Master thesis Synopsis

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Abstract

This document is a concise presentation of the author's master thesis "Numerical Simulation of Electro-Hydrodynamics Systems" in order to participate in the IEOM Master Thesis Presentation Award. This project has been started on the 1st March 2018 for a a duration of six months and has been proposed for more detailed studies through a PhD. position in colaboration with French National Center for Scientific Research (CNRS) and Total under the supervison of Dr. Mostafa S. Shadloo.

1 Objectives

This project aims to develop a reliable numerical tool that is able to model electrohydrodynamics (EHD) phenomena and to help designing electrical demulsification system. In particular, we try to model the deformation of suspended Water droplets in Oil medium (WiO) and to efficiently remove the droplets from the crude oil emulsion while applying external electric and/or magnetic field.

2 Motivation and Problem statement

In many natural as well as synthetic products, dispersion of two or more fluids (phases) can be observed such as oil, blood, syrups, paints, beverages, etc. For numerous applications, the separation of two phases becomes important for purification and treatments in a process.
The extracted crude oil form a well contains different components, one which is water. High water percentage may cause more corrosion, extra transportation costs ,and other negative consequences. Acquiring a much better understanding of the electrohydrodynamic behaviour of droplets suspended in a bulk liquid medium, as well as reliable numerical solutions to predict and enhance the separation of WiO emulsions which could lead the path to inventing the next generation of small portable demulsification devices, are of the main approaches of this study. Therefore, the project will have academic and industrial impacts by answering the major concern of energy saving.

3 Methodology in brief

To design this simulation, based on the principles of Computational Fluid Dynamics, a model has been proposed to illustrate the behaviour of the two-phase system according to the Partial Differential Equations (PDE) which describe the relationship between te field variables (such as pressure, velocity, etc). The numerical method that is going to be used for discretizing the domain and converting the set of PDEs into an algebraic set of equations is called Smoothed Particle Hydrodynamics (SPH) which is a mathematical model to approximate a continues media by a set of particles and then solve the matrix form of the linear system. This linear system contains the Navier-Stokes equations (mass conservation, momentum conservation, energy conservation) and Maxwell equations.

4 Keywords

Simulation of two-phase fluid flows, mathematical modelling, Smoothed Particle Hydrodynamics, Electrohydrodynamics

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