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Surface modification of oil tube steel by plasma coating for corrosion resistance enhancement in CO2/brine

Yun Ma[1], Haitao Bai[2], Bo Yang[3], Qingsong Yu[4], John Jones[4], Qingbo Zhang[3]

[1]Xi'an Shiyou University, xi'an, China [2]Southwest Petroleum University, Chengdu, China [3]Xi'an Shiyou University, Xi'an, China [4]University of Missouri, Columbia,MO, United States

mayun9401@xsyu.edu.cn

More and more oil and gas reservoirs are used for commercial CO_2 enhanced oil recovery, resulting in associated CO_2 storage that occurs as part of the process. CO_2 /brine corrosion of oil tube steel that can occur anywhere along the wellbore is a challenging issue facing the oil and gas industry. To enhance their corrosion resistance in CO_2/brine, J55 and N80 oil tube steels were coated with trimethylsilane plasma coatings (TMS-PCs) by plasma chemical vapor deposition□PCVD□method. Both atmosphere and vacuum direct current (DC) discharges were utilized for TMS-PCs deposition. X-ray photoelectron spectroscopy (XPS) was used to characterize the coating surface chemistry. It was found that TMS-PCs deposited by vacuum DC plasma coatings (VDCPC) had higher Si- and C-rich composition than atmospheric DC plasma coatings □ADCPC□. The corrosion resistance of TMS-PC coupons was evaluated through weight loss method (WLM) and three dimension pitting corrosion quantitative evaluation method (3D-PCQEM), which was conducted in CO_2/brine with the self-built corrosion resistant performance evaluation system (CRPES). The results demonstrated that the TMS-PCs can significantly decrease not only the uniform corrosion rate but also the pitting corrosion rate of N80 and J55 oil tube steels. TMS-PCs deposited by VDCPC showed less corrosion rate than that of ADCPC. The scanning electron microscopy (SEM) was used to characterize the coating surface morphology before and after WLM, and the results indicated less corrosion and pitting corrosion on coated coupons than uncoated controls. The energy dispersive spectrometer (EDS) was used to characterize the coating surface chemistry before and after WLM, which also indicated that the ferric content of coated coupons was higher than that of uncoated controls after WLM. The results obtained in this study indicate that plasma coatings may serve as a very promising barrier against the corrosion and pitting corrosion of oil tube steel in CO_2/brine.

Keywords
Corrosion resistance
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