IITB-Monash Research Academy

Indian Institute of Technology Bombay | MONASH University

An Indian-Australian research partnership

Project title: Numerical Simulation of CO_2 sequestration and recovery of CH4 from coal seams.

Project number: IMURA0098

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Research Academy theme/s

Clean Energy
Infrastructure Engineering
Advanced computational Engineering, simulation and manufacture

The research Problem Project Title

The emission of enormous amounts of CO_2, one of the mostly abundant greenhouse gases, into the environment results in a series of global problems such as warming of the climate and deforestation, caused by acid rain etc. For example, global average temperature of the earth has increased by approximately 0.6 ± 30 0C over the last century from the literature.

One of the ways to reduce the CO_2 emission into atmosphere is that of injecting CO_2 into underground coal-bed where CO_2 is stored in the coal seam in an adsorbed state but the residual methane can also be replaced and recovered as a by-product from coal seams. Methane is mainly stored in coal as adsorbed gas on the surfaces of micro fractures in the coal matrix which accounts for more than 90% of total gas in place and also present in the form of free gas in natural fracture system comprising of 70% of total storage capacity. Production of methane in this way adds more value to the carbon dioxide sequestration operation because coal bed methane (CBM) can also be produced to generate revenue that offsets the expenses for CO_2 sequestration.

Numerical modeling can provide predictions of storage capacity of the reservoir, and enables to estimate possible methane recovery as a by product of CO2 sequestration. This study aims to predict the carbon dioxide transport in two phases, multi-layer environment of a typical unmineable coal-bed basin based on the variable saturation model. In this study, the variable porosity, relative permeability, and saturation will be tracked as their partial pressures would changing between the existing methane in coal seams and layers subjected to the injection of CO2. The concentration of carbon dioxide which is adsorbed on the coal surface will be analyzed by using the unsteady Langmuir equation with the variable pressure.

Project aims

1. To study the effect of methane migration on porosity and permeability distribution in coal seam.
2. To study the stress distribution, deformations and developed fracture network of coal seams resulting from methane migration and vice-versa
3. To investigate the possible leakage of mine gas during the underground mining operations
4. To identify the optimum parameters for extraction of CH4 using CO2

Expected outcomes

1. Improved understanding of the mechanisms of flow properties of CO2/CH4 through porous coal bed.
2. Helps to improve the permeability for efficient CO2 sequestration and CH4 production.
3. Improved understanding of induced ground settlement at the surface due to migration of methane
4. Gives a tool to predict controlled extraction of methane so that structures ling on the ground are safe
5. How much CO_2 can be injected into a coal seam and amount of CH_4 released and related subsidence profile of Mine
6. Understanding of Dual porosity nature of coal bed and multiphase Darcy flow with diffusion of gas in the natural fracture system

Which of the above Theme does this project address?

This project will address the themes of clean coal energy, Infrastructure and Environmental engineering and advanced computational engineering, simulation and manufacture.

How will the project address the Goals of the above Themes?

This project addresses the themes like Clean Coal Energy, Infrastructure Engineering, Environmental Engineering and advanced computational engineering, simulation and manufacture. The output of the project will result in the quantitative description of CO_2 injected into the coal bed and methane generated in turn. Prediction of stresses and deformations induced in the coal mine will help to take preventative measures (for any infrastructural damage at the surface) during ECBM production.