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Bundesministerium für Bildung und Forschung

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WavE
Wassertechnologien: Wiederverwendung

FONA
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Eine Initiative des Bundesministeriums für Bildung und Forschung
Wasser: N
SCHUTZ. NUTZUNG. INNOVATION.

WEISS_4PN

Integrative application of innovations and digital cooling capacity management to reduce the amount of water required in steel production

Project overview

Goals	Approach	Result
Ensuring water availability	Desalination process	Decoupling of steel production from availability of water
Application of innovative technologies	Development of new processes according to the requirements of the industry (mCDI, antifouling membranes)	Increasing efficiency, reducing operating costs
Tapping the full potential of digitalization	Connecting production to the processes of water supply	Minimization of water demand through digital cooling capacity management; prediction of water supply bottlenecks
Transferability to other facilities, incl. concentrate treatment	Extension of the technology application	Ensuring utilization of the results within the steel industry and implementation of the results achieved in the HighCon project
Sustainability in concentrate treatment	Separation of the interfering organic material; recovery of salts by means of fractional precipitation	Cost-effective salt recovery from concentrates; closed cycles; reduction of salt discharge into the environment
Establishment of a reference project	Implementation in a demo application	Proof of technological feasibility of the results achieved in the WEISS/WEISS_4PN projects

Original situation based on WEISS

Availability of water for cooling at risk due to climate change, therefore decoupling of cooling water requirements and fresh water supply by means of water recovery

Results from WEISS preceding project:

- **The modular concept from WEISS works in principle**, up to 96% of the blowdown water can be recycled; there are **weaknesses**:
- Improved pre-treatment is required
- Impurities prevented the perfect operation of the mCDI in the direct cooling circuit
- The antifouling coating for the RO membranes developed during WEISS did not withstand chemical cleaning
- The disposal of the concentrates produced by the WEISS process is a problem
- **Asset:** The concept can be transferred to other sectors with cooling water requirements, e.g. chemical, refining, paper, power generation, food industries, etc.

Work in WEISS_4PN

- Improvement in **pre-treatment** (laboratory + piloting)
- Extended tests with the pilot plant from WEISS:
  - **Review of the results** in the blowdown water from WEISS at another location with a higher salt concentration
  - Tests for **the treatment of other water flows** as cooling water: Workflow for the in-factory purification plant
  - Integration **of the UF pilot plant** for pre-treatment
- Testing an **improved mCDI** (lower sensitivity to impurities)
- Development of **an acid-resistant antifouling coating**
- Increased **planning reliability** thanks to a digital forecasting tool based on SIMBA#
- Minimization of evaporation losses and harmonization with production through **digital cooling capacity management**
- Development of **a water-saving** radiative **cooler**
- **Concentrate treatment** for use as secondary raw material

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"Water technologies: Re-use" (water: N)
Funding priority
"Sustainable water management" (German: *NaWaM*)

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Project coordination
Dr. Angela Ante
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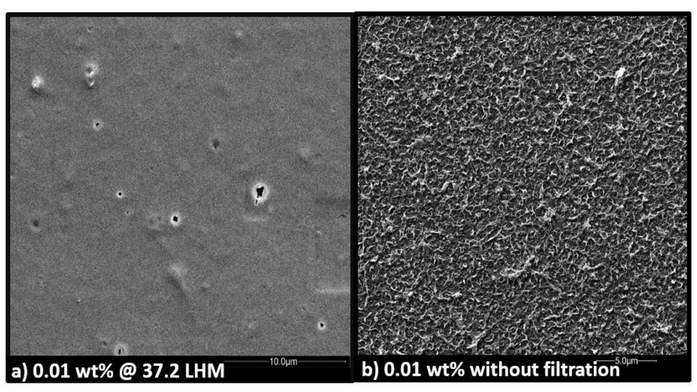
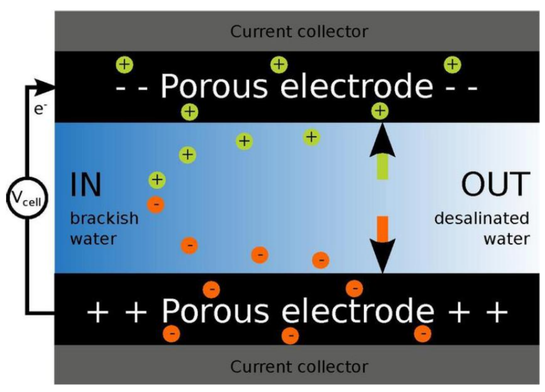
Practical focus of work

