

SteamDry

Innovative Solution for Decarbonising Drying Processes in the Paper Industry

NEFI Technology Talk 25.10.2024: Decarbonisation of the Paper Industry – Perspectives, Opportunities, and Innovative Solutions



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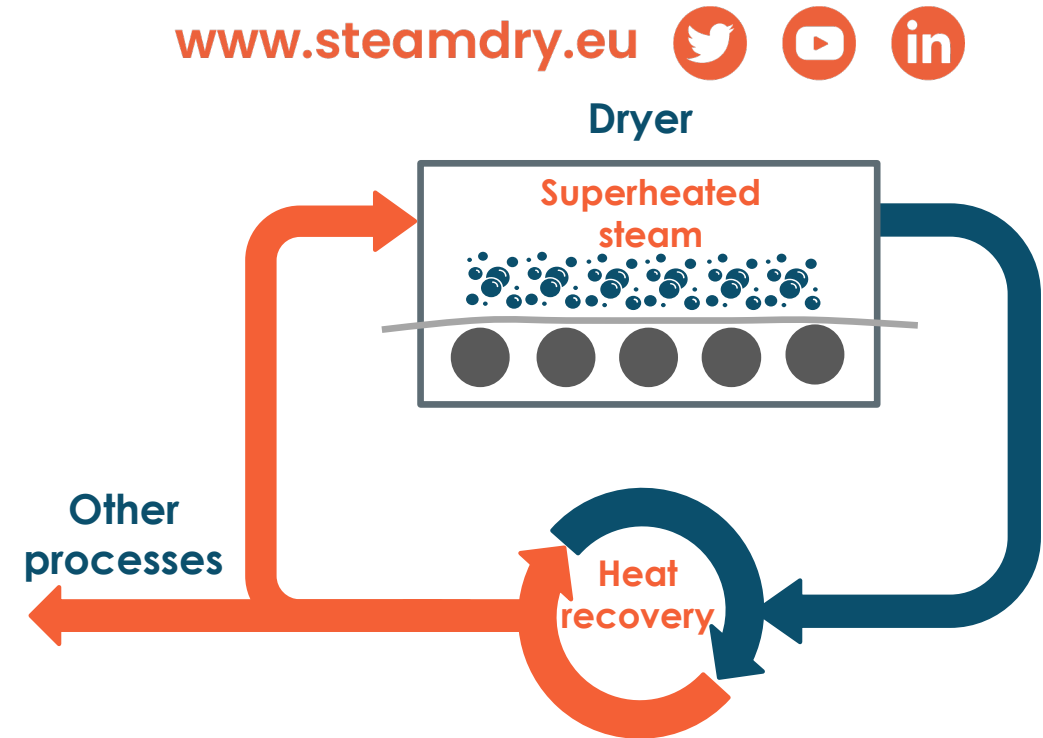
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Introduction SteamDry

- Superheated steam as drying medium to remove excess water from materials quickly and effectively.
- Circulating and reheating steam in a closed loop and use of surplus steam for other processes within the facility.
- System integration and advanced digitalisation of monitoring and control systems.
- Demonstration of substantial improvement potential by pilot-scale measurements.



