Demonstration of PDC-based coating and online corrosion monitoring by EIS sensor developed in the ACHIEF Project for the oil refining industry

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Energy intensive industries (EIIs) have a crucial role in driving economic growth, contributing significantly to employment and production. However, this comes with the cost of environmental challenges posed by their substantial carbon footprint. ACHIEF project addresses this issue and aims to reduce CO2 emissions and increase efficiency in EIIs such as oil&gas, steel, and aluminium production. To achieve this goal, ACHIEF project has developed innovative and sustainable technologies to improve corrosion resistance such as Polymer Derived Ceramic (PDC) coatings and monitoring performances of these technologies in real time with Electrochemical Impedance Spectroscopy (EIS) sensors. Oil refineries have different corrosion environments due to the nature of the processes. Therefore, corrosion protection is crucial and brings significant benefits such as extending the equipment lifetime, reducing maintenance costs and shutdown periods. To validate innovative technologies under a dynamic industrial condition, a pipeline operating in an aggressive environment at the TÜPRAŞ Izmit refinery was coated by PDC. The fluid is a mixture of gas and aqueous liquid, with dissolved HCl, causing dew point corrosion as the temperature reduces along the pipeline. The best performing PDC coating composition, developed with CEA at laboratory scale, was coated by a robotic spraying system inside the 8'' AISI321 SS pipe and the EIS sensor with standard three electrode electrochemical cell configuration designed by AIMEN was integrated inside the pipe. The performance of the PDC coating is online monitored in terms of time in operation and conditions in the process such as liquid/gas ratio, total flow rate, etc. After the commissioning of the pipeline with the sensor system in February 2024, upon completion of the start-up procedure, which lasted about 12 hours, the corrosion monitoring system gave a regular OCP (open circuit potential) curve corresponding to the formation of a stable liquid medium to be used as electrolyte inside the pipe, and this stability persisted during the following week. The results of the real-time impedance and OCP data will be discussed and compared in detail over time and with data taken from the laboratory-scale experiment over the six-month demonstration period. If the PDC coating shows promising results under real refinery condition, it will signal that it will perform successfully in varying harsh environments. As these technologies to be validated in the ACHIEF project prove industrial applicability and usability, it is highly likely that these technologies will become widespread among other industries in the near future.