

reasonable doubt

Madam,

May I, through you, explain to Dennis Twist (*tce* 831, Sept 2010, p4) and others why I believe that there is genuine room for doubting that carbon dioxide causes climate change.

My first task when I joined ICI after graduating was to work on infra-red spectroscopy. I still remember that carbon dioxide absorbs only two narrow wavelength bands, as shown on the left and right ends of Figure 1. The wavelengths of the two bands are 2.7 μm and 4.3 μm . In contrast, water vapour absorbs, to varying extents, a large part of the infra-red spectrum (Figure 2).

The areas above the lines indicate the amount of carbon dioxide that is absorbed and show that water vapour absorbs about 25 times more than CO_2 . About 95% of the greenhouse effect is therefore due to water vapour and CO_2 contributes most of the remaining 5%. If anyone wants to confirm the estimate of 95% they can do so by measuring the areas above the lines in the two figures.

In addition, most of the CO_2 in the atmosphere is said to come from the oceans and animals, and only 3–4% from human activity. Its contribution is thus a negligible part of the total.

“ The climate has been getting warmer for the last 20,000 years, not uniformly but interrupted by occasional large or small cold periods ”

It is remarkable that little attention has been paid in the huge literature on global warming to the different absorption abilities of water vapour and CO_2 . Unfortunately, many people, whatever their views, have strongly held mind-sets.

The climate has been getting warmer for the last 20,000 years, not uniformly but interrupted by occasional large or small cold periods. There was a small cold period in the mid-20th century and we do not know when there will be another. Instead of trying to change the climate we should be learning how to cope with a warmer one. Perhaps our plan B should be considering how we could cope with another cold spell.

Trevor Kletz *FIChemE*

Visiting professor, Loughborough University, UK

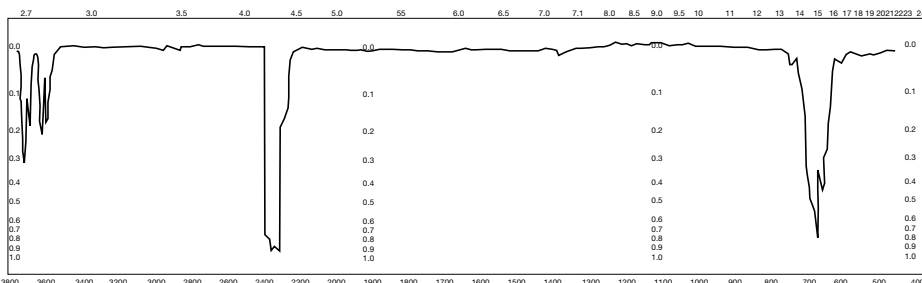


Figure 1: Carbon Dioxide absorbs infrared waves only on two narrow wavelengths

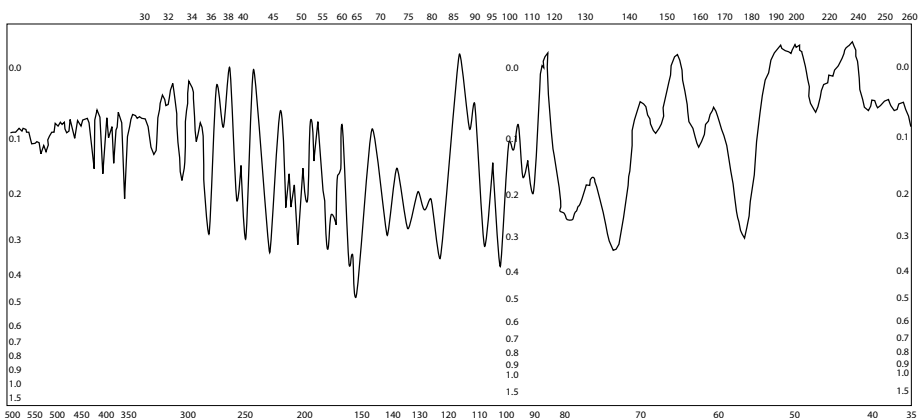


Figure 2: Water vapour absorbs infrared across a broad spectrum

(both figures from Nyquist, Putzig and Leugers: *Handbook of Infrared and Raman Spectra of Inorganic Compounds and Organic Salts, Volume 3. Academic Press (1997)*)

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Madam,

Regarding Malcolm Leach's letter (*tce* 832, October 2010), my reaction to Trevor Kletz's apparent climate change skepticism was one of surprise, not criticism – and I now express my surprise that while Mr Leach accepts the reality of global warming he doubts the link with carbon dioxide. May I refer him, and other skeptical readers, to the September 2010 report (*Climate change: a summary of the science*) published by the Royal Society, surely the most independent and trustworthy body of distinguished scientists in the UK. Here is the first sentence of the report's conclusions: "There is strong evidence that changes in greenhouse gas concentrations due to human activity are the dominant cause of the global warming that has taken place over the last half century". For a more detailed technical account of the science, visit www.bis.gov.uk/go-science/climatescience.

