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Methanol Steam Reforming and CO_2 Methanation Using Low Rank Coal Supported Metal Catalysts

Low rank coal generally contains many oxygen functional groups, especially carboxyl groups, and metals can be evenly dispersed on a nano-scale through ion-exchange in the carboxyl group. The carbon support catalyst prepared in this way has a high coking resistance by inhibiting carbon polymerization. The dispersed metal exists in a reduced state due to the high reducing power of the carbon support, so pre-reduction before the reaction can be avoided. The high thermal conductivity of the oxygen material can increase the thermal efficiency of the reactor, and it is easy to recycle the catalyst after use. The activity can be controlled by easy manipulation of the pore structure. In this study, various metals such as nickel, cobalt, indium, rhodium, platinum, etc., and also the mixed metals were dispersed on low rank coal via simple incipient wetness impregnation. Nano-dispersion (particles with less than 10 nm diameter) was achieved for most of the metals. A pore structure of low rank coal support was modified by pyrolysis, and physical/chemical activation. Then, the prepared catalysts were applied to methanol steam reforming (MSR) and CO_2 methanation. Several metals such as Ni and Rh showed > 90% MSR conversion at 350 °C. Product selectivity varied significantly depending on the kind of metals. Rh dispersed on low rank coal exhibited excellent durability during 1,000 h continuous run with minor deactivation due to coking. Their catalytic behavior was also discussed, comparing with that of hierarchical and mesoporous carbon supported catalysts.