
Executive Certificate in Carbon Capture and Storage

Carbon Capture and Storage in Industrial Applications

Carbon Capture and Storage (CCS) is a set of technologies that captures carbon dioxide (CO₂) emissions from industrial processes and power plants, transports it to a storage site, and injects it into rock formations for long-term isolation from the atmosphere. CCS is a critical technology for reducing CO₂ emissions and mitigating climate change. In this explanation, we will explore the key terms and vocabulary related to CCS in industrial applications.

1. Carbon Capture

Carbon capture is the process of capturing CO₂ emissions from industrial sources, such as cement plants, steel mills, and power plants. There are three primary methods of carbon capture: pre-combustion capture, post-combustion capture, and oxyfuel combustion capture.

Pre-combustion capture involves capturing CO₂ before the fossil fuel is burned. The fuel is gasified, and the resulting syngas (a mixture of hydrogen and CO₂) is shifted to produce a stream of CO₂ and hydrogen. The CO₂ is then captured, and the hydrogen is used as a clean fuel.

Post-combustion capture involves capturing CO₂ after the fossil fuel is burned. The flue gases are cooled, and a chemical solvent is used to absorb the CO₂. The CO₂ is then released from the solvent, compressed, and transported for storage.

Oxyfuel combustion capture involves burning the fossil fuel in pure oxygen instead of air. This produces a flue gas that is primarily CO₂ and water vapor. The water vapor is condensed, and the CO₂ is captured, compressed, and transported for storage.

2. Carbon Transport

Carbon transport involves the transportation of captured CO₂ from the capture site to the storage site. CO₂ can be transported via pipeline, ship, or truck. Pipeline transport is the most common method and is used for transporting large volumes of CO₂ over long distances. CO₂ is compressed to a liquid state for pipeline transport, which reduces its volume and makes it easier to transport.

3. Carbon Storage

Carbon storage involves the injection of captured CO₂ into rock formations for long-term isolation from the atmosphere. The most common storage method is geological storage, where CO₂ is injected into deep saline aquifers, depleted oil and gas reservoirs, or coal seams.

Geological storage is preferred because of its large storage capacity, long-term stability, and ability to

permanently isolate CO₂ from the atmosphere. CO₂ injection into saline aquifers involves injecting CO₂ into the pore spaces of rock formations, where it becomes trapped in place. CO₂ injection into depleted oil and gas reservoirs involves injecting CO₂ into the reservoir to enhance oil or gas recovery, while also storing the CO₂. CO₂ injection into coal seams involves injecting CO₂ into the coal seam, where it can displace methane and enhance coalbed methane recovery, while also storing the CO₂.

4. Monitoring and Verification

Monitoring and verification are critical components of CCS. Monitoring involves the measurement and tracking of CO₂ injection and storage, while verification involves the confirmation that the injected CO₂ is being stored as intended. Monitoring and verification are necessary to ensure the safety and effectiveness of CCS.

Monitoring can be done using a variety of methods, including seismic surveys, well logs, and tracer studies. Seismic surveys involve the use of sound waves to map the subsurface rock formations and detect the presence of CO₂. Well logs involve the measurement of physical properties of the rock formations, such as porosity and permeability, to determine the suitability of the formation for CO₂ storage. Tracer studies involve the injection of a tracer gas, such as sulfur hexafluoride, along with the CO₂, to track the movement of the CO₂.

Verification can be done using a variety of methods, including reservoir simulation, well testing, and geophysical monitoring. Reservoir simulation involves the use of computer models to simulate the behavior of the CO₂ in the rock formation. Well testing involves the measurement of pressure and flow rates in the well to determine the amount of CO₂ that is being stored. Geophysical monitoring involves the use of seismic surveys, well logs, and tracer studies to confirm the presence and location of the CO₂.

5. Challenges and Opportunities

There are several challenges and opportunities associated with CCS. The challenges include the high cost of CCS, the need for large-scale infrastructure, and the potential risks associated with CO₂ injection and storage. The opportunities include the potential for CCS to reduce CO₂ emissions, enhance energy security, and create new economic opportunities.

The high cost of CCS is a significant challenge. The cost of CCS can be several times higher than the cost of traditional fossil fuel power generation. However, the cost of CCS is expected to decrease as the technology matures and scales up.

The need for large-scale infrastructure is another challenge. CCS requires the development of new infrastructure, including CO₂ pipelines, storage sites, and monitoring systems. This infrastructure can be expensive to build and maintain.

The potential risks associated with CO₂ injection and storage are also a challenge. There is a risk of CO₂ leakage from the storage site, which could harm human health and the environment. However, the risk of CO₂ leakage is low, and can be minimized through proper monitoring and verification.

Despite these challenges, there are also significant opportunities associated with CCS. CCS has the potential to reduce CO₂ emissions by up to 90%. This can help to mitigate climate change and enhance energy security. CCS can also create new economic opportunities, including the development of new industries and jobs.

In conclusion, Carbon Capture and Storage (CCS) is a critical technology for reducing CO₂ emissions and mitigating climate change. CCS involves the capture of CO₂ emissions from industrial processes and power plants, the transport of CO₂ to a storage site, and the injection of CO₂ into rock formations for long-term isolation from the atmosphere. CCS is a complex technology that requires a thorough understanding of key terms and vocabulary, including carbon capture, carbon transport, carbon storage, monitoring and verification, challenges and opportunities. With proper implementation, CCS can help to reduce CO₂ emissions, enhance energy security, and create new economic opportunities.