**Sponges are great aren’t they? Super absorbent materials that you can just dab onto whatever it is you clumsily spilt this time, safe in the knowledge it’ll soak it all up and keep you out of trouble!**

**And that’s kind of how we’ve been unwittingly treating our oceans for the last couple of hundred years, except it’s not excess liquid that they’ve been mopping up, it’s excess carbon dioxide from the atmosphere. In fact, it’s reckoned that our oceans have absorbed at least thirty percent of all the CO2 we humans have spewed out since the start of the industrial revolution, and by the way more ninety percent of the excess heat too. If they hadn’t have done that then our average surface temperature would be more than double what it is now, and I wouldn’t be sitting here talking to you because I’d be dead.**

**But sponges have their limits don’t they. If you completely drench them then they start to leak, because they just don’t have any more space to absorb any more stuff.**

**And in a similar way, as we humans rapidly change the ocean’s carbon balance, we’re reaching the limits of how much CO2 can be absorbed before the oceans start breathing some of it back out again in a process the scientists refer to as degassing.**

**Now, when a sponge starts dripping water all over your floor you can be fairly sure it’s saturated and at that point, if you had any sense, you’d find somewhere to wring it out so it could regain its absorbency.**

**And that’s quite a good analogy for the proposal in a recent paper from a research team at UCLA which outlines a method for capturing carbon dioxide from our oceans at the kind of gigaton scale that could genuinely make a meaningful impact on our climate mitigation challenge.**

**So, is this yet another exercise in wishful thinking, or have we got ourselves a potential winner?**

***“Are you gonna clean that up?”***

**Yes…**

**Hello and welcome to Just Have a Think.**

**This whole ocean CO2 concentration thing doesn’t really get quite as much attention as it probably deserves. The fact is we’re extremely fortunate that about seventy percent of the planet is covered in water, and that water, by volume, just happens to have the ability to hold onto about a hundred and fifty times more carbon dioxide than the air. That rather serendipitous physical phenomenon has, at least so far, saved us humans and all the other species we share the land with from far more severe climate change impacts than the ones we’re already witnessing around the world today.**

**But there’s a price to pay for all that surplus carbon dioxide in the upper layers of our oceans. It upsets delicately balanced ecosystems, resulting in damaging consequences like marine heatwaves, species migration and ocean acidification.**

**Reducing the levels of CO2 in our oceans would therefore, at least on the face of it, seem like a good way to slow down or even reverse those consequences and restore the marine balance. But the atmosphere and the oceans are in a state of equilibrium, so if we did find a way to reduce the levels of CO2 in our oceans, then to maintain the equilibrium, the oceans would react by absorbing more CO2 back out of the atmosphere. Now, it just so happens that removing carbon dioxide from our atmosphere is precisely what the Intergovernmental Panel on Climate Change, or IPCC tell us will be essential in the coming decades if we’re to stand any chance of keeping planetary warming within safe limits. So, the challenge is to find an ocean carbon dioxide removal method that doesn’t cause even more shocks and disruptions to marine ecosystems, while removing CO2 at a scale of billions of tonnes per year and storing it durably so that it can’t seep back into the system.**

**That’s a pretty seriously complicated conundrum, but in this research paper published in twenty-twenty-one, the UCLA team outline a method that they reckon might just do the job.**

**Interviewed in an article for the UCLA newsroom, the paper’s senior author, Gaurav Sant explains**

**“To mitigate climate change, we need to remove carbon dioxide from the atmosphere at a level between 10 billion and 20 billion metric tons per year. To fulfil a solution at that scale, we’ve got to draw inspiration from nature.”**

**The system that Sant and his co-authors are proposing is called ‘Single Step Carbon Sequestration and Storage”, or sCS squared, and in basic terms it works like this.**

**Sea water is drawn up into a flow reactor and through an electrically conductive stainless steel mesh which acts like a cathode in a battery and causes electrolysis of the water. That increases the concentration of hydroxide ions which facilitates chemical reactions between the carbon dioxide and calcium and magnesium that are naturally present in seawater to produce solid limestone and magnesite in a process very similar to how seashells are formed, only at a vastly accelerated rate.**

**The seawater that flows out of the other end now has far less carbon dioxide dissolved in it and it can be returned back to the ocean.**

**The solid limestone and magnesite mass that builds up on the mesh itself can then be removed using a rotary drum and it too can be returned back into the ocean where it’d take it’s chemically captured carbon dioxide to the seabed in a solid state that would effectively remain permanently stable.**

**Now, any chemistry teacher watching this might gently point out that electrolysis of salt water produces chlorine gas at the anode, which is nasty, and at the scale these guys are talking about, it’d be extremely dangerous if it got into the local atmosphere, so the UCLA system would need to incorporate special coatings in the anode, or a commercial adsorption technology like activated carbon to soak up the chlorine and stop it getting airborne.**

