Establishing water reuse networks in mixed-industry parks using a model-based approach

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Advancing industrial water reuse

To further reduce fresh water demand **new concepts and approaches to industrial water reuse** are required in addition to already established practices. Especially larger mixed-industry parks show highly diverse wastewater qualities and freshwater demands. This type of industrial parks has great potential for implementing **water reuse networks at the industrial park level**. The planning and design of such networks requires an integrated approach and a system-wide perspective from freshwater abstraction to water use and treatment to discharge. As actual implementations of park-wide reuse networks are still rare, network design cannot be based largely on experience. To tackle this complex design task, planning and decision-making tools should foster **creativity and a comprehensive exploration of innovative, tailor-made solutions**.

Using models in conceptual design

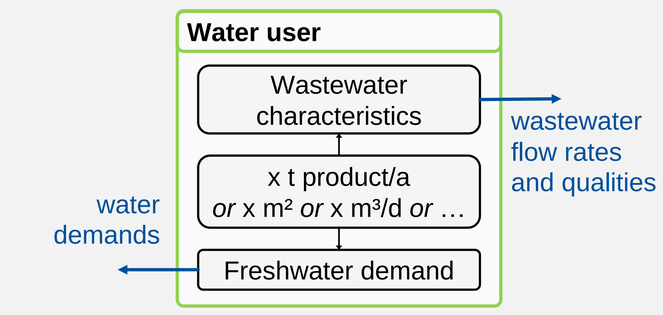
In the conceptual design phase, there is a **great variety of options**, and accordingly **great optimisation potential**. However, typically only **limited and uncertain data** is available on which the process design can be based. The use of models allows to explore many possible designs and to account for limited knowledge e. g. through uncertainty and sensitivity analysis. To **support decision-making** in early process development, a model should ideally:

- ✓ make use of all available (case-specific) data
- ✓ yield decision-relevant outputs
- ✓ reliably, consistently and accurately characterise the modelled treatment process
- ✓ be comprehensible and easy to use.

Developing a flowsheet simulation model for decision-support in early project phases

Water user modules

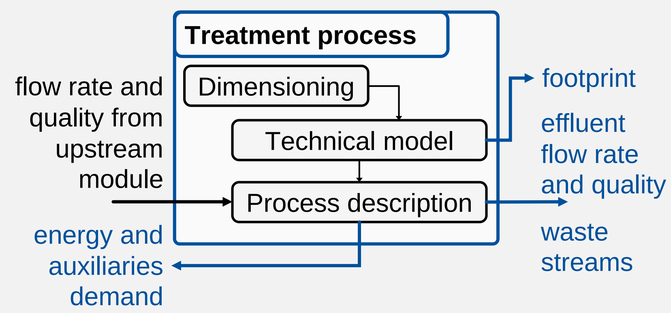
model input
model output



parameters
- annual production (amount and time)
- specific wastewater discharge and quality
- specific water demand and quality requirements

Treatment process modules

model input
model output



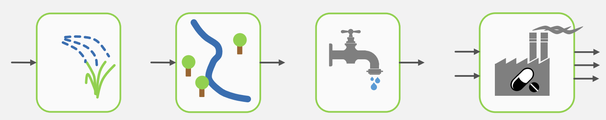
parameters
- dimensioning load case and parameters
- operating parameters
- specific energy and auxiliaries demand
- specific emissions and residuals
- range of applicability

- practical, static process models
- quality parameters are measurable and relevant to process design

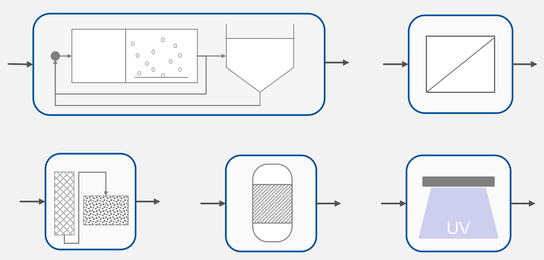
add

Module library

Water users



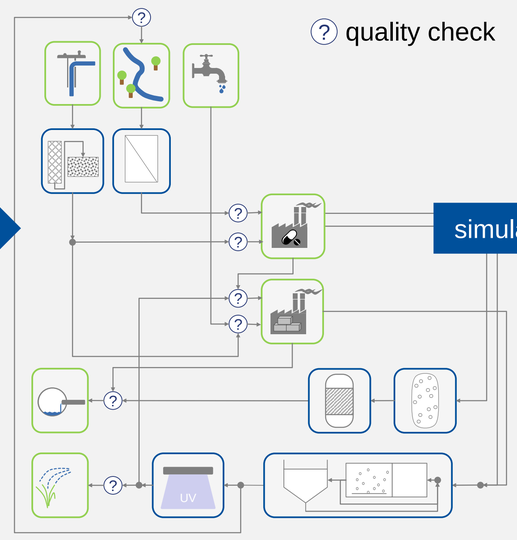
Treatment processes



- pre-configured modules for typical industrial water treatment processes and water users
- scripts for process dimensioning
- case-specifically adaptable through module parameters
- extendable by user-defined modules

connect

Flowsheet simulation



simulate

- estimation of technical performance, costs and ecological impact can be based on simulation results
- meeting of quality requirements and technical feasibility are checked by simulation
- modules can easily be replaced e.g. by more sophisticated models at later project stages

Simulation results

- water quantities and qualities
- waste and emissions
- energy demand and utilisation (electrical/heat/biogas)
- auxiliaries demand
- footprint

Water quality parameter vector

Q	**T**	**C_{COD}**	**S_{COD}**	**$S_{COD,rb}$**	**$S_{COD,inert}$**	**TKN**	**NH_4-N**	**NO_3-N**	**PO_4-P**	**P_{total}**	**TSS**	+ case-specific parameters
volume flow (m^3/d)	temperature (°C)	total COD (mg/L)	soluble COD (mg/L)	readily biodegr. COD (mg/L)	soluble inert COD (mg/L)	Kjehldahl-nitrogen (mg N/L)	ammonium nitrogen (mg N/L)	nitrate nitrogen (mg N/L)	phosphate phosphorus (mg P/L)	total phosphorus (mg P/L)	total suspended solids (g/L)	

Conclusion

- flexible and easy-to-use modelling approach that addresses the requirements of the early conceptual project phase
- facilitates a structured and transparent design approach
- computationally inexpensive model runs allow simulation of different scenarios, uncertainty and sensitivity analysis, optimisation etc.

Outlook

- testing and comparison of process models through uncertainty and sensitivity analysis
- application to real-life case-studies
- online library of implemented modules in SIMBA#3 and software-independent module documentation

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WaReIp
Water Reuse in Industrial Parks

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