Experimental and numerical analysis of scale deposition in a turbulent Taylor-Couette flow

JAKOB ROAR BENTZON[1], BENAIAH U. ANABARAONYE[2], SIMON IVAR ANDERSEN[2], JENS HONORE WALTHER[1,3], KAREN LOUISE FEILBERG[2]

[1] Department of Mechanical Engineering, Technical University of Denmark, Kgs. Lyngby, 2800, Denmark, jroben@mek.dtu.dk

[2] The Danish Hydrocarbon Research and Technology Centre, Technical University of Denmark, Kgs. Lyngby, 2800, Denmark

[3] Computational Science and Engineering Laboratory, ETH, Zürich, CH-8092, Switzerland

Inorganic scale formation and removal present a significant challenge during oil and gas production. While a majority of published studies has focused on deposition occurring at laminar flow conditions, the nature of flow in production lines is typically complex and turbulent. The influence of the underlying flow on the formation of scale is interesting for mitigation and prediction. This paper presents a combined experimental and numerical study of barium sulphate deposition investigated using a newly designed Taylor-Couette reactor. Experiments are carried out at representative temperatures (30-70°C), turbulent flow conditions ($2\times10^4 < Re < 8\times10^4$), high Taylor numbers ($3\times10^8 < Ta < 1\times10^{10}$), and effluents analyzed using an inductively coupled plasma (ICP) spectrometer. Simulations are performed in STAR—CCM+ using a combination of RANS and LES turbulence modelling. Activity coefficients of ionic species are calculated using a Debye-Hückel model and various modelling methods are tested for wall deposition. Finally, model predictions are compared to experiments in terms of location and rate of deposition.