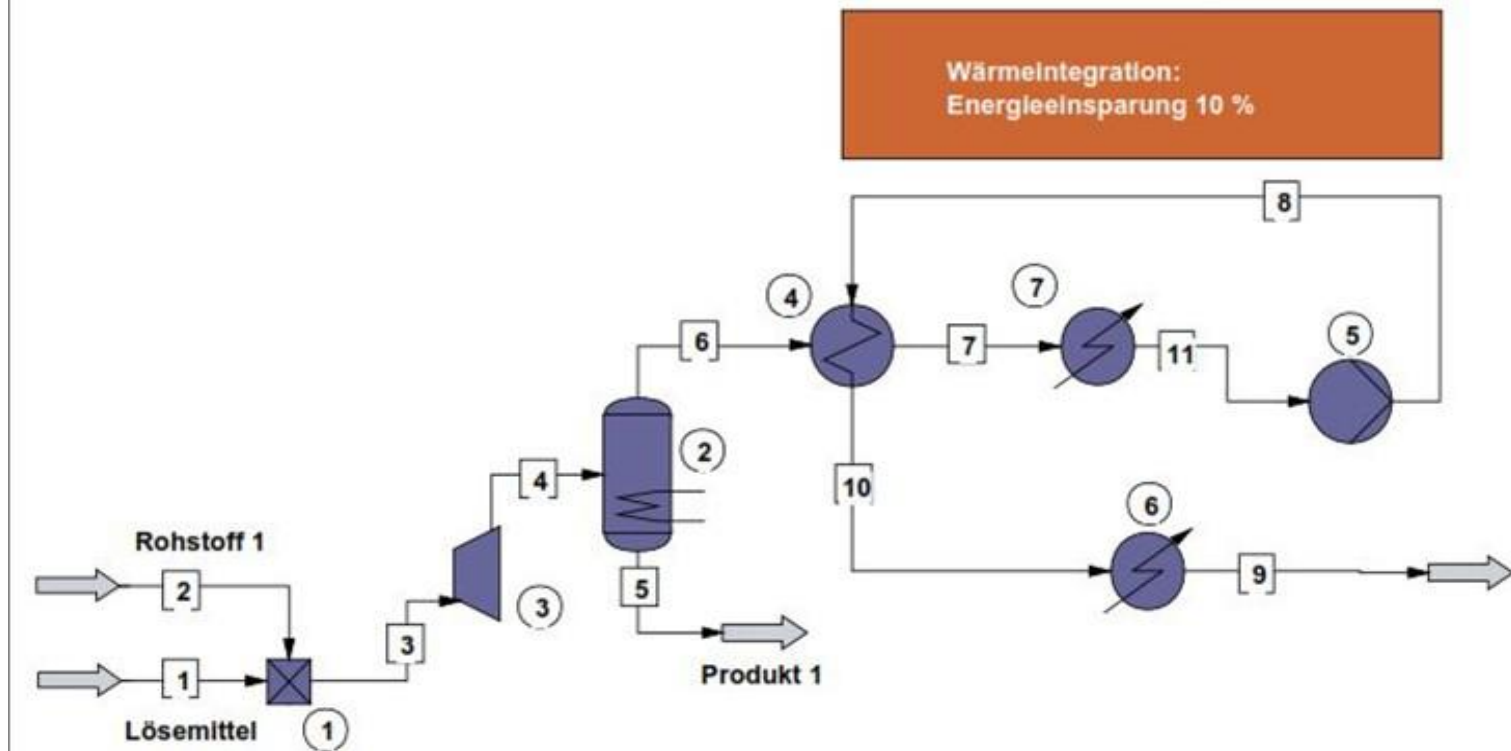
- Useful for complex tasks in conceptual phase and beginning of layout phase
- High flexibility in defining the depth of detail and the variables to be analysed
- Possibility of structured analysis because of process visualisation in Sankey diagrams (as well for non-technicians)
- Analysis of different scenarios easy to realise
- License necessary
- In Umberto: Input of data possible via Live Links from Excel to Umberto

Examples of resource efficiency tasks in the processing industry

Dimensioning / layout of production unit

Flowsheet simulation analysis

Example: Heat recovery



Flowsheet simulation analysis for resource efficiency tasks in the processing industry

Flowsheet simulation analysis

e.g. ProSim, Chemcad, Aspen

- Useful for complex tasks in design phase and for complex non-ideal material mixtures
- Databases for thermophysical properties and unit operation models (especially in fluid process engineering) available
- Illustration of process in a more technical way
- License necessary
- Interface to other software tools possible, e.g. spreadsheet analysis tools