Pretreatment:
Untreated water and UF filtrate



SEM images of RO membrane
with and without antifouling coating



Schematic: mCDI

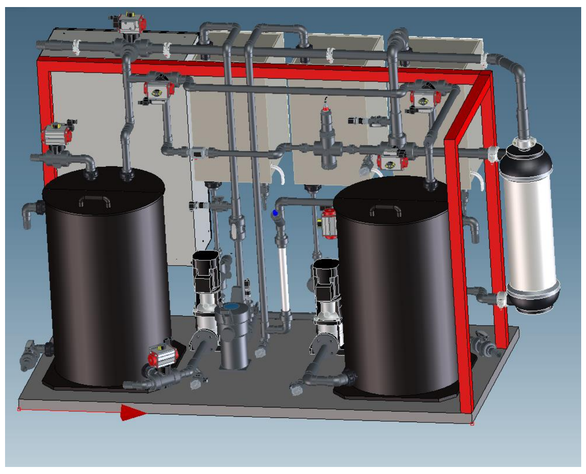
Prototype: Radiative cooler

Laboratory testing

- Pre-treatment of waste water for reverse osmosis (RO)
- Acid-resistant antifouling membranes
- Membrane capacitive deionization (mCDI)
- Concentrate treatment
- Coating for radiative cooling modules

- Testing of a suitable **pre-treatment** system (ultrafiltration) for the desalination of factory waste water by means of RO
- Development of a pH-value-tolerant **antifouling coating for RO-membranes** for the reduction of fouling while improving the cleaning properties at the same time
- Improvement in the insensitivity to impurities of **membrane capacitive deionization** (mCDI) by means of modified ion exchange membranes
- Further development of **the ZLD solutions** from HighCon for the recovery of materials from **the RO concentrates produced during desalination**
- Production of water-free **radiative coolers** by means of multi-layer coating

Fresh water source at the site



UF pilot plant (in the planning stage)

2-stage RO pilot plant

mCDI pilot plant

Pilot tests

- Integration of pre-treatment into the pilot plant
- Desalination of waste water
- Pre-treatment and 2-stage desalination of waste water
- Testing of the radiative cooling modules

- Utilization of the **pilot plant** from WEISS at the Eisenhüttenstadt location and testing of various **pre-treatment systems** incl. ultrafiltration
- **Desalination of blowdown water** by means of RO (improved data basis)
- Comparative examination of the desalination of waste water **with 2-stage RO** with pre-treatment and enhanced **mCDI** without pre-treatment
- Testing of **the radiative pilot cooler** (no evaporation losses)

