OBSERVATION AND ANALYSIS OF LOW TEMPERATURE LEAK CHARACTERISTICS OF THE O-RING FOR HYDGROGEN ELECTRIC VEHICLES

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A variety of O-rings made of rubbers are used to seal the connectors and pipelines in hydrogen electric vehicles (HEV). Due to the small volumetric energy density of hydrogen and to maintain the pressure gradient required for fast recharging, in hydrogen refueling stations, hydrogen gas is charged into HEV at high pressure and low temperature at -40 degrees Celsius. It is well known that the mechanical behaviors of rubbers are sensitive to temperature change. At certain temperature range, it undergoes glass transition, resulting in drastic changes of strength and toughness. Therefore, finding the proper rubber material for guaranteeing the safety of HEV under operating temperature ranges is an important for designing seals of HEV. However, in actual practice, the critical leak temperature, i.e., the temperature at which hydrogen gas leak starts to occur, tend to deviate from the conventional glass transition temperature of the rubber. This poses a great obstacle in reliable designing of O-rings. In this study, a scheme involving both testing and finite element analysis is designed to not only determine the critical leak temperatures but also investigate the physical nature of interfacial leakage for O-rings. A noble testing method is proposed to measure the critical leak temperature of facial O-rings by detecting gas leak and contact force drops. Using the test results and observing the damaged geometry of the cross section of O-rings, a finite element model is constructed and analyzed using ABAQUS software.