Dennis Twist

Clun, Shropshire, UK

Madam,

I am concerned and puzzled as to why Trevor Kletz (*tce* 831, September 2010) and Malcolm Leach (*tce* 832, October 2010) think that CO₂ may not have a significant climate change effect. They presumably accept it is a greenhouse gas but the climate change misinformation machine is highly efficient and many readers may have adopted erroneous theories. These are common examples:

1. Excess CO₂ will be absorbed by the oceans. This was countered by Roger Revelle's ocean studies in the 1950s showing that carbonate, bicarbonate and carbonic acid form a three-way equilibrium limiting CO₂ absorption. (The work paid for Keeling's CO₂ monitoring station on Mauna Loa)¹.
2. CO₂ and H₂O heat absorption spectra overlap so are not additive. Early spectrometers show continuous spectra with the profile of an on-coming bird. But high altitude US Air Force planes with modern equipment see true quantum spectra as a 'picked fence' of individual lines with enough gaps for all the greenhouse gasses. In practice, if infrared radiation is not absorbed by one layer it simply goes to the one above¹.
3. Water vapour absorbs more heat than CO₂. This is true. But water vapour increases when greenhouse gases warm the ocean so it amplifies the greenhouse effect. Professor Richard Lindzen of MIT claims that climate models overestimate water vapour feedback



“there is strong evidence that changes in greenhouse gas concentrations due to human activity are the dominant cause of the global warming that has taken place over the last half century”

but his recent paper cherry-picks result to verify his theory².

4. Aerosols are melting the Himalayan glaciers. This is partially true. But aerosols are emitted by human activity and included in climate calculations¹.
5. Human CO₂ emissions are insignificant compared with natural emissions. NASA CO₂ mass balance shows fossil fuel, forestry and farming as about 4% of total emissions. The Keeling Curve of CO₂ on Mauna Loa (use Google) shows steady CO₂ growth accounting for about 60% of human emissions. So natural processes are absorbing more CO₂ or emitting less! The atmospheric CO₂ shows increasing C12 isotope, which is a clear fossil fuel signature.
6. Clouds will increase to reflect sunlight. Clouds are being intensively studied by satellite. High altitude cirrus produces net warming by reflecting heat downwards. Cumulus varies depending on water vapour and ice structures. Available cloud data is kept up to date in the climate calculations.
7. It's just a natural process. Maximum temperature rise at the end of the last ice age was at 1°/1000 years. The current rate is 1°/100 years and accelerating! CO₂ played

a leading role in this and clouds did not prevent it!

8. Current warming is insignificant. Glaciers are melting at both poles. Rising sea levels and drought are consuming fertile land, increasing forest fires and Methane emissions. Engineers know how long it takes to implement new technology globally. But only a decline in greenhouse gas concentration will finally allow heat to escape and the sea to begin to shed its vast reserve of heat. It will take more than 100 years to achieve this even if we start now³. We must do it!

David Skinner

Knutsford, UK

References

1. American Institute Physics. www.aip.org/history/climate/index.htm#contents
2. www.realclimate.org/index.php/archives/2010/01/lindzen-and-choi-unraveled/
3. www.pnas.org/content/early/2010/08/20/1008153107

Madam,

In response to last month's letter from Malcolm Leach, I believe chemical engineers should not rely on the debate about whether carbon dioxide is responsible for global warming as an excuse to delay development of the analytical tools needed to quantify and compare the carbon footprint or energy return on energy invested of the processes we design. Some of these processes, such as those used to monetise stranded hydrocarbon assets, have large embodied energy contents and are carbon intensive in operation. Others, such as those that seek to sequester carbon, lower the operating efficiency of power generation plants and raise utility demands, most particularly cooling water.

We live in times where the planet's ability to accommodate emissions from industrial processes (be they to the atmosphere, water or the soil) continues to give cause for concern. Chemical engineers therefore need to be extremely mindful of the public and regulatory response should warnings about climate change come to pass and we were seen not to have taken a precautionary stance in respect to quantifying the risks and potential liabilities associated with the release of carbon dioxide, methane and other greenhouse gases (GHG) into the environment.

