ReWaCEM Project Leaflet II

Results from the ReWaCEM Project

Project Title: Resource recovery from liquid **Wa**ste streams by **C**utting **E**dge **M**embrane technologies
www.rewacem.eu

Topic: SPIRE-01-2016
Systematic approaches for resource-efficient water management systems in process industries

The ReWaCEM approach offers a promising solution to the problem of wastewater disposal in the metal surface treatment industry and aims at creating a circular economy by recovery of resources.

Fraunhofer ISE

HR EXCELLENCE IN RESEARCH

This Horizon 2020 project has been coordinated by Fraunhofer ISE

DEMO A: Hot-Dip Galvanizing
TECNOZINCO – Carini, Italy

What's it about

Recovery of HCl and Iron from hot dip galvanizing pickling solutions by using two cutting-edge membrane technologies (Diffusion Dialysis and Membrane Distillation) coupled with a reactive precipitation unit. The demo was designed and sized to guarantee the correct functioning of a single pickling tank (50m³). The idea: With the demo, the pickling solution is treated constantly and kept within the optimal working parameters. This should ideally produce a total reduction of the acid waste produced and an increase in the productivity of the pickling baths due to the fact that they always work in optimal conditions.

Key Performance Indicators

Manufacturing capacity: Capacity of 20,000 tons/year of steel manufacturing.

Problem definition: Variation in bath concentration during the operation; loss of precious metals like zinc; high transportation costs for acid / waste acid in Sicily.

Waste water streams: 7 pickling baths containing more than 350 m³ of acid pickling solution; 160-240 tons of acid consumption per year; 300 tons per year of waste to disposal.

Waste acid stream covered with the Demo-System: 50 m³

Advantages of ReWaCEM technology: Circular economy approach – no waste; recovery of valuable materials; Reduction of operating costs; Reduction of environmental pollution (less transportation); Reduction of pickling time: Increase of plant productivity and quality; Reduction of operators' labour cost; Use of waste heat; Increase of company profit.

Validated models will be used for future scenarios analysis and planning.

Actual Results: Acid Recovery of up to 90%; Decreasing pickling time of 30%; Fe(III) hydroxide recovery of about 24 kg/day.

DEMO B: Metal Plating
ELECTRONIQUEL – Gijón, Spain

What's it about

Recovery of Sulfuric Acid (H_2SO_4) and Copper from electroplating solutions by using two cutting-edge membrane technologies (Diffusion Dialysis and Membrane Distillation).

Key Performance Indicators

Manufacturing capacity: 705 tons per year of Copper plated Steel.

Problem definition: Variation in bath concentration during the operation; loss of precious metals like copper.

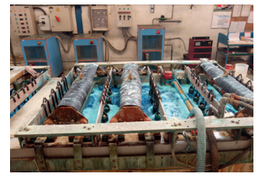
Waste water streams: 4,800 m³ of water; 50 tons/year of waste to disposal.

Share of waste acid copper sulfate stream covered with the Demo-system compared to total waste acid solution is: 300%.

Advantages of ReWaCEM technology: Circular economy approach – no waste; recovery of valuable materials; Reduction of operating costs; Reduction of environmental pollution (less transportation); Increase of plant productivity; Reduction of operators' labour cost; Increase of company profit.

Validated models will be used for future scenarios analysis and planning.

Actual Results: Annual cost savings of about 14% of current expenses for energy, water and chemical products. 78% of acid and 75% of copper recovery from waste copper sulfate stream covered with the Demo-System.



DEUTSCHE EDELSTAHLWERKE

BFI Angewandte Spitzenforschung | VDEh-Betriebsforschungsinstitut GmbH

DEMO C: Steel Pickling
DEUTSCHE EDELSTAHL-WERKE – Hagen, Germany

What's it about

The demonstration plant for acid recovery from waste acid was operated at Deutsche Edelstahlwerke (DEW) in Hagen.

The waste acid from the stainless steel pickling process contains free hydrofluoric and nitric acid (HF, HNO_3). The used spent acid is currently neutralized in the waste water treatment and the resulting metal sludge is landfilled.

Solution within the framework of the EU project ReWaCem includes the recovery of the free acid by diffusion dialysis (DD) and concentration by membrane distillation (MD).

Key Performance Indicators

Problem definition:

- Spent acid from the stainless steel pickling tanks contains free acid: <4%$_{mass}$ Hydro fluoric acid (HF), and 11 %$_{mass}$ nitric acid (HNO_3) were lost in the process chain.
- Used spent acid is neutralized in the waste water treatment.
- About 10.000 t/a process and rinsing water are treated annually in the waste water treatment plant.
- Metal sludge has to be disposed of at high cost.

Membranes applied: Two parallel DD stacks with an exchange area of 68 m² designed for a volume flow of 35 l/h per DD module.
The subsequent MD unit has a membrane area of 12 m².

Advantages:

- By means of diffusion dialysis, the recovery of more than 85 - 90 % of the free acid (HF, HNO_3) from the waste acid is possible.
- With increasing Waste acid / Recovered acid ratio, higher acid concentrations are obtained in the diffusate.
- Savings in acid of 86,000 €/a through the operation of a diffusion dialysis system.
- A treatment with large Pyrohydrolysis systems would require an energy consumption for the regenerating of waste acid in the range of 60 to 120 MWh per year – it enables a higher efficiency of acid recovery, but is feasible only for big plants and needs very high investment costs.

Actual Results: Amortisation period of the plant is about 3 years.

