Effect of tube pitch on the multi-tube membrane reactor for hydrogen production using computational fluid dynamics

김범수, 최홍범[1], 이재형[1,†]
카이스트; [1]KAIST
(jayhlee@kaist.ac.kr[†])

Steam methane reforming is the most conventional method to produce hydrogen which is regarded as eco-friendly and a potential future energy carrier. Catalytic packed-bed reactor reduces the energy consumption from high operating temperature due to strong endothermic property of steam methane reforming reaction. Adding the Pd-based membrane, which selectively permeates hydrogen, intensifies the reactor performance by shifting the thermodynamic equilibrium forward. In this study, a 7-tube catalytic membrane reactor is modeled and simulated using computational fluid dynamics (CFD) in order to investigate how the placement of the tubes in the reactor affects its performance. Our 3-D CFD model uses an experimentally validated hydrogen permeation model and intrinsic reaction kinetics. The periodic symmetry method is used to reduce the computational cost. The tube pitch ratio from 1.25 to 1.708 are discussed. The hydrogen recovery and the methane conversion are selected as the performance of the multi-tube membrane reactor. The tube pitch ratio affects the performance of the multi-tube membrane reactor. Mass transfer limitation and heat transfer limitation are studied.