Carbon capture and air quality

Reduced pollutants, improved air quality, and health benefits

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Key takeaways

- Air pollution has a detrimental impact on human health, causing a wide range of adverse effects. Efforts to protect and improve air quality are vital to prevent associated health complications and reduce the burden of preventable illnesses.
- Emmissions from industrial and power facilities contain carbon dioxide (CO_2) and other pollutants. Amine-based carbon capture requires the removal of pollutants including nitrogen oxides (NO_x), sulfur dioxide (SO_2), and particulate matter (PM), for optimal performance.
- NO_x, SO_2, and PM can cause a range of health and environmental impacts.
- Improving air quality by installing a carbon capture system can lead to substantial health benefits for people around a facility, often leading to economic benefits in the tens of millions of dollars per year, from reducing emissions at a single facility.

Air quality and public health

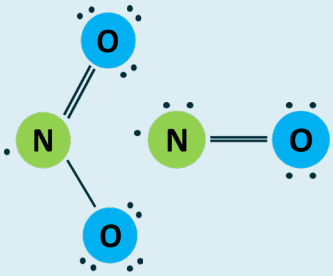
Clean air is crucial for maintaining good health and well-being for all individuals, regardless of age, gender, or background. Exposure to air pollution can lead to a range of adverse health effects, both short-term and long-term, from minor irritations to severe respiratory problems and chronic diseases.

Studies have shown that certain people are more impacted by air pollution than others, including those living in communities of color and low-income areas. To protect human health and reduce preventable illnesses caused by air pollution, improving air quality must be prioritized.

Air pollution comes from multiple sources, including industrial and power emissions. In 2016, air pollution from the oil and gas sector led to an estimated 77 billion dollars in health impacts. Carbon capture is one technology that can help the United States work to reduce these emissions and improve air quality by reducing pollutants including, SO_2, NO_x, and PM.

Pollutants

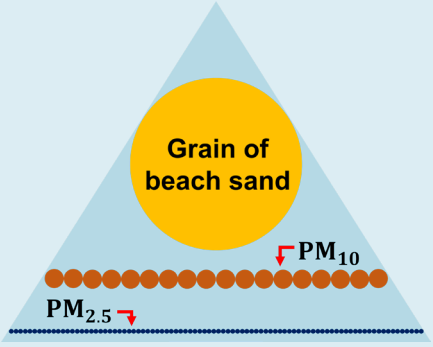
Nitrous oxides (NO_x)



When fossil fuels are burned, oxygen and nitrogen in the air react to create nitrogen oxides (NO_x), including nitrogen dioxide (NO_2) and nitric oxide (NO).

NO_x gases are harmful to the environment and human health. Breathing in NO_x over a long time can lead to respiratory diseases and make it easier to get respiratory infections. NO_x is also a major contributor to other types of pollution like ozone and acid rain.

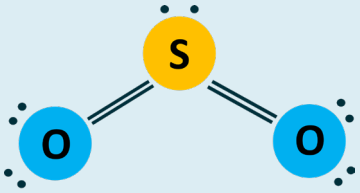
Particulate matter (PM)



Particulate matter (PM) are fine particles found in the air that can be formed through natural processes (e.g., dust, bacteria fragments), the combustion of fossil fuels, and the secondary oxidation of NO_x and SO_x. PM includes particles smaller than 10 microns (PM_{10}) and 2.5 microns ($PM_{2.5}$). Generally, smaller particles will be more harmful to environmental and human health.

Exposure to these particles can affect the lungs and heart, leading to problems such as increased respiratory issues, diminished lung function, and non-fatal heart attacks.

Sulfur dioxide (SO_2)



When some fossil fuels are burned, sulfur compounds in the fuels react and form sulfur oxides (SO_x), which are then released into the air. SO_x are composed of sulfur dioxide (SO_2) and sulfur trioxide (SO_3), with most atmospheric SO_2 resulting from fossil fuel combustion.

Breathing in high levels of SO_2 concentrations can have significant effects on public health. SO_2 leads to various harmful lung impacts, including wheezing, respiratory symptoms, and increased hospital visits.

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Carbon capture is a valuable technology for reducing the CO_2 emissions from power and industrial facility emissions. Although the primary goal of carbon capture is mitigating the climate impacts from industrial and power processes, adding a carbon capture system to a facility can provide additional benefits to people and the environment by removing harmful pollutants present in a facility's emissions. In addition to CO_2, facility emissions are often accompanied by other pollutants, including NO_x, SO_2, and PM, which cause poor air quality and have negative health impacts. Before CO_2 emissions from an industrial facility can be captured, the NO_x, SO_2, and PM must be removed for the system to work efficiently.

