WEISS_4PN

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

- **Brief description**

In the industrial sector, water is mainly needed for cooling. In the steel industry, 75% of the amount of water used is required for cooling. Facing climate change, it must be assumed that the availability of water will – at least temporarily – be limited in the future. In order to nevertheless ensure high operational reliability for steel production, the demand for fresh water must be largely separated from production operations and minimized by recovering water from the production site's wastewater.

For this purpose, the pilot plant (capacity: 1 m³/h) available from the WEISS project (https://www.bmbf-wave.de/1441.php) will be set up at the Eisenhüttenstadt facility and waste water volumes that had not been considered to date will be desalinated so as to make maximum use of the potential to compensate for evaporation losses occurring in open cooling circuits using in-house water flows. First of all, the discharge of the waste water treatment system will be tested. For this purpose, after thorough analysis of the water composition, additionally required pre-treatment steps will be defined and their effectiveness will be tested in the laboratory. The pre-treatment tested in this way will then be implemented and integrated in the pilot plant, and the waste water will be desalinated.

A crucial aspect for the economic application of this concept is the safe and cost-effective disposal of the concentrates produced in the desalination process. That is why the salt fractions will be separated from each other by means of two different approaches.

An optimization and forecasting tool is intended to determine the development of the composition and the availability of fresh water to be able to detect bottlenecks at an early stage. A digital cooling capacity management system integrated in the process is intended to

optimally utilize the potential of the existing cooling circuit systems by linking the production-related heat load with the current weather-related cooling capacity.

Finally, the concepts shall be evaluated economically and ecologically in order to select the most economically favorable and environmentally compatible solutions.

- **Goals**

In order to increase the water availability, desalination processes are to ensure that steel production is decoupled from the availability of water.
Innovative technologies such as membrane capacitive deionization (mCDI) and the development of antifouling membranes for reverse osmosis are used with the aim of increasing efficiency and improving selectivity.
Minimization of water demand and prediction of bottlenecks in water supply are to be achieved by means of digital tools and the production could be connected to the water supply possibilities.
The results already achieved in the WEISS project shall be transferred to other facilities and confirmed, and the application of the technology shall be extended. The results from the HighCon project on cost-effective and environmentally compatible concentrate treatment will also be taken into account. In addition, work will be carried out on the separation of monovalent salt compounds, and the salt fractions are to be separated from each other to the greatest possible extent by means of fractional precipitation according to their solubility product.
The establishment of a reference project with a capacity of around 50 m^3/h is intended to prove the technological feasibility of the results achieved in the WEISS project in a demonstration application.

- **Focus of work**

The water demand is to be reduced by optimizing the use of water in terms of time and location using a forecast model and a digital cooling water management system based on this model by creating a digital twin.

As a technological innovation, antifouling membranes that have a higher pH tolerance shall make it possible to perform reverse osmosis largely without alkaline and enzymatic cleaning, thus improving the operational reliability of the RO membranes, increasing their service life and reducing maintenance costs. Furthermore, the economically particularly favorable process of membrane capacitive deionization (mCDI) shall be adapted to real-life conditions with modified ion exchange membranes.

Finally, a novel method of radiative cooling without water, which is currently in the process of being patented, will be examined for the first time for application in the steel industry. In the laboratory, a multi-layer coating of radiative cooling modules shall be produced and thoroughly evaluated.

In the scope of laboratory tests, mono-concentrates are to be produced (e.g. by means of an ion-selective membrane) in order to come as close as possible to an environmentally compatible ZLD solution.

To further reduce the fresh water demand, other waste water from the steelmaking plants shall be treated to be used as make-up water for cooling circuits, for example water from the top gas scrubber water treatment plant and the central waste water treatment plant. The usable waste water shall be desalinated in trials on site using an existing pilot plant after the required pre-treatment defined in the laboratory has been established.

