CFD simulation of an Electrohydrodynamic Floating Liquid Bridge

Electrohydrodynamic (EHD) liquid bridges are a peculiar phenomenon, which have recently come into focus to study the intersection of continuum and molecular scale interactions in liquid matter (see Fig. 1).

Fig. 1 – EHD liquid bridge. Left: bridge; middle: bridge with set-up; right: E-field 3D simulation

EHD bridges are easy to produce, requiring only a low electric conductivity polar liquid (such as water), two reservoirs, and a high potential low current DC power source, shown in Fig.1. Using optical methods, such as schlieren visualization and high-speed imaging it was possible to reveal a bi-directional flow that is corroborated by mass transfer, and in particular for water results in a net mass transport from anode to cathode. The overall flow dynamics can be understood within an EHD framework, as the system acts as extended Taylor pump. In addition to the EHD mass transport, electrolysis takes place producing protons and hydroxyl ions at the anode and cathode, respectively. These ions change the local pH drastically and move according to the electric and dielectric forces. Because the mobility of a proton is higher than that of a hydroxyl ion, the two species recombine to H_2O not inside of the bridge but in the catholyte beaker.

Tasks

The goal of this project is to gain detailed knowledge of the involved flow physics by performing 3D simulations of the water bridge using the commercial CFD code Ansys CFX. The geometry of the water bridge can be assumed as given (taken from experiments), which allows to simulate the liquid phase only. The electrochemical reactions, the associated ion production and local pH change, the ion transport and the liquid transport due to the electrodynamic force must be included.

Requirements

The ideal candidate has had previous experience with computational fluid dynamics and basic physical and chemical knowledge about electrolysis. You should be highly motivated and have passion for research, and excellent communication and writing skills.

Starting date: As soon as possible
Duration: At least 5 months

Research institute

This project is a cooperation of the Fluid dynamics of energy systems team at TU Delft and Wetsus, Centre of Excellence for Sustainable Water Technology, located in Leeuwarden. The institute employs people from very different fields and backgrounds and combines this knowledge for the best results. This project is part of the Wetsus Applied Water Physics theme. Wetsus has an international environment where the working language is English, so fluency in this language is required. The researcher will required to regularly travel between Wetsus in Leeuwarden and TU Delft.

Application

If you are interested in this project, please contact Dr. Elmar C. Fuchs at Wetsus (elmar.fuchs@wetsus.nl) or Prof. Dr. Rene Pecnik at Delft University of Technology, r.pecnik@tudelft.nl for more information or directly apply by sending your CV to the same address. The internship/MSc thesis includes a reimbursement for living expenses of 350 euro per month.