Examples of resource efficiency tasks in the processing industry

Plan of concept for improved resource efficiency

Sankey analysis

+

Flowsheet simulation analysis

Example: Influence of different solvents on a process

Combination of advantages of Sankey analysis and flowsheet simulation analysis

Picture on next slide



Schwartz id.vt

Ingenieurdienstleistungen in der Verfahrenstechnik



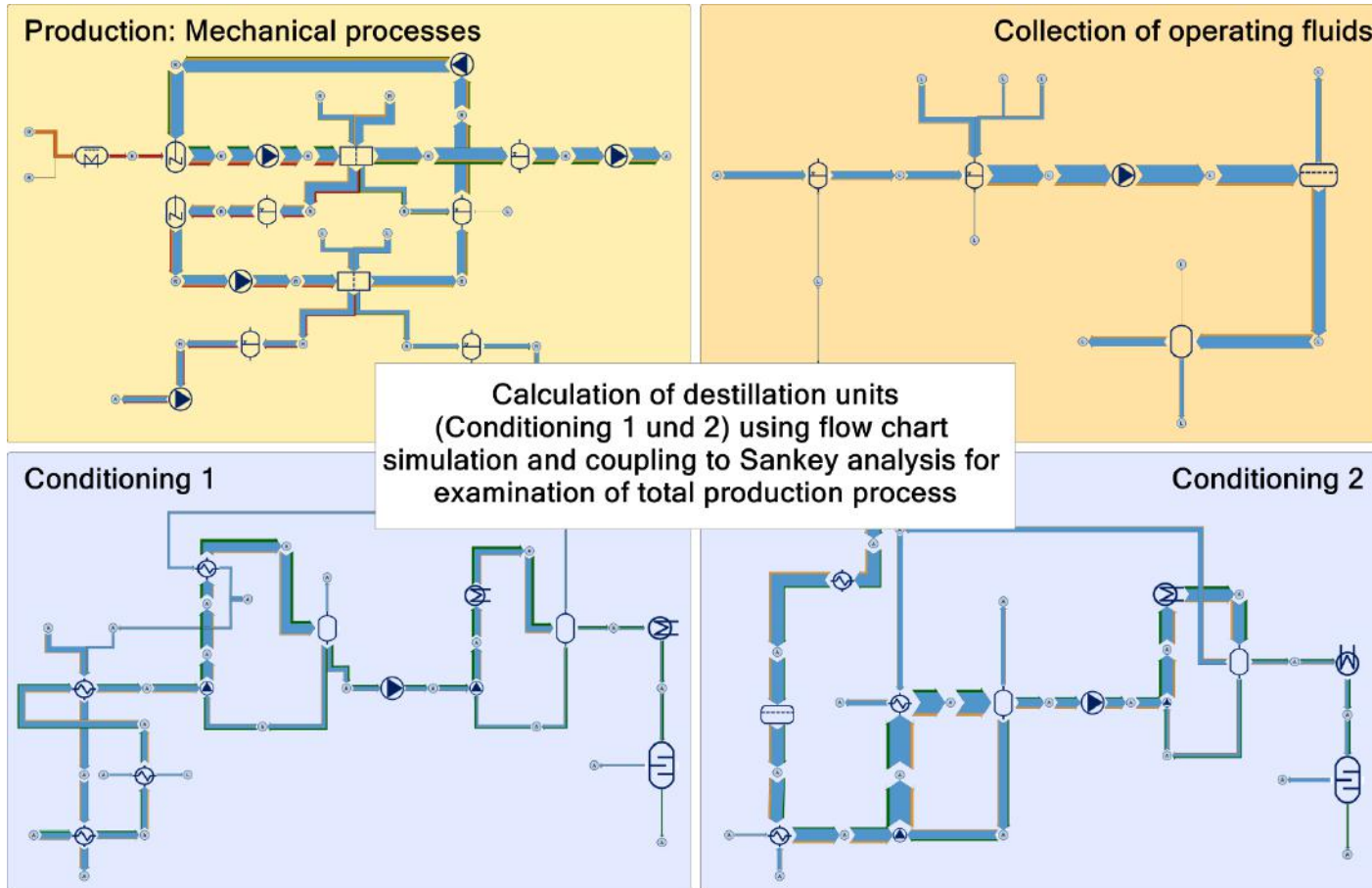
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Examples of resource efficiency tasks in the processing industry

Example: Influence of different solvents on a process



Thank you for your attention!

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