

Underground Coal Gasification (UCG), Process, Benefits, Risks

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Recently, the Ministry of Coal formalised Coal Mine/Block Production and Development Agreements (CMDPAs) with selected bidders for four coal blocks, introducing provisions for Underground Coal Gasification for the first time within India's commercial coal mining regime.

About Underground Coal Gasification (UCG)

Underground Coal Gasification (UCG) is a **thermo-chemical process** in which **coal** is partially combusted underground using controlled injection of oxygen (or air) and steam. This produces **syngas**, primarily composed of **hydrogen (H₂)**, **carbon monoxide (CO)**, **methane (CH₄)**, and **carbon dioxide (CO₂)**, which is extracted through wells and used for power generation, chemicals, or hydrogen production.

Process of Underground Coal Gasification

The process requires careful engineering and control to ensure that gasification occurs efficiently inside the coal seam.

- **Injection well:** Oxygen or air along with steam is injected into the coal seam
- **Linkage or channel formation:** A connection is created between the injection and production wells. This is achieved through techniques such as directional drilling or controlled combustion so that gases can move through the coal seam
- **Gasification zone:** High-temperature reactions convert coal into synthesis gas through oxidation, reduction, and thermal decomposition
- **Production well:** The gas produced is collected and transported to the surface for further use.

Advantages of Underground Coal Gasification

The advantages of Underground Coal Gasification lie in its ability to combine efficient resource utilisation with lower costs and reduced environmental impact, while also strengthening energy security.

- **Efficient use of resources:** This method allows access to large quantities of coal that would otherwise remain unused due to technical or economic limitations.
- **Cost advantages:** Since mining, transportation, and surface gasification infrastructure are not required, the overall cost can be lower compared to conventional gasification methods.
- **Reduced surface impact:** There is significantly less damage to land and ecosystems because the coal is not excavated.
- **Improved safety:** The risks associated with underground mining, such as accidents and exposure to hazardous conditions, are largely avoided.
- **Contribution to energy security:** It can help countries like India make better use of domestic energy resources and reduce dependence on imports.

Underground Coal Gasification Environmental Risks and Challenges

- **Groundwater contamination through leaching:** After the gasification process ends, groundwater may enter the underground cavity and dissolve residual chemicals. This can create contaminated liquid known as leachate, which may contain toxic substances such as phenols and complex hydrocarbons.
- **Carbon emissions:** Although more efficient than traditional coal use, the process still produces carbon dioxide, which contributes to climate change concerns.
- **Land subsidence:** The collapse of underground cavities may lead to sinking of the land surface, affecting infrastructure and ecosystems.
- **Technical and regulatory complexity:** The process requires continuous monitoring, detailed geological assessment, and strict regulation to ensure safety and environmental protection.

Underground Coal Gasification in India

India has large coal reserves, a significant part of which lies deep underground and cannot be mined easily. To utilise these resources, the Ministry of Coal has been promoting Underground Coal Gasification through:

- Policy support and incentives such as viability gap funding and reduced revenue sharing for gasification projects.

- A major development took place in April 2026, when the government signed **Coal Mine/Block Production and Development Agreements (CMDPAs)** for four coal blocks under commercial mining.
- For the first time, these agreements included provisions for Underground Coal Gasification, marking its shift towards commercial use.
- Under this, **Reliance Industries Limited** was awarded the Recherla and Chintalpudi Sector A1 blocks in Andhra Pradesh, while **Axis Energy Ventures** secured the Dip Extension of Belpahar and Tangardihi East blocks in Odisha.
- This step allows companies to use both conventional mining and gasification methods, improving the value obtained from coal. The gas produced can be used in fertilisers, petrochemicals, and synthetic fuels, helping reduce dependence on imports and strengthening India's energy and food security.

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