**But water electrolysis also produces hydrogen gas, which could be an extremely valuable by-product if it was integrated into the right infrastructure. And the system could also be a perfect compliment to existing desalination facilities, providing pre-softened water for the processing plant, reducing the overall cost and energy demand of the desalination process by something like nine percent, according to the UCLA research team.**

**The team also calculated that their sCs squared carbon removal technology would use far less energy than existing direct air capture technologies currently in development. That energy would ideally come from renewable sources like wind and solar. In fact, it could prove to be a useful way to utilise excess power generation from those intermittent sources which would otherwise be wasted through the process of curtailment, where renewable power generators have to be periodically shut down to prevent grid overloads.**

**The “single-step” in the name differentiates the UCLA proposal from atmospheric carbon dioxide capture technologies which invariably require the captured CO2 to undergo multiple concentration processes before it can be stored. And those atmospheric carbon capture systems generally involve storing the CO2 in geological formations like depleted natural oil and gas reservoirs, where there’s a risk of the gas leaking back out and escaping up into the atmosphere. By contrast, the sCS2 concept would durably store carbon dioxide in the form of solid minerals.**

**As Gaurav Sant points out**

**“What’s nice about turning carbon dioxide into a rock is, it’s not going anywhere,”**

**The science bods have calculated that the amount of carbon currently stored on our ocean seabeds, in the form of these solid carbonates and bicarbonates, is about fifty times more than all the carbon in our atmosphere, so we know that even relatively minor increases to that ocean carbon storage vault could produce huge reductions in atmospheric CO2 concentrations.**

**The scale and cost of the infrastructure required are a bit eye watering though! The team carried out detailed analyses of the material and energy inputs, as well as the costs involved in running the system and dealing with the various by-products. By their calculations, to remove ten billion metric tons of carbon dioxide from the ocean per year, the world would need to construct about eighteen hundred of these facilities in strategic coastal and river delta locations around the world, and the up-front capital expenditure would run to trillions of dollars. But climate mitigation at the scale now required IS going to cost money, whichever methodology we choose to employ. What’s required is the political will to find that money. It can be done though. After all, our world leaders managed to find several trillion dollars almost overnight when the clear and present danger of COVID 19 presented itself, didn’t they? And all the major global financial institutions like the IMF, the World Bank, and even hard-nosed asset managers like Blackrock, now agree that if we don’t take rapid and radical action now then the financial consequences of future extreme climate events will completely eclipse the costs of implementing mitigation measures today.**

**“We should be clear” says Gustav Sant “Managing and mitigating carbon dioxide is foremost an economic challenge.”**

**“We have tried to use a lens of pragmatism to consider how we may be able to achieve synthetic interventions at an unprecedented scale, while considering the finite energy and financial resources we have.”**

**What we’ve got here though is essentially a form of geoengineering, and while the UCLA team do go to some length to assess and quantify the potential knock-on effects of tinkering with nature’s eco-systems at this kind of scale, there is still a risk that initiatives like this may do more harm than good in the long term.**

**And there’s another school of thought that says we can achieve similar levels of decarbonisation in a biological rather than a geological way by cultivating the growth of photosynthesizers like kelp, seagrass meadows and mangroves, all of which can suck up far more CO2 by volume than our land-based rain forests. It’s something we looked at on this channel a couple of years ago, and I’ll leave a link to that video up there somewhere. But even here, the long-term effects of our interference on delicately balanced ocean ecosystems are not yet fully understood.**

**It was the subject of some considerable debate at the recent World Ocean Summit Week. Here’s Brad Ack, the Chief Innovation officer of a decarbonisation startup called Ocean Vision, discussing the challenge during the event.**

**4:57 “We don’t know enough yet to know which ones are going to be the most successful the least harmful, most positive, so we need a great deal more research and development and testing in water I multiple replicates all around the globe to be able to answer the question that you asked” 5:18**

**And of course, the other major caveat with any carbon dioxide removal or CDR scheme is that it’ll only work if it runs alongside very large, very rapid and very genuine reductions in energy consumption and greenhouse gas emissions in industry, commerce, food and transport systems across the globe. If governments and corporations look at CDR as an excuse to carry on business as usual then whatever system we choose will turn out to be an extremely expensive waste of time and money.**

**As usual, leave your thoughts in the comments section below, but that’s it for this week.**

**Thanks to our amazing Patreon supporters who allow me to keep this channel completely independent and ad free, and a quick shout out to some folks who’ve joined recently with pledges of ten dollars or more a month. They are**

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**As always, thanks very much for watching, have a great week, and remember to Just Have a Think.  
See you next week**