



New process engineering solution for gold recovery in the printed circuit board industry via Membrane Distillation

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Introduction and Research Aims

The printed circuit board industry deals with baths of high-value chemicals in the production. Gold and palladium baths are crucial steps in the production, and their efficiency is of highest importance – in order to recover high value chemicals and save waste water disposal costs. In this project a new process engineering approach is presented to minimise chemical losses with rinsing water, to recover the precious gold solution and substantially reduce the amount of waste water. Membrane Distillation is the innovative technology applied for bath concentration.



Gold Baths in PCB industry

- Gold baths are an important step in galvanising printed circuit boards
- Galvanic ingredients, in this case gold, are lost with the rinsing water
- Recovery requires efficient systems for the concentration of liquid substances
- an energy-efficient (CO₂ neutral) and sustainable process for recovering the critical raw materials gold and palladium from the processes of circuit board production is needed
- Membrane Distillation (MD) is a thermal separation process at a low temperature level (Waste Heat driven)

Innovative solution approach

The innovative solution approach includes a new rinsing strategy directly above the gold bath. To avoid dilution of the active bath, a membrane distillation unit as concentrator is proposed, recovering the gold solution at the desired concentration.

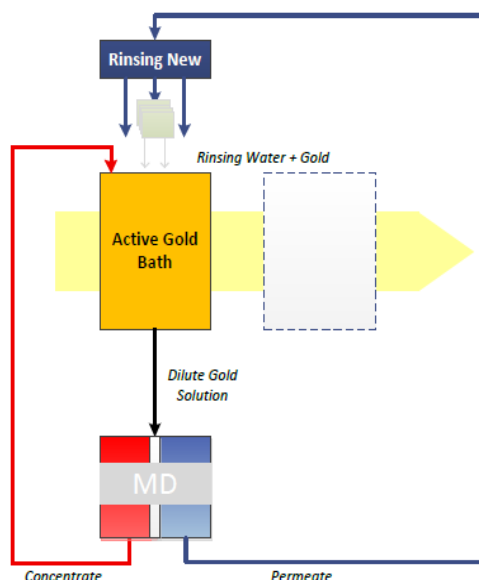


Fig. 1: New process concept for rinsing

Methodology

- Static exposure tests of membranes in gold baths
- Design of optimal operating temperatures via modelling
- Test Cell experiments (DCMD, 0,0375m² membrane area)
- Validation of the modelling and design tool
- Demonstration Plant Design

Contact Angle Measurements

Static exposure to the gold baths with different membranes proved the chemical resistance of the membranes to the bath solution, as no negative effects on the contact angle of the membrane surface could be detected.

Test Cell Experiments

Test cell experiments were performed to mimic real operational data.

- Temperature of feed side: 35°C
- Temperature of permeate side: 16°C
- pH feed: 4.7
- Flow velocities ranging from 0.07 to 0.12 m/s

Tests were performed over a total testing time of 150 h at 5 mg/l gold cyanide feed concentration. The experiments proved the feasibility to treat the solution without fouling or wetting effects at a constant transmembrane flux of 6.1 kg/m².h.



Fig. 2: No visible fouling effects after 2 weeks of operation

Validation of design model

The data gathered in the experiments were used to validate the available modelling tool that can predict the membrane distillation performance based on a numerical model. Figure 3 shows that for different feed velocities the calculated values of feed and permeate temperatures at the test cell outlet are very well predicted with the modelling tool. This shows that the tool can predict mass and heat transfer along the membrane length very accurately.

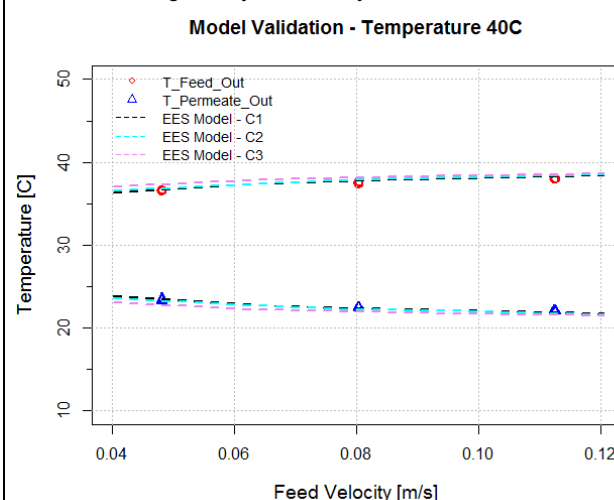


Fig. 3: Validation of MD model with experimental data

Demonstration Plant Design

The experiences drawn from the feasibility tests in the test cell served as boundary conditions for the validated simulation tool developed at Fraunhofer ISE, which led to a comprehensive module design suitable for the demo plant at AT&S. The membrane area applied will be 32 m².

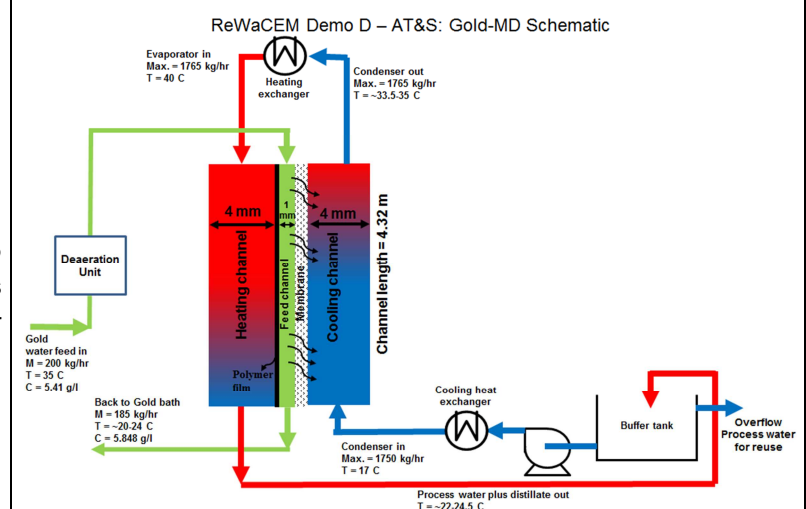


Fig. 4: Demonstration Plant Concept for ReWaCem

Conclusions

- Membrane Distillation is a promising technology for gold bath concentration and recovery of gold solution
- Constant flux performance was shown in the test cell experiments without fouling or wetting effects
- The modelling tool developed for Membrane Distillation performance showed very accurate prediction of process performance

Outlook

These results laid the foundation for the further development of the process to a real-scale facility. The installation of a first real scale demo MD-Plant at AT&S Fehring is planned for the second half of the year 2018.



Acknowledgement

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