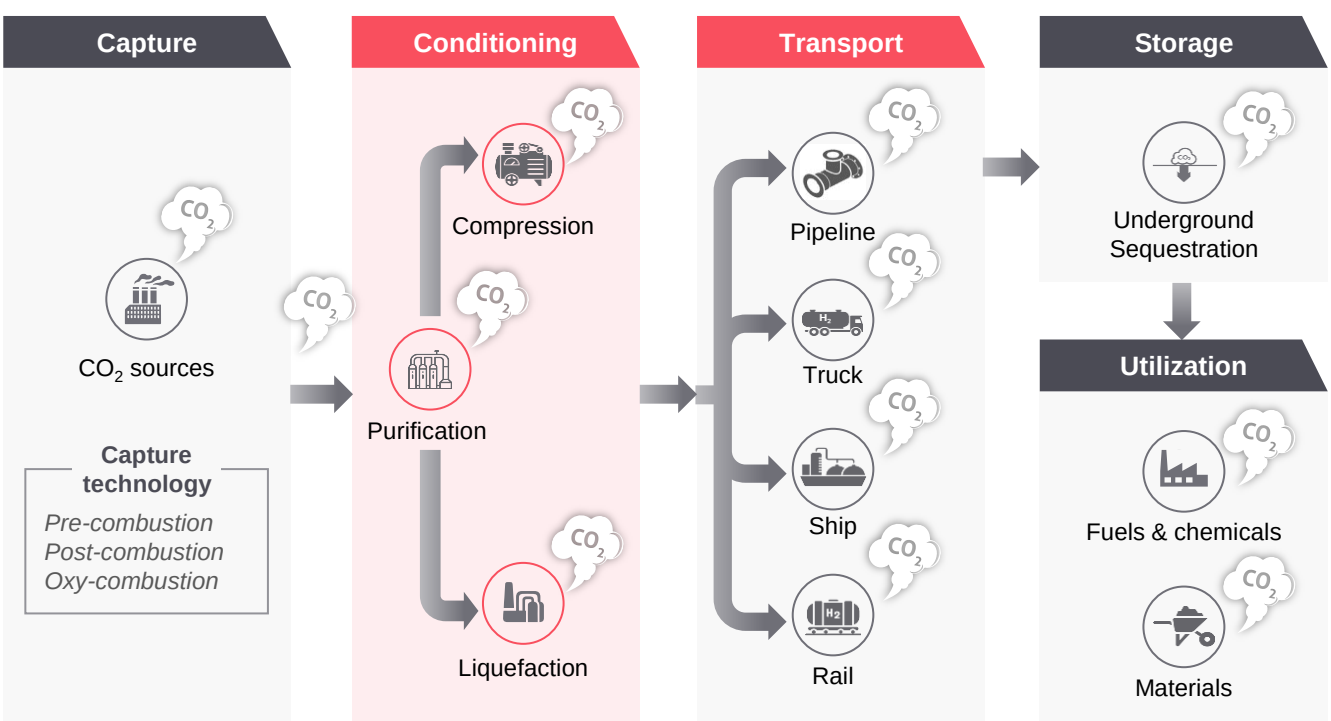
FutureBridge

CO_2 MONITORING

Eyes on Emissions: Across CCUS Value Chain

CCUS Value Chain: Emission Sources

CO_2 monitoring is the systematic measurement and analysis of carbon dioxide (CO_2) levels at each stage which ensures safety, environmental protection, regulatory compliance and operational efficiency and for that emission source identification is of utmost importance.



The Need for CO_2 Monitoring

CO_2 is an odorless, colorless, and denser-than-air gas that is hazardous for humans, animals and the planet.

At concentrations above **5%,** CO2 is toxic to humans and animals. Breathing high concentrations of CO2 does not cause hypoxia; rather, it results in CO2 intoxication in body tissues, which can lead to death..

A large-scale leakage of stored CO_2 can undo years of effort in capturing and storing CO_2. Adding large amounts of CO_2 back into the atmosphere.

A CO2 leak could be catastrophic because CO2 is **60% denser than air** and will therefore travel at low levels, displacing oxygen and creating toxic conditions on inhabited land.

CO_2 leaked in undersea storage facilities could react with seawater to form **carbonic acid**, leading to ocean acidification and local ecological damage .

Source: Drager

CCUS Value Chain: What is Measured

It is very important for the flow rate of CO2 to adhere to the desired design specifications. Monitoring real-time leak detection is crucial to avoid fugitive emissions, and the placement of flow meters and leak detectors is essential at all stages of the CO2 value chain.