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Key data

Project duration: 01/2024 – 06/2027

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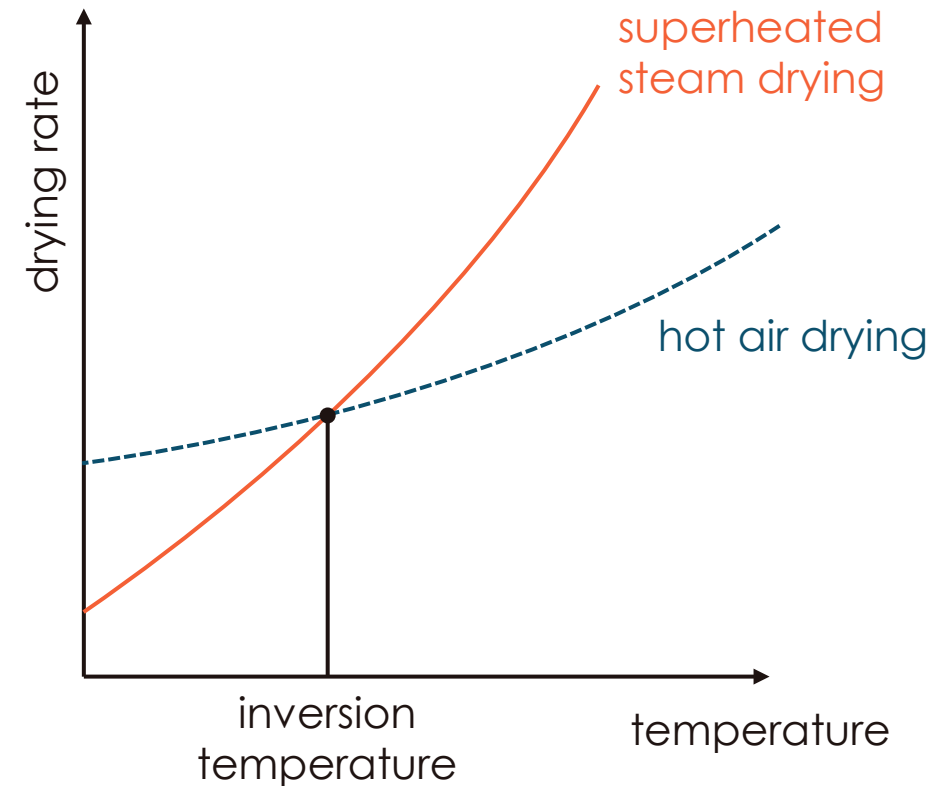
Project partners:



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Superheated steam drying

- Higher drying rate for the same temperature and mass flow above the inversion temperature
 - Inversion temperature 160°C – 350°C
 - Depending on the drying conditions
- Energy recovery at higher temperature level
- Can improve paper quality (e.g. due to product temperature $\geq 100^\circ\text{C}$):
 - No oxidation \rightarrow no browning
 - Hygienisation



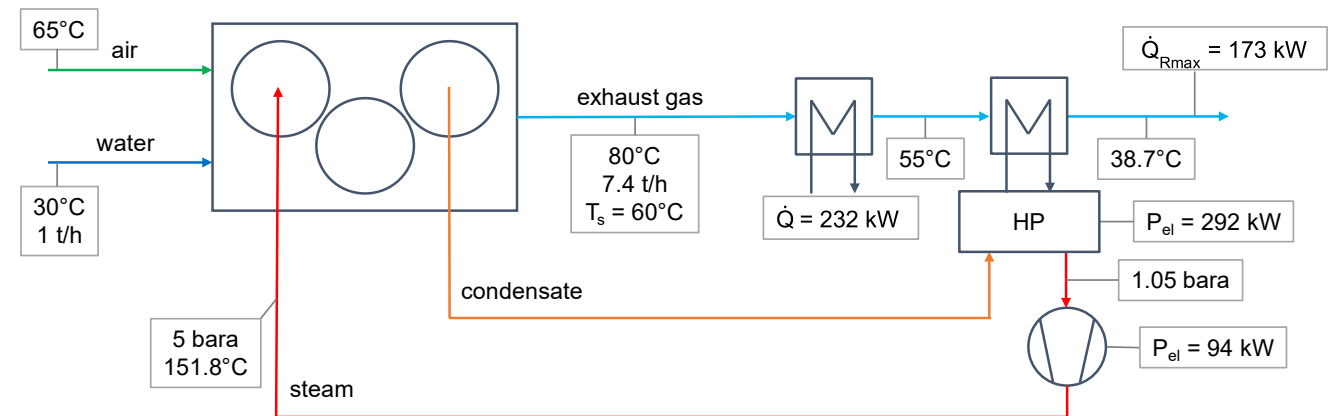
Based on: X. D. Chen and A. S. Mujumdar, *Drying Technologies in Food Processing*: Wiley, 2009.

H.T. Kiiskinen, K.E. Edelman, Superheated Steam Drying of Paper Web. *Dev. Chem. Eng. Mineral Process.* 2002;10:349-365. <https://doi.org/10.1002/apj.5500100408>

Example heat recovery – air case

- **Reference case:** natural gas burning with an efficiency of 90%, without heat pump
- **Assumptions:**
 - 70 % isentropic efficiency steam compressor
 - 0,45 second law efficiency heat pump
 - Only water mass flow to be dried in the paper considered
 - Emission factors:
natural gas 268 g_{CO₂eq}/kWh¹,
electricity 275 g_{CO₂eq}/kWh²

52% final energy savings
51% CO₂-emission savings



V. Wilk et al., Superheated steam drying for paper production: process efficiency assessment, In Proceedings of ECOS 2023, 25-30 June, 2023, Las Palmas de Gran Canaria, Spain, <https://www.proceedings.com/content/069/069564-0128open.pdf>, Accessed on 14.10.2024.