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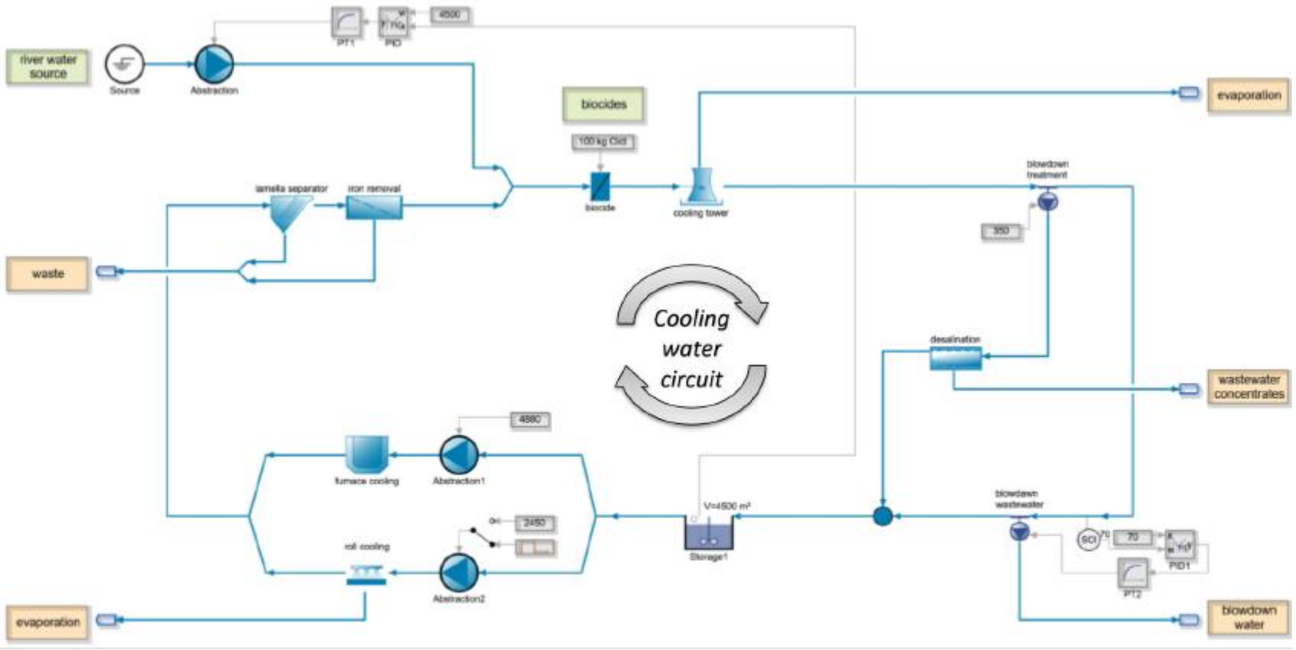
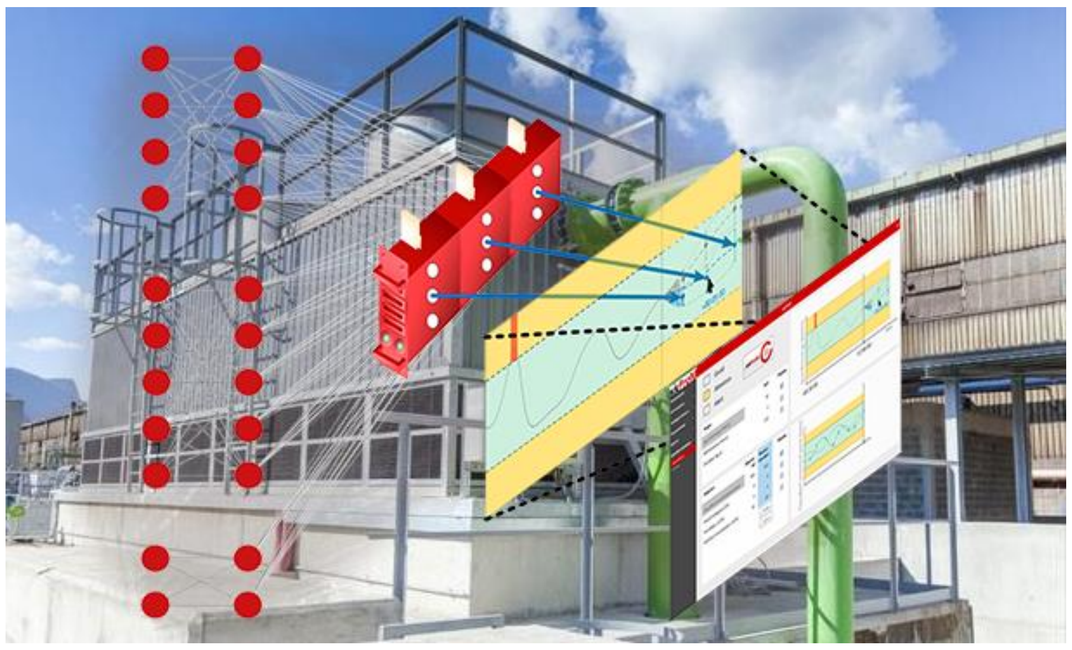
Theoretical focus of work



