Towards a Cleaner Future: Electrochemical Innovations in Hydrogen Separation and Purification from Natural Gas in Distribution Networks and Their Impact on Air Quality

Nowadays energy plays a fundamental role in our society and hydrogen seems to have a key role in a scenario dominated by depletion of fossil fuels, global warming, and rising energy demand. However, its use is limited by storage and transport problems. A possible solution is blending hydrogen into natural gas pipeline network. The separation, purification, and potential storage of this energy vector are therefore important challenges. In this study, low-temperature Electrochemical Hydrogen Compressor (EHC) with Nafion membrane was investigated and tested in hydrogen separation from different methane-hydrogen mixtures. This technology is based on the oxidation of impure hydrogen at the anode and the evolution of pure, high-pressure hydrogen at the cathode. The core of this device is the proton exchange membrane (PEM). This component is crucial for EHC system performance, a membrane with high ionic conductivity is required to reduce ohmic losses. In addition, the membrane must have high mechanical, thermal and chemical stability to withstand working conditions. Therefore, it was decided to test three different Nafion membranes, namely N-115, N-117 and N-212. The efficiency of the system and the purity of the obtained hydrogen were evaluated, confirming the effective actual purification efficiency of the system. Another important component of this electrochemical system is the catalysts. Usually, the main material used for both the electrodes is Pt/C that show a high activity for hydrogen oxidation (HOR) and hydrogen reduction reactions (HER). However, it has some drawback, like the leaching and agglomeration of the metal NPs and the poisoning of the active site (CO, CO_2, H_2S) and it is also susceptible to corrosion and expensive and rare. So, it is necessary to find PMG free catalysts that is also composed by sustainable elements. Tungsten carbide (WC) has been considered as an alternative to Pt catalysts because of the “Pt-like d-band electronic structure”, and widely used as an electrocatalytic component or support owing to its high electrical conductivity, stability, and activity. On this material cyclovoltammetry measurements were done to investigate its behaviour in HOR and HER.