Compressors are one of the most costly components at hydrogen stations, which leads to the high price of hydrogen production. The substitution of a solid piston with ionic liquid is a promising option that may solve some of the challenges related to conventional reciprocating compressors and, consequently, significantly reduce the final cost of hydrogen production. The correct choice of ionic liquid and construction materials is critical for avoiding significant corrosion problems. Hence, the objective of this study is to evaluate the compatibility of various austenitic stainless steels and nickel-based alloys as construction materials in contact with 80 °C ionic liquids in an ionic liquid hydrogen compressor, considering the role of parameters such as the temperature, viscosity, ionic liquid cation and anion, and water absorption. The results show that temperature contributes to increasing the corrosion rate. However, even at 80 °C, the very low corrosion current densities proved that all of the tested alloys are safe to use as construction materials. AISI 347 showed very high corrosion resistance in all of the ionic liquids. The highest corrosion resistance among all of the tested alloys was observed in trihexyltetradecylphosphonium bis (trifluoromethylsulfonyl) imide, which had a relatively high viscosity and the lowest water content.