Use of ceramic nano-filtration membranes with high specific surfaces for the processing of bio-leachate and the treatment of saline mine water

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Abstract

Mine water with high salinity occurs through many mining activities in huge quantities. Its treatment can be very challenging because of the high solubility of salts like magnesium and sodium sulfates and chlorides. The application of ceramic membranes with high specific surfaces is a relatively new engineering approach for treatment of high saline mine water and for processing of bio-leachate as well. The great advantages of those membranes are their high temperature and chemical resistance. Therefore they allow longer operating life, better maintenance and cleaning characteristics. They can be used for nano-filtration and membrane distillation.

The first investigation of an alumina ceramic membrane with 0.9 nm pore width was executed by a partner of the joint research project. This test reached high permeate flow and the results with bio-leachate ($c(SO_4^{2-})$=18 g/L) and treated mining water ($c(SO_4^{2-})$=2.4 g/L) were promising. Based on this test results, the production process for the ceramic membranes was improved in terms of increasing permeate flow and selectivity. For that objective a thin and stable membrane support (nano-membrane tube: diameter about 10 mm; flat membrane distillation: thickness of 1 mm) was developed to reduce wall resistance by the permeate flow. The membrane selectivity was optimized by changing the surface material (TiO_2/ZrO_2) which influences the hydrophobicity and the zeta-potential.

The new membranes have a high specific membrane surface area and will be tested as tube modules and in flat form. The up-scaling of the laboratory test of 4 waters from various mining processes with the improved membrane is in preparation:

- treated mine water, $c(SO_4^{2-})$=2.4 g/L, pH: 7
- bio-leachate, $c(SO_4^{2-})$=18 g/L, pH: 2.2
- industry cooling-water, c(Cl-)= 84 g/L, $c(Ca^{2+})$= 31 g/L, $c(Na^{+})$=21 g/L, pH: 6-9
- leachate of a mining plant, $c(SO_4^{2-})$=4.3 g/L, pH: 8

These lab-scale tests (membrane area of 0.005 m²) will allow the membrane characterization with normal solutions (pure water, defined saline solution) and with industrial water.

The next test scales will be different pilot plants with membrane areas of 0.25 m² and 1.3 m², each at a length of 1.2 m and with 19 or 152 membrane tubes, respectively. In addition, the implementation of an industrial scale plant with a ceramic nano-filtration membrane is in preparation. The active membrane area will be 4.5 m² and 10 m² which spread of 559 and 1500 tubes, each in one membrane module.

Keywords: ceramic membrane; nano filtration; mine water; bio leachate; saline water