ZERO BRINE

WHITE PAPER
TOWARDS A ZERO BRINE CIRCULAR ECONOMY

The European objective to move forward towards a circular economy in which resources are recovered, re-cycled and re-used at the end of the traditional linear production line, has been elaborated for industrial saline wastewater (brine) within the ZERO BRINE project, funded under H2020, GA 730390.

ZERO BRINE aims at an integrated approach, covering technology development, market development, establishment of an on-line match-making platform, business modelling, policy development, sustainability, communication and dissemination.

SPECIFIC FEATURES ARE:

Technology development:

Within ZERO BRINE, a great set of technologies has been further developed during pilot demonstration projects in the Netherlands (Industry water sector), Spain (Silica mining sector), Poland (Coal mining sector) and Turkey (Textile industry sector). Technologies have been tested, optimised and demonstrated individually and in different process combinations with convincing results on high-quality, recovered minerals and water (see Factsheet in Annex). Simulation software has been made available for design of new configurations of technologies, evaluating resource recovery volumes, energy use and costs. A framework agreement between technology developers has been signed, securing future cooperation.

Matchmaking:

an online matchmaking tool for brine suppliers, mineral users and technology suppliers has been developed and applied in the Netherlands. Upscaling to a European application level would be the next step in pushing the circularity agenda, ready for financial and policy support.

Policy development:

Policy briefs have been written and submitted in the public consultation process on the Industrial Emissions Directive and on the Zero Pollution Strategy. The techniques proposed within the project framework are considered as Best Available Techniques (BATs) in Reference Documents (BREFs) for substances and water recovery from waste. Existing legislation however is more oriented to brine discharging than to brine processing and resource recovery. Additional policy mechanisms are required to foster circularity in brine treatment.

Transformation from waste into product:

Whereas the demonstration projects showed good results, the upscaling of the technologies to a more general application will require additional efforts. Entrepreneurs presently active in the linear production chain are still reluctant to accept responsibilities for returned resources from business partners in the circular setting. To which partner in the circular production chain will an unforeseen drop in product quality be attributed? Also, existing government policies on waste and product are not tuned to circular use of resources yet.

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Business cases:

For the four demonstration sites the business cases have a very site-specific character. In all cases the impact of Government rules and regulations are of key importance. Permits, subsidies and taxes determine the attractiveness of introducing ZERO BRINE technologies. In addition, practical considerations limit the applicability of technically sound technologies. At the Dutch demonstration site for example, the amounts of high-purity magnesium that can be recovered from the demi-water plant (5 trucks a year) is not sufficient to attract business. At the Spanish demonstration site, however, the environmental permit limited the brine discharge and thus the capacity of the silica plant. By reducing the brine discharge through the application of ZERO BRINE technologies, the silica plant could double its production capacity resulting in a sound business case to invest in circular solutions.

Sectoral development within Europe:

To aim for self-sustainability within Europe in resources, energy and basic industries would ask for additional policy instruments to encourage implementation of circular economy solutions. Textile industry within Europe can be reinforced if brine waste streams can be reduced. Scarce minerals can be recovered from brines and re-used to reduce dependency from other continents or China. A global strategy for self-sustainability within Europe is not in place yet. Such strategy could definitely stimulate application of ZERO BRINE technologies.

FOLLOW-UP ACTIONS PROPOSED:

General: To strengthen the appreciation of ZERO BRINE technologies perspectives and a European circular economy additional demonstration pilots will be required in other industrial sectors such as mineral producers, oil and gas, and other European countries. Also, a more extensive video collection of successful technology demonstrations and business cases will be very supportive, disseminated through workshops and training sessions in different industrial sectors and European countries. It is also important to consider the ambition of the EU to reduce raw material use (50% by 2030).

Technology development:

Continuous development, optimisation and implementation of new technologies is recommended and requires adequate funding from joint efforts of government and private sources.