¹Umweltbundesamt, Calculation of green house gas emissions for different energy carriers in Austria, updated in November 2022 - available at <https://secure.umweltbundesamt.at/co2mon/co2mon.html>, Accessed on 20.03.2023

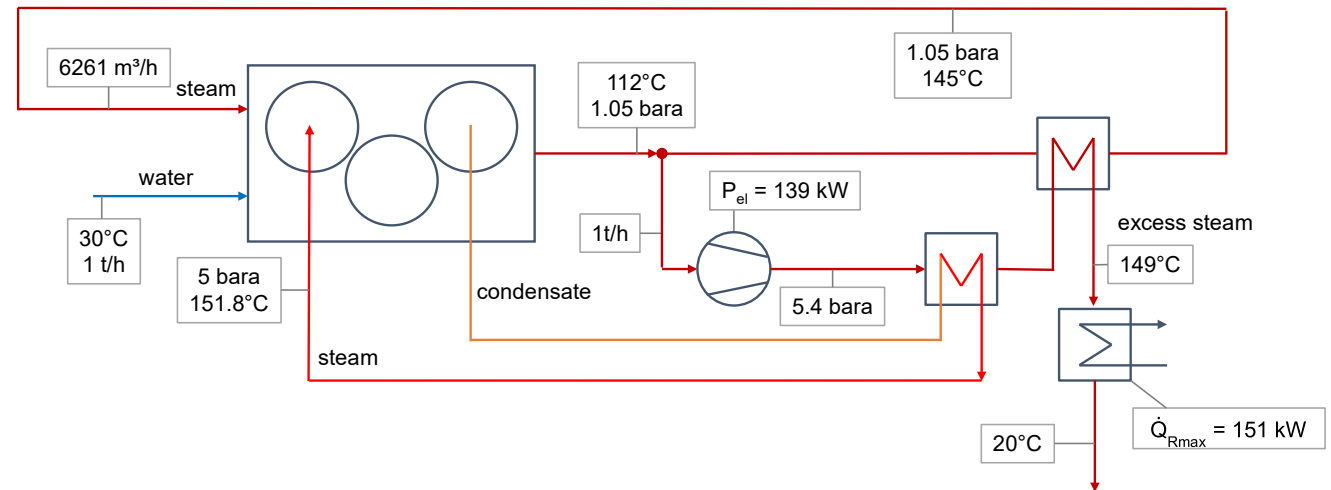
²European Environment Agency, Greenhouse gas emission intensity of electricity generation, published on 2022-10-26 - available at https://www.eea.europa.eu/data-and-maps/daviz/co2-emission-intensity-12#tab-googlechartid_chart_11, Accessed on 20.03.2023

Example heat recovery – steam case

- **Reference case:** natural gas burning with an efficiency of 90%, without heat pump
- **Assumptions:**
 - 70 % isentropic efficiency steam compressor
 - Only water mass flow to be dried in the paper considered
 - Emission factors:
natural gas $268 \text{ g}_{\text{CO}_2\text{eq}}/\text{kWh}^1$,
electricity $275 \text{ g}_{\text{CO}_2\text{eq}}/\text{kWh}^2$

83% final energy savings

82% CO₂-emission savings



V. Wilk et al., Superheated steam drying for paper production: process efficiency assessment, In Proceedings of ECOS 2023, 25-30 June, 2023, Las Palmas de Gran Canaria, Spain, <https://www.proceedings.com/content/069/069564-0128open.pdf>, Accessed on 14.10.2024.

Objectives and next steps

	CURRENT	SteamDry
ENERGY	~1100 kWh/ton	~450 kWh/ton
CO2 (FOSSIL)	0,45 tCO ₂ /t paper	No emissions
HEAT	30-40% lost to air	Latent heat recovered
SOURCE	Combustion	Electricity

- (1) Developing Energy-Efficient Drying Technology
- (2) Achieving CO₂ - Emission Free Drying Process
- (3) Advanced Control System for Superheated Steam Dryer
- (4) Pilot Superheated Steam Drying Process for Web-like Products
- (5) Environmental and Techno-economic Assessment of Superheated Steam Drying
- (6) Evaluate Business Potential for Various Product Manufacturing Sectors
- (7) Communicate, Disseminate, and Exploit Project Outcomes



www.steamdry.eu   

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Thank you
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