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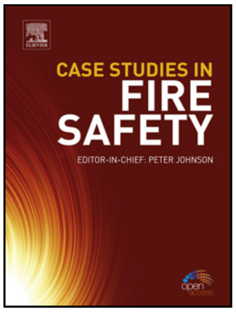

Title: Flow cell apparatus for quantitative evaluation of carbon steel corrosion during transitions in fluid composition: Application to transition from inhibited hydrochloric acid to sodium chloride brine

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Flow cell apparatus for quantitative evaluation of carbon steel corrosion during transitions in fluid composition: Application to transition from inhibited hydrochloric acid to sodium chloride brine

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Highlights

- A technique is proposed for modelling steel corrosion during acidizing flowback.
- The technique can be applied to any given acid flowback scenario.
- Experiments are conducted using a simplified chemistry and show repeatability.
- The setup eliminates acid spending concerns which influence closed cell results.

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Abstract

This paper introduces a new flow cell technique that offers the advantage of real-time corrosion rate behaviour acquired as transitions in fluid chemistry occur using *in situ* electrochemistry. The present study quantifies the corrosion behaviour of a metal surface initially exposed to inhibited acid and subsequently exposed to a model formation brine. The design, optimisation and validation of the flow cell set-up is discussed. Results from initial tests show that inhibition efficiency and steel corrosion rate change significantly during the dilution process as the inhibitor film experiences concomitant changes in the "external" concentrations of acid and propargyl alcohol inhibitor.

Keywords: Acid solutions (A); Carbon steel (A); Electrochemical calculation (B); Weight loss (B); Acid corrosion inhibitor (C)

1. Introduction

Three types of acid treatments exist as a means of increasing hydrocarbon production from oil and gas reservoirs: acidic flushing of wells (in order to remove acid-soluble well sediments), acid fracturing (whereby acid is injected into the formation above the fracture pressure), and matrix acidizing. The method of matrix acidizing [1-3] is one of the most widely used techniques to enhance the rate of production from hydrocarbon reservoirs. The process involves injecting acid into the near-wellbore rock at a flow rate below that required to exceed the fracturing pressure. The acid is designed to partially dissolve the reservoir rock, e.g. forming "wormholes" in carbonate rocks, or to dissolve permeability-damaging materials introduced during drilling, completion, or production operations, e.g. as in sandstone acidizing treatments. The acid reacts with rock minerals and damaging materials to create soluble products that can be easily removed when production is resumed. It is essential the acid is sufficiently "inhibited" to minimise corrosion of metals in the wellbore. Acid Corrosion Inhibitor (ACI) products are complex mixtures of various molecules designed to minimise the rate of corrosion of oilfield steels and alloys exposed to typical matrix acids under high-temperature and high-pressure conditions.

Typical matrix acidizing fluids contain hydrochloric acid, hydrochloric acid/hydrofluoric acid mixtures, acetic acid, and formic acid [1-3]. New fluids were developed to extend matrix acidizing to higher temperatures. For example, acid-internal emulsions retard reaction rates in carbonate reservoirs and