Matchmaking:

The online matchmaking platform is to be up-scaled to European-wide application. This will require some investments on European level, aimed at stimulating circular use of minerals within Europe.

Policy development:

The techniques proposed within the project framework, considered as Best Available Techniques (BATs) should be promoted in governmental directives and regulations. Investments in circular innovations like the zero brine production chain scan be developed and stimulated by a mix of taxes and subsidies. One of the points to address is the CO_2 emission, for which emission rights need suddenly be payed once a waste stream turns into a product

Transformation from waste into product:

Actual barriers in business-to-business operations in connection with government regulations to introduce and implement ZERO BRINE technologies need to be reviewed, removed and replaced by a practical approach to move forward. An example would be the establishment of quality standards for products or renewed resources generated from waste. This would remove business risks in the re-introduction of recovered materials on the market.

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Business cases:

A larger set of example business cases throughout Europe is to be identified and elaborated for inspiration and stimulation. Recycling cases already implemented within integrated chemical sites as presented in the follow-up project WaterMining support this aim. Making societal cost such as energy losses (CO_2), impacts on the environment and health risks tangible in these business cases will foster broader introduction. This would fit into a European Policy on circularity.

Sectoral development within Europe:

Successful demonstrations of circular economy implementations of ZERO BRINE technologies in selected industrial sectors may support the development of a global European strategy on self-sustainability in natural resources. The European Commission needs to do much more to develop and implement such strategy.

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ANNEX

Impacts of the ZERO BRINE technology on water, emissions, energy, and resource recovery in industry

	Expected reduction in:			
	Water	**Emissions**	**Energy**	**Recovered resources**
Demineralised Water Plant	• 15-20% reduction in water withdrawal at Evides DWP	• >98% reduction of brine discharged to the environment (>2.5 million m^3/year) • 1,012 tons/year CO_2 emissions or 14% CO_2 reduction by recovering minerals, salts, and clean water	• Thermal energy required for the evaporation process can be supplied by waste heat/residual heat of neighbouring industries • 44% less energy used by MED evaporator when compared to conventional methods	• 92% water recovery for internal use (demi water) • 6.2% IEX regeneration solution recovery for internal use (>3.1% purity) • 94.7% Calcium recovery ($Ca(OH)_2$) for external valorisation (>95.6% purity) • 87.8% Magnesium recovery ($Mg(OH)_2$) for external valorisation (>88.9% purity) • 93% Sulphate recovery (Na_2SO_4) for external valorisation (unwashed: 94.6% purity)
Coal mine	NA	• 92.8% reduction of sodium chloride (NaCl) discharged to freshwater resources • 347 kg CO_2 /ton NaCl or 32.5% CO_2 reduction	• 33% energy reduction	• 90.6% water recovery (demi water) • 92.8% salt recovery (99% purity) • 94.9% magnesium hydroxide recovery $Mg(OH)_2$) for external valorisation (97% purity) • 0.84 kg/m^3 gypsum for external valorisation
Textile factory	• 7% reduction in total freshwater consumption of Zorlu Textile or freshwater abstraction by 123,000 tons/year	• 90-95% reduction of brine discharged to the environment • 150-200 tons/year CO_2 reduction	NA	• 70-80% water recovery from brine treatment system for onsite use • 600-700 tons salt/year for onsite dyeing of textiles
Silica factory	• 30% reduction in overall annual water consumption at IQE	• 100% reduction of brine discharged to the environment • 60% reduction of sodium sulphate (Na_2SO_4) releases into the Ebro River 6,000 tons/year CO_2 reduction or 5 kg CO_2/ m^3 of wastewater	• 72% reduction by waste heat (EFC technology compared to direct evaporation)	• 75-90% water recovery suitable for internal use • 90% recovery of sodium sulphate (Na_2SO_4) or 20,000 tons/year for external valorisation (>99% purity) • Sodium hydroxide (NaOH) (94% purity) and sulphuric acid ($H2SO_4$) (72% purity) for external valorisation

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