

Kinetics of Calcium Carbonate Mineral Scale Formation

KABIR RAHEEM¹, OLUJIDE SANNI², THIBAUT CHARPENTIER³, ANNE NEVILLE⁴

¹*School of Mechanical Engineering, University of Leeds, United Kingdom. Mn09kar@leeds.ac.uk*

²*School of Mechanical Engineering, University of Leeds, United Kingdom. O.S.Sanni@leeds.ac.uk*

³*School of Chemical and Process Engineering, University of Leeds, United Kingdom.
T.Charpentier@leeds.ac.uk*

⁴*School of Mechanical Engineering, University of Leeds, United Kingdom. A.Neville@leeds.ac.uk*

The formation of inorganic scale in reservoirs and importantly on surface facilities is one of the most significant challenges faced by the oil and gas industry with respect to flow assurance. Recently, studies have shown that scaling processes on the surface is not necessarily a result of bulk scaling and that they do not often share the same trends with regards to crystal growth kinetics and inhibition. It is important to develop fundamental understanding of mechanisms of scale formation on components' surfaces.

In this study, an adapted capillary rig, a modification of the conventional tube blocking methodology was used to evaluate surface formation of CaCO₃ under dynamic flowing conditions. An important characteristic of this set-up is that saturation ratio remains constant and that there are no bulk crystals in the solution when the brine flows through the capillary cell. This allows the decoupling of bulk and surface scaling, providing a better mechanistic understanding of how scale layers build up on a surface.

CaCO₃ surface scaling kinetics was investigated by evaluating the induction times and gravimetric measurement of mass gain in the capillary cell. Scale precipitation was carried out at 25^oC and 70^oC on stainless steel samples at three saturation ratios of 50, 60 & 70, with five different flow rates values ranging from 10-30ml/min.

The results from the assessment of surface induction time and growth rate points to the significant influence of flow velocity and surface conditions/properties on heterogeneous surface crystallisation process.