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Study of sorption and swelling on block coals

Shijie Qu (1), Guoqing Chen (2), Jianli Yang (1), Wenzhong Shen (1), Yunmei Li (1), Hongxian Niu (1), and Andreas Busch (3)

(1) State Key Laboratory of Coal Conversion, Institute of Coal Chemistry, Chinese Academy of Sciences, 030001 Taiyuan, P.R. China , (2) Shanxi Provincial Guoxin Energy Development Group CO., LTD., 030006 Taiyuan, P.R. China, (3) Shell Global Solutions International, Kessler Park 1, 2288GS Rijswijk, Netherlands

Reducing CO_2 emission into atmosphere is very important for the mitigation of global climate change. Many processes have been proposed for this purpose, including CO_2 sequestration in un-minable coalbeds and enhance coalbed methane production (CO_2-ECBM). Several theoretical studies and worldwide demonstration sites have illustrated the potential of the process.Most of these projects experienced permeability reduction of the coalbed with time, leading to operational difficulties because of the loss of injectability. The permeability reduction is generally considered to be caused by the coal swelling that is induced by gas sorption, because it can narrow or close the cleat of the coalbed. As a result, the migration of injected CO_2 in coal pore or cleat becomes more difficult. Therefore, sorption and swelling characterizations are important issues for forecasting the performance of aimed coalbed.

In this work, CO_2/CH_4sorption and swelling isotherms of two Chinese block coals (QS and YQ) were measured simultaneously under different temperature and pressure conditions. It was found that the swelling ratio of coal block by CO_2 sorption increased with the increase of the gas sorption amount until it approached to a value of $\sim$3 mmol-gas/g-coal and decreased slightly afterwards for both coals; while the swelling ratio of coal block by CH_4 sorption increased with the increase of the gas sorption amount in the entire test region for both coals. By correlating the gas sorption amount and the corresponding swelling ratio, it was found that the swelling ratio of coal block is independent of temperature and coal type when the gas sorption amount is less than $\sim$2mmol/g-coal. The differential profile of the swelling ratio with respect to sorption amount is appeared with a maximum value at $\sim$1 mmol/g-coal for CH_4 and at $\sim$1.8 mmol/g-coal for CO_2. Based on the theories related to gas sorption and solid surface energy, a mathematical model which correlates sorption and swelling behavior was proposed.