AT&S | AEE INTEC

DEMO D: Printed Circuit Board
AT&S – Fehring, Austria

What's it about

Recovery of fresh water and gold from the PCB production by applying Membrane Distillation.

Key Performance Indicators

Manufacturing capacity: 250.000 m² PCB per year.

Problem definition:

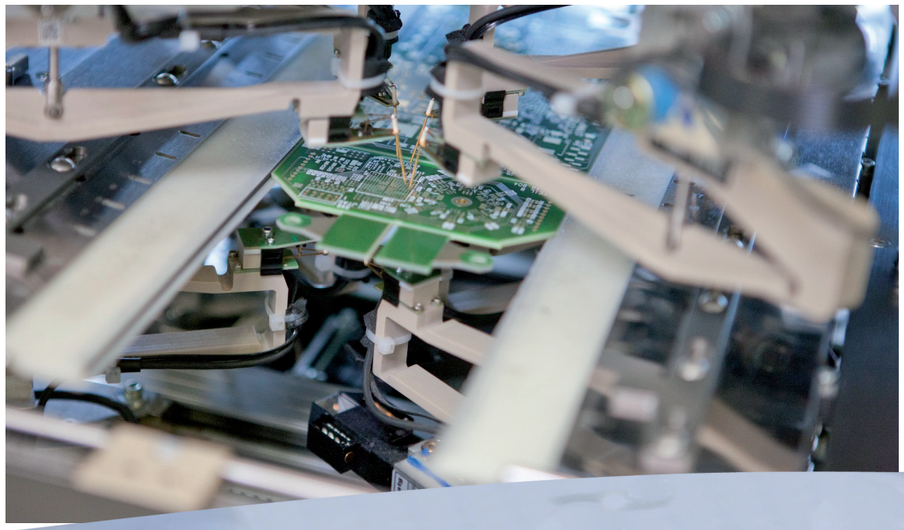
- Variation in bath concentration during the operation
- Loss of precious metals like gold and palladium.

Waste water streams: 100.000 m³ of waste water/a.

Advantages: Circular economy approach – no waste; recovery of valuable resources; Use of waste heat; Reduction of operating costs; Reduction of environmental pollution, Increase of company profit.

Validated models will be used for future scenarios analysis and planning.

Actual Results: Significant reduction of gold loss



University of Stuttgart
Institute for Acoustics and Building Physics
Life Cycle Engineering GaBi

Economic assessment

In ReWaCEM we gained promising results for membrane technologies in real industrial environment in four different demonstration cases. We identified applications where the payback period can be below one year. Nevertheless, individual assessment of each case is recommended.

DEMO A: Hot-Dip Galvanizing: Recovery of HCl, Iron and Zinc from hot dip galvanizing pickling solutions:
Acid disposal cost savings of 20,000 € per year. Zinc recovery to be used in fluxing solution with savings up to 9,000 € per year. Increase in steel production capacity of up to 28%. Revenue of up to 125,000 € can be generated by recovery of Iron Hydroxide.

DEMO B: Metal Plating: Recovery of Sulfuric Acid and Copper from electroplating solutions:
Total avoided costs: 908 €/m^3 distributed as 128 €/m^3 from acid, water and current treatment cost savings, 139 €/m^3 from copper, and 641 €/m^3 from process improvements.

DEMO C: Steel Pickling: Recovery of mixed Hydrofluoric Acid and Nitric Acid pickling solutions from stainless steel wire rod production:
By operating a diffusion dialysis system, acid savings of approx. 86,000 €/a are possible for the concrete application investigated; the amortisation period of the plant is between 2 to 3 years.

DEMO D: Printed Circuit Board: Recovery of fresh water and gold from the PCB production:
By operating a membrane distillation system, significant savings of potassium gold cyanide are possible for the concrete application.

Regulatory compliance

Neutralization for disposal or reuse of the acidic solution without any treatment is not considered a Best Available Technique (BAT). BATs have to be adopted for the environmental permit of plants by authorities.

Environmental Potentials: Life Cycle Assessment (LCA) and Water Footprint Profile

The LCA of the University of Stuttgart on the production lines is based on a simulated full-scale application of the proved concept of the Demo equipment.

The results show significant reduction potentials of the new technology on the environmental impact of the processing lines throughout the analysed impact categories. Key findings are given for the four industrial applications as follows.

DEMO A: Hot-Dip Galvanizing: Recovery of HCl, Iron and fluxing solution from pickling waste acid solutions:

- About 40% less greenhouse gas emissions.
- About 30% lower fossil primary energy demand.
- Up to 90% less mass for disposal.

DEMO B: Metal Plating: Recovery of Sulfuric Acid and Copper from electroplating pickling solutions:

- Up to 85% less consumption of primary H_2SO_4.
- Up to 10% less primary copper used.

DEMO C: Steel Pickling: Recovery of mixed Hydrofluoric Acid and Nitric Acid pickling solutions from stainless steel wire rod production:

- Around 25% lower consumption of primary $HN0_3$.
- Approximately 5% lower consumption of primary HF.

DEMO D: Printed Circuit Board Production: Recovery of gold salt solution from hard gold plating:

- Significant reduction of gold loss.
- About 600 m^3/a reduction of rinsing water demand.
- Up to 30% lower greenhouse gas emissions.

If you are interested in membrane technologies ... please contact:

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Fraunhofer ISE

Fraunhofer ISE has designed and built the 3 Demonstration systems for acid recovery Demo A-C.

Membrane technologies suppliers:

Diffusion Dialysis
DEUKUM GmbH
www.deukum.de

Membrane Distillation
SolarSpring GmbH
membrane solutions
www.solarspring.de

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PSE

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