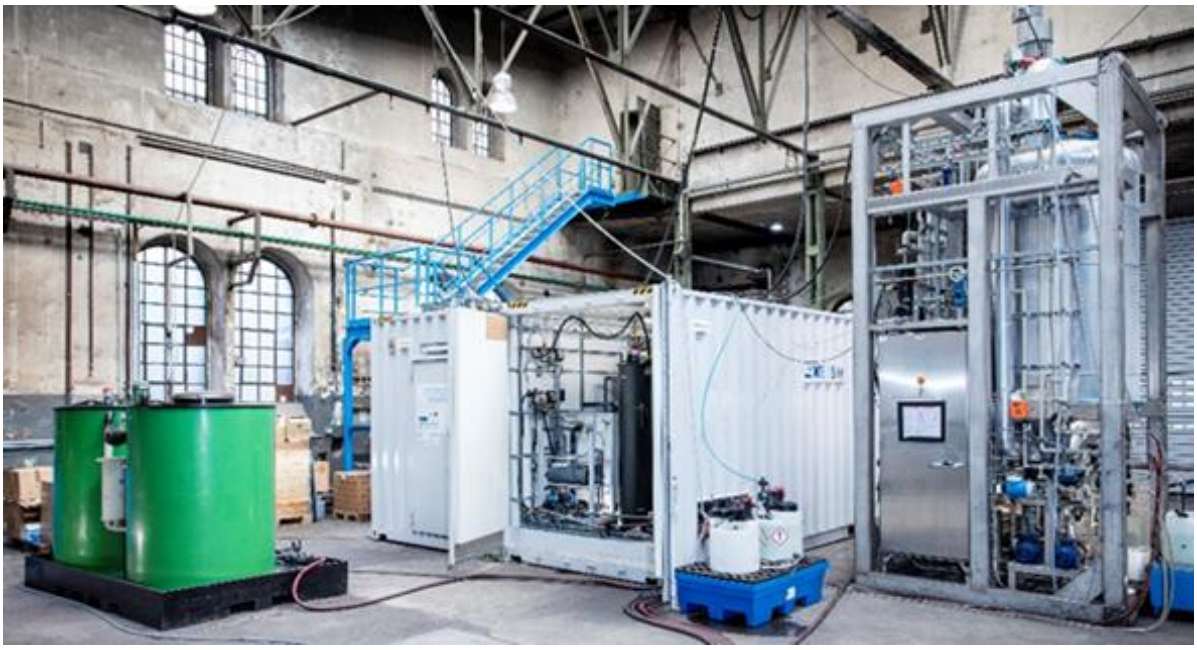

Figure 1: Multi-stage desalination plant from the WEISS project (DEW; Hagen) ©SMS group

Information on work packages (WP):

No.	Title of the WP	Person in charge of the WP (name, organization)
WP 1	**Situation assessment and target definition**	Martin Hubrich; BFI
WP 2	**Laboratory work on waste water pre-treatment, production of mono-concentrates**	Prof. Dr. Mathias Ulbricht; UDE
WP 3	**Pilot trials on site**	Ingo Wiebelitz; SMS
WP 4	**Design and operation of a large-scale demonstration plant**	Dr. Angela Ante; SMS
WP 5	**Development of digital tools**	Stefan Schmidt; SMS Martin Habermehl; Aixprocess Martin Hubrich; BFI
WP 6	**Profitability analysis**	Dr. Angela Ante; SMS
WP 7	**Sustainability assessment**	Moritz Münch; TUB
WP 8	**Documentation, coordination, transfer of results, capacity development**	Dr. Angela Ante; SMS

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Information on the site of investigation:

ArcelorMittal Eisenhüttenstadt GmbH (AMEh)
Werkstraße 1, 15890 Eisenhüttenstadt

Information on the project:

Project``s duration: Part 1: 01.04.2021-31.03.2022 (Part 2: 01.04.2022-31.03.2024)

Coordinator: SMS group GmbH (SMS)

- Name: Dr. Angela Ante
- Organization: Abteilung FRE - Neuentwicklungen
- Adress: Wiesenstr. 30, 57271 Hilchenbach
- Phone: 02733/29-3009
- E-Mail-Adresse angela.ante@sms-group.com:

Website (URL): www.sms-group.com/fresh-water-saving

Project partners:

SMS group GmbH (SMS):

aixprocess GmbH (AixP)

ArcelorMittal Eisenhüttenstadt GmbH (AMEh)

VDEh-Betriebsforschungsinstitut (BFI)

fem | Forschungsinstitut Edelmetalle + Metallchemie (FEM)

TRUMPF GmbH + Co. KG (TRU)

Technische Universität Berlin (TUB)

Universität Duisburg-Essen (UDE)

WEHRLE Umwelt GmbH (Wehrle)

Contacts Project partners:

Partner 1:	**SMS group GmbH (SMS)** Plant manufacturer (Metallurgy) / Coodinator Eduard-Schloemann-Str. 4, D-40088 Düsseldorf	Dr. Angela Ante Angela.ante@sms-group.com +49 2733- 29 3009 +49 151-17141982
Partner 2	**aixprocess GmbH** Alfonsstr. 44, D-52070 Aachen	Dr. Martin Weng weng@aixprocess.de fon +49 241 4134492-10 fax +49 241 4134492-39
Partner 3:	**ArcelorMittal Eisenhüttenstadt GmbH (AMEh)** Werkstraße 1, D-15890 Eisenhüttenstadt	Steffi Marquardt Steffi.Marquardt@arcelormittal.com +49 3364 372131 +49 162 2040838
Partner 4:	**VDEh-Betriebsforschungsinstitut (BFI)** Forschungsinstitut / Koordinator Sohnstr. 65, D-40237 Düsseldorf	Martin Hubrich martin.hubrich@bfi.de +49 211 6707 -343 +49 170 5825805
Partner 5:	**fem | Forschungsinstitut Edelmetalle + Metallchemie (fem)** Katharinenstraße 17, D-73525 Schwäbisch Gmünd	Christof Langer langer@fem-online.de +49 7171 1006 500
Partner 6	**TRUMPF GmbH + Co. KG (TRU)** Johann-Maus-Straße 2, D-71254 Ditzingen	Dr. Mostafa Biglari Mostafa.biglari@trumpf.com +49 151-65532555 +49 7156-303 34428
Partner 7	**Technische Universität Berlin (TUB)** Institut für Technischen Umweltschutz, FG Umweltverfahrenstechnik Hochschule Sekr. KF2, Straße des 17. Juni 135, D-10623 Berlin	Moritz Münch m.muench@tu-berlin.de Fon +49 30 314-25059 Fax +49 30 314-25487
Partner 8	**Universität Duisburg-Essen (UDE)** **Lehrstuhl für Technische Chemie II** Hochschule Universitätsstr. 7, D-45141 Essen	Prof. Dr. Mathias Ulbricht mathias.ulbricht@uni-essen.de Tel.: + 49 201 - 183 3151 Fax.: + 49 201 - 183 3147
Partner 9	**WEHRLE Umwelt GmbH (Wehrle)** Plant manufacturer (Environment), Bismarckstr. 1-11, D-79312 Emmendingen	Dr. Miriam Weissroth weissroth@wehrle-umwelt.com +49 7641 585-151 +49 172 7455591