SIMBA# model of a simple cooling circuit

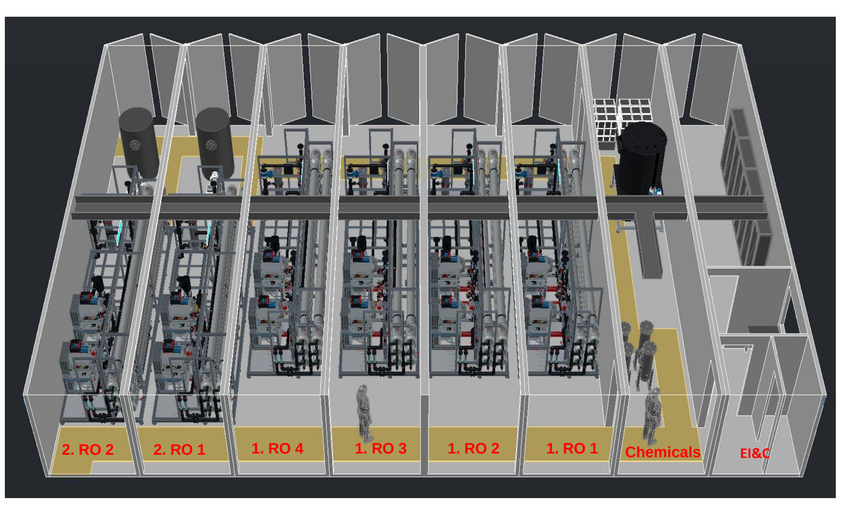


Development of a neural network to create a system of digital cooling capacity management

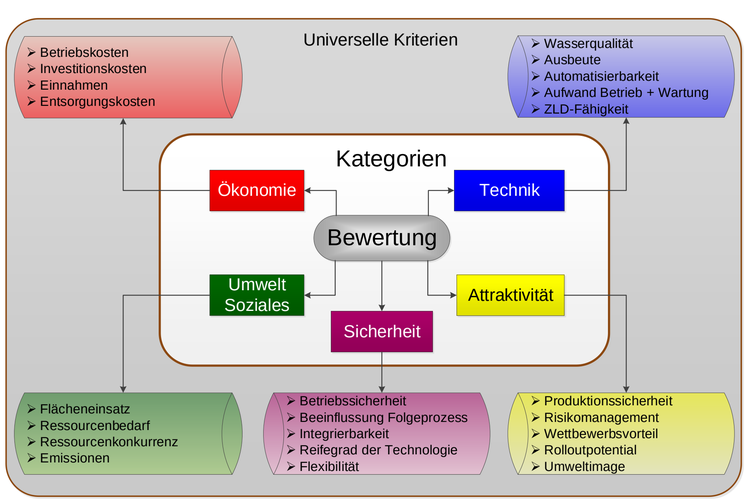
Theoretical considerations

- Digital forecasting tool
- Digital cooling capacity management
  - Concept preparation
  - Cost comparison
- Multi-criteria decision analysis (MCDA)
- Life cycle assessment (LCA)

- Increased planning reliability thanks to **a digital forecasting tool** based on SIMBA# as well as **big data analyses** and AI models based on production data
- Minimization of evaporation losses and harmonization with production through a system of integrated **digital cooling capacity management**
- Elaboration of **a large-scale technical concept** for the processes that have been successfully tested
- Determination and **comparison of the costs** for large-scale plants for successfully tested processes
- **Evaluation** of the procedures based on numerous relevant criteria and expert interviews
- **Ecological evaluation** of the resulting concepts and processes by means of LCA



Concept of a large-scale WEISS plant



Criteria for the MCDA

LCA principle

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