After NO_x, SO_2, and PM have been removed through a "scrubbing" process, the emissions enter an absorber tower, where the CO_2 is absorbed by the amine solvent. The solvent, which now has a high concentration of CO_2, is then sent to a stripper and heated with steam to release the CO_2. This pure CO_2 stream can then be utilized on-site or prepared for transport and sent to a permanent geologic storage location or reused to create various products. Once the amine solvent no longer contains the absorbed CO_2, it can then be recycled into the carbon capture system. For a detailed description of this process, see figure 1.

Carbon capture process

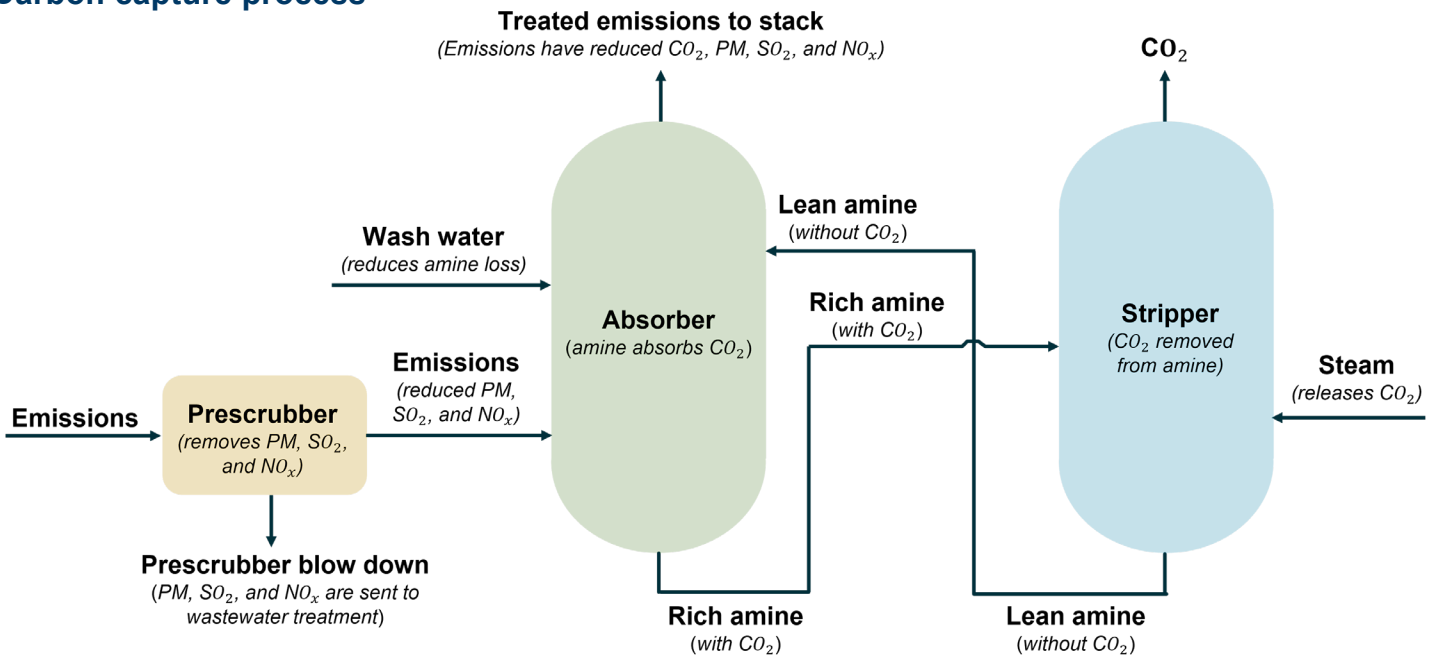

Figure 1: Simplified diagram of Shell's Cansolv amine-based carbon capture system based on NETL (2022)

Carbon capture health benefits

The health benefits of removing NO_x, SO_2, and PM as part of the carbon capture process vary widely, with conservative estimates indicating that using carbon capture on eligible facilities could lead to billions of dollars in total health benefits across the United States each year. These health benefits include reductions in mortality and asthma exacerbations. For more information on these health benefits, read the Great Plains Institute's carbon capture co-benefits factsheet or report.

Author: Emma Thomley

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For more carbon management resources related to carbon capture and air quality, visit the Carbon Capture Coalition, Industrial Innovation Initiative, Carbon Action Alliance, or Carbon Capture Ready websites or reach out to Kelley Reierson at kreierson@gpisd.net.

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