More than half of US’ electricity is generated by the combustion of coal which liberates NOx and SO2 that contribute to the formation of acid rain and greenhouse gases.

- Coal gasification is an incomplete combustion of coal that produces a synthesis gas composed primarily of CO and H2.

- At least 98% of sulfur contaminants are removed as the slag by product of gasification.

- If the syngas is to be used to produce electricity, it is typically used as a fuel in an integrated gasification combined cycle (IGCC) power generation configuration, which is the cleanest, most efficient means of producing electricity from coal.

- Carbon dioxide (CO2) can be captured prior to the synthetic gas combustion in gas turbines. It offers the lowest cost of CO2 capture from any fossil-fuel-based power plant.

- Efficiency of an IGCC system could reach 55%.

ECCC’s Research Activities:
- Simulate gasification process and thermal flow behavior in various gasifiers.
- Improve reliability of gasifiers.

**GLOBAL GASIFICATION REACTIONS:**

**Heterogeneous**

\[
\begin{align*}
\text{C(s) + O}_2 & \rightarrow \text{CO} & \Delta H^\circ_F &= -110.5 \text{ MJ/kmol} \\
\text{C(s) + CO}_2 & \rightarrow 2\text{CO} & \Delta H^\circ_F &= +172.0 \text{ MJ/kmol} \\
\text{C(s) + H}_2\text{O(g)} & \rightarrow \text{CO} + \text{H}_2 & \Delta H^\circ_F &= +131.4 \text{ MJ/kmol}
\end{align*}
\]

**Combustion**

\[
\begin{align*}
\text{C(s) + O}_2 & \rightarrow \text{CO}_2 & \Delta H^\circ_F &= -393.5 \text{ MJ/kmol}
\end{align*}
\]

**Gasification (Boudouard reaction)**

\[
\begin{align*}
\text{C(s) + CO}_2 & \rightarrow 2\text{CO} & \Delta H^\circ_F &= +172.0 \text{ MJ/kmol}
\end{align*}
\]

**Gasification**

\[
\begin{align*}
\text{C(s) + H}_2\text{O(g)} & \rightarrow \text{CO} + \text{H}_2 & \Delta H^\circ_F &= +131.4 \text{ MJ/kmol}
\end{align*}
\]

**Homogeneous**

\[
\begin{align*}
\text{CO} + \frac{1}{2}\text{O}_2 & \rightarrow \text{CO}_2 & \Delta H^\circ_F &= -283.1 \text{ MJ/kmol}
\end{align*}
\]

\[
\begin{align*}
\text{CO} + \text{H}_2\text{O(g)} & \rightarrow \text{CO}_2 + \text{H}_2 & \Delta H^\circ_F &= -41.0 \text{ MJ/kmol}
\end{align*}
\]

\[
\begin{align*}
\text{CH}_2\text{O}_.5855 & \rightarrow 0.5855\text{CO} + 0.8532\text{H}_2 + 0.06907\text{C}_6\text{H}_6 & \text{(Volatil cracking)}
\end{align*}
\]

\[
\begin{align*}
\text{C}_6\text{H}_6 + 3\text{O}_2 & \rightarrow 6\text{CO} + 3\text{H}_2 & \text{(Volatile cracking)}
\end{align*}
\]
Pathline traces inside a two-stage entrained-flow gasifier.

Pathline traces and temperature distribution in the fuel injection region of Industrial Technology Research Institute’s gasifier.

Distribution of the gas temperature and the gas mole fraction at different horizontal planes inside two-stage coal-slurry-fed gasifier.