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Simulation of CO_2 process for enhanced Coalbed Methane recovery at early stage of Production- A case study from Jharia Coalfield, India

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Coalbed methane (CBM) or Coalbed gas has gained considerable ground as an unconventional source of energy in the recent past. Due to incremental demand for conventional fossil fuel both in industrial and domestic sectors, coupled with dwindling reserves of oil and gas, the hunt for unconventional sources of energy has gained momentum the world over. Gas production in CBM reservoirs requires the pressure to drop sufficiently for gas to desorb from the coal matrix and flow through natural fracture system of cleats. The complexity in the storage and transport mechanism makes reservoir simulation an important tool in performance analysis of coal bed methane reservoirs.

In the present study the coal samples were collected from the Jharia coalfield, Jharkhand (near Parbatpur, latitudes 23°41'31.28" and longitudes 86°20'56.20" and covered in the Survey of India toposheet No. 73I/6). Numerical modelling and simulation studies for primary and CO_2 enhanced CBM recovery have been carried out. The depth of the coalbed considered for the present study ranges from 905 m to 968.50 m. The adsorption isotherm parameters were evaluated as per Langmuir Adsorption model (P_1 values for both CO_2 and CH_4 are 360 psia and 611 psia, and V_1 values for both CO_2 and CH_4 are 924 scf/ton and 578 scf/ton). A non-equilibrium two-phase black oil model was used for simulating the system. Using a 5 spot pattern, efficiency of CO_2 injection was analysed and the optimum well spacing was determined. Sensitivity analysis using optimum well spacing was performed on dominant factors of production, such as initial water saturation, sorption time and injection pressure for optimization of different operational parameters using the ECLIPSE simulator.

The studies conclude that CO_2 injection is very effective for enhancing the recovery of methane and reducing the dewatering period. Simulation studies shows that CO_2 injection at the early stage also reduced total project duration, thus it may make the CBM project an economic one in the present CBM field.

CBM gas recovery by CO_2 sequestration is a comparatively new technology, where research projects are mainly based to evaluate the potential economic benefits of CO_2 sequestration in combination with CBM production. Investigations have been limited to measurement of adsorption isotherms under static conditions, and lack in providing information of gas pressure-driven and concentration-driven conditions. The matrix swelling associated with CO_2 injection could result in a reduction in formation permeability around the injection well, so methane production rate is lowered with time. Geological and mechanical properties of cap rock and coal seams are also very important and must be studied in detail for safe and effective injection of CO_2. CO_2 sequestration is a very cost effective and proven technology for enhanced recovery of methane gas from CBM reservoirs, but still it is at its incipient stage.