

<ONTOLOGY>

/704/106/35/824: Earth and environmental sciences/Climate sciences/Atmospheric science/Atmospheric chemistry

/704/172/169/824: Earth and environmental sciences/Environmental sciences/Environmental chemistry/Atmospheric chemistry

/706/689/694/2739: Scientific community and society/Social sciences/Climate change/Climate-change impacts

/639/638/169: Physical sciences/Chemistry/Environmental chemistry

<Title>

CO₂ but not as you know it

<Standfirst>

Jennifer Rudd reflects on how, in recent history, carbon dioxide has been largely vilified for its role in global warming. Yet responsibility for the current climate crisis lies squarely with humans, not a molecule that is crucial for life on Earth.

What might be the most demonised molecule on the planet? Perhaps hydrogen cyanide, the ingestion of which can cause comas and death? Or nicotine, an addictive component in cigarettes and the forerunner to bee-killing neonicotinoids? Another strong contender is hydrogen peroxide, which can be easily combined with acetone to make the explosive triacetone triperoxide (dubbed 'Mother of Satan') that was used in several terrorist attacks in recent years. But I argue that carbon dioxide, CO₂, is the most demonised molecule in recent history.

One of the first molecules to appear when Earth was formed 4.5 billion years ago, CO₂ has been key to the formation of the biosphere and is paramount for the continuation of life on Earth. It is essential for plant growth through the process of photosynthesis, and without it we wouldn't have the variety of fruit, vegetables and grains that we currently take for granted. Recently, it has been used to stimulate larger crop size in greenhouses.

Crucially, carbon dioxide in our atmosphere has made life on Earth possible for humans; by absorbing infra-red radiation from the sun and re-radiating it back to Earth, it has brought the planet's surface temperature to a life-supporting 15 °C, as opposed to -18 °C otherwise². It also dissolves in the ocean to form calcium carbonate (CaCO₃), the building block for marine shells and skeletons, thus enabling marine life to flourish.

The dissolution of carbon dioxide in potable water was used by sailors across the oceans after Joseph Priestley suggested it as a cure for scurvy¹. Priestley didn't profit from his idea, but J.J. Scheppe formed the "Schweppes" company in 1783, which still turns a profit to this day. This

drinks carbonation process is still applied, using CO₂ from various sources — including captured directly from the atmosphere, by the Swiss company Climeworks.

Carbon dioxide also serves as a carbon source in industrial processes to make urea (a fertiliser), salicylic acid (for aspirin) and as a green solvent in its supercritical form. With all these life-giving and productive effects, how did CO₂ gain such a bad reputation? The answer is of course global heating.

Eunice Foote first noted the warming effect of carbon dioxide in 1856 in her paper entitled “Circumstances affecting the heat of the sun’s rays”³. Her experiment involved her putting two cylindrical receivers containing thermometers in direct sunlight. One cylinder contained ‘common air’ and the other contained ‘carbonic acid gas’ (CO₂). Eunice Foote noted that “the receiver containing the gas became itself much heated (...) and on being removed [from direct sunlight], it was many times as long in cooling [compared to the receiver containing ‘common air’].” She also proposed that if, in history, there had been more CO₂ in the atmosphere, it would have resulted in a higher temperature on Earth. Five years later, but with no reference to Eunice Foote’s work, John Tyndall published a paper observing that carbon dioxide could absorb heat and he also made the link between increasing carbon dioxide concentrations and a change in the climate⁴.

Since the Industrial Revolution began in 1850 we have converted more and more hydrocarbons into carbon dioxide gas. This activity has increased the atmospheric concentration of CO₂ by almost 50%, (from 278 ppm to 417 ppm), and led to a surface temperature rise of 1.2 °C since pre-industrial levels. This is destabilising the planet, resulting in more frequent extreme weather events, famine, marine death, loss of habitat, rising sea levels and homes across the world being lost to the ocean, all leading to millions of climate refugees. Industrial clusters around the UK are piloting the capture of CO₂ from cement, steel and other heavy emitting processes. Year after year we are promised this as the ‘silver bullet’ to fix the climate emergency by the UK government but time is running out and no appreciable scale has yet been reached.

It would thus be easy to conclude by commenting on the power of such a small molecule to effect so much change across our planet. Actually, CO₂ is innocent in all of this. Rather than demonising the molecule we should celebrate it and treat it with respect. Carbon dioxide supports life on Earth. We humans are the reason our planet is becoming uninhabitable. We need to take responsibility for increasing the concentration of carbon dioxide in our atmosphere — and urgently act to slow global emissions. We need to take responsibility for increasing the concentration of carbon dioxide in our atmosphere — and urgently act to slow global emissions. I still have a modicum of hope that we can create a safer atmosphere, but there is no denying that we are in dire circumstances. What will you do to take charge of your own emissions, at home and at work?

References

1. Priestley, J.J. (1772), accessed through <https://wellcomecollection.org/works/bs6kgbcq/items?canvas=3>
2. Schmidt, G.A. *et al.*, *J. Geophysical Research*, **115**, D20106 (2010)
3. Foote, E. *The American Journal of Science and Arts*, Art. XXXI (1856)
4. Tyndall, J. *Phil. Trans. R. Soc.* **151**, 1–36 (1861)

Illustration

Alamy D5JG53