IITB-Monash Research Academy

Indian Institute of Technology Bombay | MONASH University

An Indian-Australian research partnership

Project title: Numerical and experimental study of rocks under very high temperature conditions: Underground coal gasification.

Project number: IMURA0200

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Research Academy theme/s

Clean Energy
Infrastructure Engineering
Advanced computational Engineering, simulation and manufacture

The research Problem Project Title

Underground Coal Gassification (UCG) can be used to convert coal into syngas which can be either used as a clean energy source, or it can be further converted into other chemicals, gaseous or liquid fuels. With development of suitable technology and a better understanding of various hydrogeological, geomechanical, geochemical and environmental aspects, UCG can be an efficient means of exploiting coal as a source of energy and for the production of liquid fuels and other useful products, and can increase the amount of coal reserves that are economically accessible. However, for the successful application of UCG, a number of issues exist and require further investigation. These issues include subsidence, potential groundwater contamination, and greenhouse gas emission because of the amount of carbon dioxide that is produced.

During the underground coal coalification process, the porosity, permeability, geomechanical and other physical and chemical properties of the processed coal and the adjacent rock may change, new fractures can be created, especially with the thermal stress that is induced by the large change in temperature. Even though the degree of subsidence can be small or acceptable, the change in fluid transport and geomechanical properties of the rock strata in and around the subsidence zone can affect the patterns of groundwater flow, and this needs to be studied so that its potential impact on the groundwater system can be assessed

Experimental and Numerical modeling can provide predictions of prediction of the mechanical behaviour of the cap rock above the coal seam, and enables to estimate how far the rock layer is going to be damaged due to the conductivity of heat generated from the coal seam. This study aims to predict heat transfer in several rocks, crack propagation of

rocks due to high temperature (exceeding 1100C). It is expected to do serious of testing on several rock types at ranges of temperatures from 30C to 1000C to study the effects of temperature on the mechanical properties of rocks. These results will be used to develop new empherical model for strength. In addition to the experimental study, an analytical model will be developed and compared with the experimental results. The developed analytical model with the experimental results will be used in numerical simulation to study the heat transfer and to establish a crack damage zone within the coal fired zone.

Project aims

1. To study the effect of temperature on the mechanical behavior of various rocks types
2. To study the effects of strain rate, temperature on the strength/stiffness of rocks
3. To study the stress distribution, deformations and developed fracture network of rock resulting from heat adsorptions
4. Development of new strength models for the simulation of roof rocks in underground coal gasification areas
5. To study the crack damage zone due to the high heat generated from the coal fire zone

Expected outcomes

1. Improved understanding of the mechanisms of rock under high temperature
2. Improved understanding of crack propagation of rocks at high temperature conditions and hence to minimise the damage of surrounding rocks and control the burning rate of coal
3. Development of new constitute models for strength and temperature

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 heat flow in rocks. Prediction of stresses and deformations induced in the underground gasification chambers will help to take to minimise the ground subsidence, escaping dangerous gases such CO and CO2 to the atmosphere..