Capture

CO2 is captured from different sources and hence contains a mixture of gases and particulate matter, leading to issues with flow meters.

- Flow
- Leaks
- Gas-moisture
- CO_2 composition

Conditioning

Checking the purity and composition is a must before the captured CO2 is sent to the compression or liquefaction stage. Impurities can invalidate the accuracy of the flow meter, as it is designed to operate in one specific phase only.

- Leaks
- Flow
- Purity and composition
- Pressure

Transport

CO2 is transported via pipeline in the dense phase/supercritical phase at high pressure. During shipping, CO2 is transported in a liquid state, where tank levels or sloshing could lead to pressure variations, potentially causing valve failure.

- Flow
- Leaks
- Tank level
- Sloshing
- Pipeline integrity

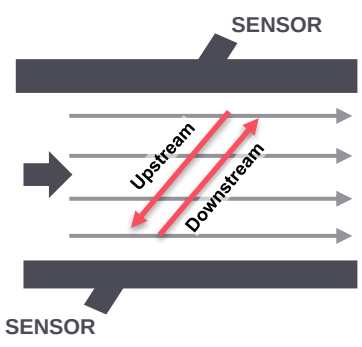
Storage

Sequestration of CO_2 requires constant monitoring of pressure management, seismic activity, well integrity issues and CO_2 plumes.

- Leaks
- Flow
- Seismic activity
- Well integrity
- Reservoir pressure

The Evolution of Flowmeter Technologies

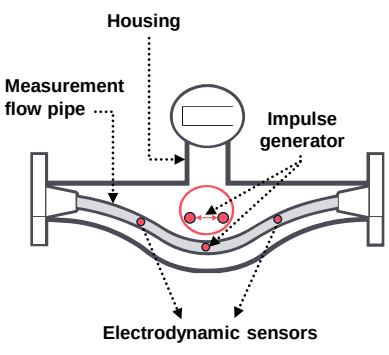
ULTRASONIC



100 bar

- It involves measuring time differences between upstream and downstream ultrasonic pulses.
- Can process 0.1 - 500 m³/min of CO_2.
- Considered least suitable due to CO2 acoustic attenuation.

CORIOLIS



400 bar

- The most versatile CO_2 flow meter as these can detect phase shift and operate on multiphase streams.
- Can process 0.01 Kg/min - 1000 Kg/min of CO_2

MAGNETIC RESONANCE

Wide range

- This emerging technology precisely measures CO2 flow in pipelines.
- The CO2 stream is exposed to a magnetic field and radiofrequency (RF) pulses, and the response is analyzed to determine flow parameters.

Current and Emerging Leak Detection Technologies

Photoacoustic CO_2 detector

- Photoacoustic detector operates on the photoacoustic effect which generates sound waves to identify and measure possible CO_2 leaks.
- Detect CO_2 concentrations at parts per billion (ppb) levels, hence highly sensitive.
- Ideal for detecting very low concentration leaks.

Ultrasonic gas leak detector

- Ultrasonic detectors use an array of microphone sensors to detect the high-frequency hissing sound of compressed gas leaks.
- They are effective for detecting larger leaks and useful in noisy industrial environments.
- However, they may give false alarms due to indistinguishable noises from compressors and other sources.

Robotic leak detector

- Robots equipped with advanced sensors and algorithms can detect CO2 leaks, with sensitivity depending on the type of sensor used.
- They can be designed to detect low to high concentrations of CO2 .
- It can access hard-to-reach areas, enhancing safety.

Future Perspectives

- CO_2 monitoring technologies hold great value as even a 1% CO_2 leak from a large capture facility could potentially cause a $2-$5 million annual loss.
- Advancements in 4D seismic monitoring, fiber optic sensing, and integrated technologies like SCADA, IoT, and AI collect and rectify real-time data from multiple sections in the CCUS value chain, increasing CO2 monitoring efficiency and reducing repairs, downtime, and associated costs.
- Supportive government policies, ‘accurate measurement, reporting and verification’ in the CCUS value chain and collaborative efforts would not only help companies save millions of dollars on safety incidents due to undetected CO_2 leak but help mitigate the GHG emission, achieving net-zero carbon emission target set for 2070.

About FutureBridge

FutureBridge is a techno-commercial consulting and advisory company. We track and advise on the future of industries from a 1-to-25-year perspective to keep you ahead of the technology curve, propel your growth, Identify new opportunities, markets and business models, answer your unknowns, and facilitate best-fit solutions and partnerships using our platforms, programs, and access to global ecosystems and players.