Application of Digital Twin Technology in Deep Sea Corrosion and Protection

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Abstract The deep-sea environment is complex and unique, and deep-sea equipment and facilities face serious corrosion problems. Traditional corrosion monitoring and prediction methods are limited by real-time performance and accuracy, making it difficult to meet the needs of engineering applications. Digital twin technology, as an emerging digital means, provides new ideas for solving deep-sea corrosion problems. Digital twin technology achieves real-time monitoring, accurate prediction, and optimized decision-making of deep-sea corrosion by constructing virtual models corresponding to actual deep-sea equipment. This paper addresses the difficulties in predicting and evaluating the dynamic development of corrosion in high-strength steel load-bearing structures used in deep-sea equipment. By utilizing online monitoring and detection of deep-sea corrosion data, multi physics field coupling simulation, and real-time transmission technology of IoT data, a basic architecture of deep-sea corrosion digital twin is established. This architecture includes key programs such as data acquisition, model construction, virtual simulation, and decision support. It can not only monitor the corrosion status of deep-sea equipment structures in real-time, but also predict corrosion development trends. Afterwards, a detailed analysis was conducted on the application of digital twin technology in deep-sea corrosion monitoring, including real-time collection of deep-sea environmental data and environmental effect data using sensor networks, data-driven construction of corrosion prediction models, and simulation of corrosion processes through virtual simulation technology. Virtual simulation and reproduction of the full life corrosion process of high-strength steel load-bearing structures were achieved. Finally, the application prospects and potential value of deep sea corrosion digital twin technology were discussed, and future research directions and development trends were discussed. The digital twin technology of deep-sea corrosion provides an efficient and accurate method for solving deep-sea corrosion problems, which can provide technical and methodological support for the full life corrosion prediction, protection, and evaluation of deep-sea marine equipment.

Keywords deep-sea corrosion; digital twin; stress structure; corrosion protection; corrosion prediction