Performance of wear and corrosion resistant coatings during simultaneous sliding and CO2 corrosion under anoxic conditions

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CO_2 corrosion combined with mechanical wear plays a significant role in limiting the lifetime of components in the oil and gas industry. This damage mechanism can be mitigated using corrosion resistant alloys. However, when evaluating the performance of corrosion resistant in CO_2 corrosive environment under anoxic conditions, the industry mostly relies on static corrosion tests, thus neglecting the influence of mechanical wear, and its synergy with CO_2 corrosion. The present work addresses this issue for the first time by using a novel testing system able to perform CO_2 tribocorrosion tests at elevated pressure (3 bar) and temperature (60 °C) under anoxic conditions (less than 30 ppb O_2). Furthermore, the test rig is characterized for having a floating cell, which allows monitoring the corrosion potential throughout the experiment and evaluate the performance of prospective wear and corrosion resistant coatings in a short time.

The results discuss the tribocorrosion surface degradation mechanisms of the materials selected under these conditions. As relevant materials for prospective oil and gas applications, we focus on wear resistant martensitic high chromium stainless steel coatings and nickel-base metal matrix composite coatings with carbide reinforcements. The corrosion rates in static conditions and during rubbing are measured using linear polarization resistance and compared in order to quantify the synergy between mechanical wear and CO_2 corrosion. The results highlight that the corrosion rate for passive metals during rubbing can be up to one order of magnitude higher than in static conditions.