Groundwater and Underground Coal Gasification in Alberta

Alex Haluszka, Gordon MacMillan, Matrix Solutions Inc.
Simon Maev, Laurus Energy Canada Inc.

Underground coal gasification (UCG) is a process that converts coal into a combustible gas in-situ. The process is initiated with the injection of an oxidant to combust the coal. The released heat initiates a series of chemical reactions creating synthesis gas (or syngas). Syngas can be used as a chemical feedstock and can also be used as a fuel source in electrical power generation (e.g. integrated gasification combined cycle). Compared to conventional coal fired power systems, IGCC has lower sulfur dioxide and particulate emissions and also produces a more pure stream of carbon dioxide that can be readily captured and integrated with carbon capture and storage projects (CCS). Groundwater is an important part of the gasification process; water is needed as a reactant and the rate of water influx into the coal seams influences the quality and composition of the syngas. In addition to groundwater consumption, byproducts are created by the gasification process and include heat, water with dissolved concentrations of ammonia, phenols, salts, and polyaromatic hydrocarbons, and liquid organic products from the pyrolysis of coal.

Given the importance of groundwater in the gasification process, a conceptual and numerical model of groundwater flow was developed to estimate groundwater consumption in the UCG process and to understand pressures and flow directions in the groundwater system prior to, during, and post gasification operations. Preliminary information comprised published reports on regional and local hydrogeology and geology. A regional study area approximately 1700 km^2 was selected based on major hydrologic and hydrogeological boundaries around the gasification site and a geological model was developed for the study area based on geophysical well logs in the strata above and below the targeted coal seams. A network of nine wells were drilled at the gasification site that were monitored for pressure and temperature using dedicated pressure transducers and nested vibrating wire piezometers. Pumping tests were conducted and water level data were collected for domestic wells within a 1.6 km radius of the project site. Regional hydrogeological data were obtained from drill stem tests and water wells in the Alberta Environment Groundwater Information Centre database. All of these data were integrated into a conceptual hydrogeological model that included horizontal and vertical groundwater flow and groundwater discharge to major hydrologic features.

A hydrogeologic numerical model was then constructed based on geologic mapping and the conceptual model of groundwater flow. The numerical model was calibrated relative to well data available at the gasification site and in the regional study area. The resulting numerical model provided a reasonable representation of the observed hydraulic gradients at the site. The numerical model proved to be a useful tool to predict and communicate potential changes to groundwater levels and groundwater quality in the vicinity of the gasifier. Based on the project description and the proprietary UCG technology (UCG) being used, the project is not predicted to affect groundwater quality in the adjacent formations or groundwater levels in any of the domestic use aquifers.

Alex Haluszka

Alex Haluszka is a junior Hydrogeologist at Matrix Solutions Inc. in Calgary. Since joining Matrix he has worked on hydrogeology assessments in support of coal gasification and in-situ oilsands projects. Alex received his B Sc. in geology at the University of Calgary in 2006 and his M Sc. in carbonate geology at the University of Calgary in 2009. Current interests include the integration of geological and sedimentological data with hydrogeology and hydrogeological modeling, carbonate geology and hydrogeology, and carbon dioxide storage.