

Carbon Dioxide

- *Technologies*
- *Sequestration*
- *Utilization*



Carbon Dioxide (CO₂)

The scientific and visible evidences that Carbon Dioxide (the greenhouse gas) and global warming present the need to develop the most economical carbon dioxide separation, purification, compression, sequestration technologies and systems.

Carbon Dioxide alone accounts for over 80 % of all greenhouse gas emissions in the United States. About 60 % of carbon dioxide is emitted by the utility and power plants based on fossil fuel combustion. The fossil fuel utilization to generate power is about 75 % in the world and keep growing exponentially.

Three major practical solutions for the sequestration and utilization

- Natural Way – Enhancement of forests, agricultural and biological carbon sink
- Enhanced Oil Recovery (EOR)
- Utilization to produce new products and supplement the existing pure hydrocarbons based products

Major source of carbon dioxide:

- Fossil Fuel combustion to produce Flue gases
- Fermentation Industry (Beer, Ethanol, etc)
- Natural Gas & Oil wells

UTC Technologies

Flue Gas Energy Recovery To Electrical Power Generation, Carbon Dioxide Separation, Purification and Compression

- **Spiral & Hybrid Cycles (SHC) Technology**

Converts any low, medium or high level energy into electrical Power.

- **Ultimate Scrubbing Control (USC) Technology**

The flue gases containing carbon dioxide are treated to remove SO_x, NO_x, particulates, Heavy metals and clean the flue gases to the pristine state.

- **Forward Heat Integration (FHI) Technology**

This technology is based on the conventional & proprietary Amines systems as well as Benfield Technology (using potassium carbonate solution) to produce high purity carbon dioxide.

This technology is also supplemented by the UTC Gravity Application (GA) Technology to reduce the capital cost and operational cost by 10 -15 %.

- **Carbon Dioxide Compression & Transmission**

UTC Offers Two Separate Technologies:

1. **Spiral Compression Integration (SCI) Technology**

This technology increases the efficiency of the conventional compressor by 35 – 40 %. The compression heat from the each stage of the compressor is used to generate indirect electrical power which is recycled back to the compressor's motor control system. Typically, a carbon dioxide compressor consuming about 19,000 – 20,000 horse power, nearly 6000 – 7000 horse power is reduced.

2. **Carbonic - Hyperfluxx (CHF) Technology – Without the Conventional Compressor**

This is a Technology Breakthrough in High Pressure Compression. This Technology is based on the critical properties of carbon dioxide. The UTC high speed spiral devices create the compression of carbon dioxide to the desired high pressure without the conventional compressor. The CHF system is extremely efficient with low capital, low operation and maintenance costs. Only 45 – 50 % of the power is required to accomplish the same compression.

Sequestration

Enhanced Oil recovery (EOR)

There are vast known oil reserves onshore and offshore which are idle for a long time. The abundance quantity of oil remains untapped in States of Texas, Louisiana, Oklahoma, Colorado, Wyoming, Montana, California and Alaska. The estimates are that the North America oil reserves could amount to additional 25 – 35 billions barrels.

The conventional technologies are not practical due to high costs. The carbon dioxide flooding at elevated pressure of 1500 – 2000 psi using the enhanced oil recovery technologies can produce the large quantity of oil daily. UTC believes that this is the most efficient and economical method for the carbon dioxide sequestration.

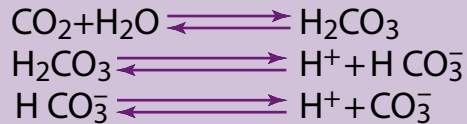
Carbon Dioxide Storage

The underground storage of carbon dioxide both in high pressure gaseous form or liquefied gas is extremely expensive not only in capital cost but also in operational and maintenance costs. UTC believes that locking the carbon dioxide in the underground storages and the oceans is not the effective way to reduce the carbon dioxide in the earth's atmosphere. The carbon dioxide must release the oxygen back to atmosphere by the natural way to maintain the oxygen balance. This natural phenomena will produce more forests, green valleys and store carbon.

UTC's CO₂ Compression Technology can reduce the CO₂ compression horsepower by 30-40%.

CO₂ Chemistry with Water

Carbon dioxide is a very safe and effective chemical for lowering the pH of various kinds of alkaline waters. When CO₂ is dissolved in an aqueous system it goes through a series of chemical reactions as shown below:

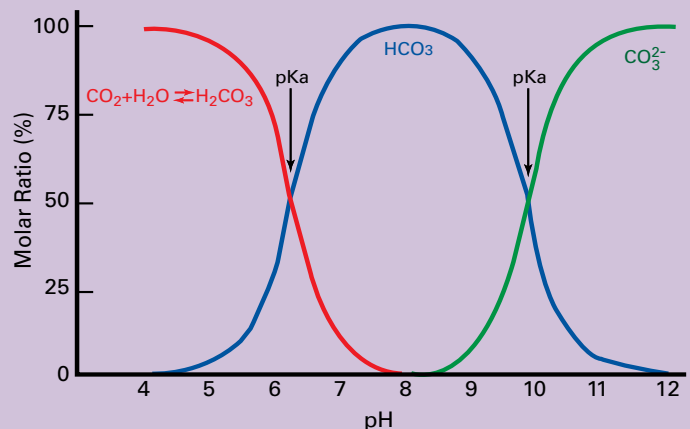


Initially dissolved CO₂ hydrolyzes into carbonic acid, which subsequently dissociates into carbonates and hydrogen ions. The hydrogen ions in turn reduce the pH. The CO₂ equilibrium is a function of pH as shown in the chart.

The actual amount of CO₂ required to achieve a given pH level is determined by two things: 1) the chemical equilibrium, and 2) the efficiency of the injection system.

CO₂ Equilibrium Relationships

The chart depicts the CO₂ chemical equilibrium shown in the equation. The curves depict the relative amount of each CO₂ species which exists at different pH levels. These curves are useful in estimating the CO₂ requirements to achieve a specific pH level.



Utilization

CO₂ is used in the Treatment of Effluents and Water Treatment

- Food and Pharmaceuticals
- Pulp and Paper
- Textile
- Cement and Concrete
- Municipal Water Filtration
- Municipal Sewage
- Salt Purification
- Refineries
- Electronics
- Aviation
- Chlor-Alkali and Vinyl
- Polymers and Plastics
- Petrochemicals and Chemicals

Shipyards: CO₂ is used for specialty laser control welding for higher durability.

Plastics and Chemicals Production: CO₂ is used to produce a variety of plastics and resins such as Melamine, Poly Urea, Urea Formaldehyde and related specialty polymers.

Fertilizers: CO₂ is used for the manufacture of Urea and Specialty Fertilizers.

Hydroponic Gardening: CO₂ utilization can be increased in the hydroponic gardens to produce a variety of fruits and agricultural products.



New Applications:

CO₂ can be used predominantly for the manufacture of:

- New Polymers and Plastics
- Specialty Chemicals and Fuel Additives
- Building Materials and Insulation

These petrochemicals, polymers & plastics and specialty products can supplement and compliment the existing and new industries.

Technologies Only Offered by Universal Technologies

Imagination is the Limit



UTC Marketing & Product Lines
P.O. Box 721260
Houston, Texas 77272-1260 USA
713 385-7478

www.unvtech.com

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