Gas bubble removal from a mesh surface in a thin film spinning disc reactor

GAS BUBBLE REMOVAL FROM A MESH SURFACE IN A THIN FILM SPINNING DISC REACTOR

Congress: ECCE10
Topic: Electrochemical Engineering (workshop)

Presenting author: Shohreh Moshtarikhah
Authors and affiliations : Shohreh Moshtarikhah:Chemical Engineering and Chemistry,Technical University of Eindhoven,Eindhoven,Netherlands|Jos T.F. Keurentjes:Chemical Engineering and Chemistry,Technical University of Eindhoven,Eindhoven,Netherlands|Jaap C.Schouten:Chemical Engineering and Chemistry,Technical University of Eindhoven,Eindhoven,Netherlands|John van der Schaaf:Chemical Engineering and Chemistry,Technical University of Eindhoven,Eindhoven,Netherlands

Abstract:
Process intensification of electrochemical cells appears promising in terms of reduced capital costs and improved safety. The size of plant equipment is severely reduced and special corrosion resistive materials can be used that are not available for large scale equipment. The productivity of electrochemical cells can be easily increased by applying a higher current at a higher potential. However, the formation of gas bubbles prevents this route to process intensification. These gas bubbles reduce the accessibility of the electrodes for electrolyte which leads to an increase in potential drop and correspondingly higher power consumption. In extreme gas evolution cases the contact between electrodes might even completely disappear periodically. The removal of gas bubbles is thus a key challenge for intensifying electrochemical processes. The thin film spinning disc reactor has been proven to intensify heat and mass transfer. Due to rotation of the disc a thin liquid film with high shear stresses is formed which also results in fast removal of gas bubbles from the surface. High mass transfer coefficients in smooth and grooved surfaces in a spinning disc reactor have been presented in previous works of Ramshaw and Jachuk. They showed that grooved surfaces lead to enhancement of transfer rate, and we show this to hold for mesh surfaces too. A mesh electrode has the benefit of a larger electrode area than a smooth disc.
To prevent the formation of an explosive hydrogen and oxygen gas mixture, we study liquid-solid mass transfer in presence of gas bubble formation by decomposition of hydrogen peroxide on a smooth Pt/C coated surface and a platinum coated stainless steel mesh disk of 13 cm diameter. The mass transfer rate is determined for rotation speeds from 0 – 1500 RPM and flow rates of 0 – 7 mL/s by measuring the concentration change of hydrogen peroxide as a function of time for initial hydrogen peroxide concentrations between 1 and 50 wt%. The mass transfer increases with rotation speed and no apparent limitation by gas evolution appears to be present. The mesh is shown to give higher mass transfer rates by increased turbulence and by the higher surface area.

Reference 1:
Reference 2 : O.K. Matar, G.M. Sisoev, C.J. Lawrence, The flow of thin liquid films over spinning discs, Can. J. Chem. Eng. 84 (2006) 625-642.
Reference 3 :
Reference 4 :

Highlight 1: Thin film spinning disc reactor intensifies heat and mass transfer
Highlight 2: Thin liquid film with high shear stress due to rotation helps fast removal of gas bubbles
Highlight 3: Mesh surface is expected to have better mass transfer than a smooth or grooved surface