It should also be a concern to the Institution that other groups are taking a lead in formulating procedures and codes of practices to record and quantify such emissions. Amongst many examples, one can point to the GHG Protocol's work to



Energy numbers don't add up

Madam,

I have just returned from Rome where I chaired a seminar on EU Energy Security. As you point out in your excellent editorial (*tce* 832, October 2010), the Italians reversed their disastrous policy to phase out nuclear power in 2008. In terms of security, and reducing emissions, they are well aware of the future importance of nuclear power in their energy portfolio. However, despite a great deal of talking, the Italians present, including a former prime minister and other ministers and civil servants, assured me that new build nuclear in Italy was most unlikely to happen. Speaker after speaker, MPs and CEOs of green NGOs, put the same points they have been putting for the last 20 years: "We do not know how to store radioactive waste" (the UK has been doing it successfully at Sellafield for 50 years); "Nuclear is too dangerous to use" (compare the accident rate with coal or hydro); and "It is too expensive" (the UK's energy department last year estimated nuclear generation costs at £51/MWh (\$80MWh), coal £54/MWh, onshore wind £88/MWh, and offshore at £122/MWh).

Like the Bourbons, they seem to have learned nothing and forgotten nothing, but nobody got up to refute the accusations, except the chairman, because there was only one engineer present and he was CEO of a renewable energy company. They were all economists, high-powered journalists, politicians and the like. So where are the pragmatic engineers? Why do they not leap to defend the industry on public platforms, consultations or in print? Far too few of them do, and it is difficult for the nuclear industry to defend its position as they are immediately accused of bias. More independent engineering advocates are required who will stand up to be counted and who are prepared to be pro-active.

Energy arithmetic can help to clear some of the misconceptions which arise when comparing nuclear with wind. A new 1650 MW EPR nuclear station costs £5b to construct, an offshore wind farm of the same nameplate capacity, at £3m per installed megawatt, would cost about the same, £4950m.

But with a load factor of 30% for wind, even without taking into account the back up required when the wind does not blow, to average 1650 MW output would cost £15b, three times the nuclear cost for the same output! If, in addition the lifetime of the wind farm is taken (optimistically considering its environment) as 20 years, and a nuclear station lasts 60 years, the wind farm will have to be replaced three times over the next 60 years to match the nuclear station. So the cost of an offshore wind farm is nine times that of an equivalent nuclear station!

Ian Fells FIChemE

Emeritus professor of energy conversion, Newcastle University, UK

develop a product and supply chain standard (www.ghgprotocol.org/standards/product-and-supply-chain-standard), the University of Bath's efforts to quantify the embodied energy content of materials of construction (www.bath.ac.uk/mech-eng/sert/embodied/) and McKinsey & Co's work to cost GHG abatement curves (www.mckinsey.com/client-service/ccsi/Costcurves.asp). It may also be noted that the International

Federation of Accountants (IFAC) has even proposed that only professionally qualified accountants be authorised to assure GHG emissions statements (www.ifac.org/Guidance/EXD-Details.php?EDID=0132). The Institution's sole contribution to date appears to be the publication some eight years ago of a procedure covering sustainable development metrics in the process industries (www.icheme.org/

[sustainability/metrics.pdf](#)).

I would be interested to learn if other members of IChemE feel that chemical engineers should take a more proactive role in accounting for carbon and emissions of greenhouse gases or whether, as Malcolm suggests, we should leave things until future surveys show the public has had a change of heart about climate change.

Robin Huttenbach

London, UK

Madam,

I concur with Malcolm Leach's comments (*tce* 832, October 2010) regarding Dennis Twist's implied criticism of Trevor Kletz's view of the alleged link between atmospheric CO₂ concentration and global warming. I add the following in support.

That climate varies is not in dispute – the geological record demonstrates this beyond doubt. What is very much in dispute is the part played by anthropogenic emissions of CO₂. We are told by supporters of the new 'green religion' to accept the consensus view that "the science is settled". As far as I and many others are concerned, the science is far from settled. As Michael Crichton put it: "I regard consensus science as an extremely pernicious development that ought to be stopped cold in its tracks; it is a way to avoid debate by claiming that the matter is already settled. Whenever you hear the consensus of scientists agree on something or other, reach for your wallet, because you're being had."

"Let's be clear: the work of science has nothing whatever to do with consensus. Consensus is the business of politics. Science, on the contrary, requires only one investigator who happens to be right, which means that he or she has results that are verifiable by reference to the real world. In science, consensus is irrelevant. What is relevant is reproducible results. The greatest scientists in history are great precisely because they broke with the consensus."

"There is no such thing as consensus science. If it's consensus, then it isn't science. If it's science, it isn't consensus. Period."

As far as the media is concerned, only 'bad' news sells newspapers – and generates research grants.

Leslie Heelam

Warrington, UK

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