**In November twenty-twenty-four an intergovernmental negotiating committee met in Busan, South Korea in an attempt to finalise the details of something called the Global Plastics Treaty. Did they absolutely nail it and agree legally binding measures to curtail the scourge of plastic waste once and for all.**

**What do you think?**

**No, there were rows about whether to limit plastic production in the first place or to just focus on waste management, and there was fierce debate about how to balance mandatory regulations with voluntary commitments.**

**Gotta love those ‘voluntary commitments’, haven’t you?**

**And there were the now ubiquitous disagreements over financial support for developing nations.**

**The session was ultimately adjourned with a rather insipid text that basically said let’s come back next year and try again.**

**It’s the sort of thing that makes you want to tear your hair out**

**…assuming you’ve got hair obviously.**

**Anyway, as usual, while the politicians and international lawyers go round and round in circles tying themselves in bureaucratic knots, teams of scientists and engineers all over the world have been quietly getting on with developing solutions to the problem.**

**One of those teams is based at the Riken University of Tokyo, Japan, and they reckon they’ve got a new type of plastic that dissolves in sea water in just a few hours leaving no microplastics, and degrades in soil in a few days, providing nutrients for subterranean ecosystems.**

**A bit too good to be true? Well, let’s have a look.**

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

**Before we get stuck in, it’s time for a shameless plug on behalf of my good friends over at the Fully Charged and Everything Electric channels. I’m delighted to say that they’ve invited me back to be a moderator for several of the discussion panels at the Everything Electric LIVE show being held at Excel London from Wednesday the sixteenth to Friday the eighteenth of April. All the usual attractions will be there, from home energy generation and storage solutions right through to the latest EV models AND electric COMMERCIAL vehicles. Plus, there’s loads of fun stuff to keep the kids occupied. Ticket prices have been slashed this year as well, to make the event as accessible as possible to as many people as possible. AND if you use the Just Have a Think discount code at the bottom of the screen now, you’ll get an extra twenty percent off that already reduced price. Absolute bargain! So follow the link in the description to the Everything Electric tickets sales page, pop the dates in your diary, and I look forward to seeing you there.**

**Right…plastic waste then.**

**Let’s just quickly go back to that Global Plastics Treaty that I mentioned at the start of the video.**

**I wonder if you can guess which nations opposed any limitations on plastic production.**

**It was of course all the main oil-producers. What a surprise, eh?**

**Now don’t get me wrong, we do need plastics if we want to maintain the global civilisation that we now live in.**

**As we all know only too well, plastics have given us almost everything, from communication technologies to food safety and medical hygiene. Without them we’d be back to Victorian levels of ignorance, disease and general rubbishness, so let’s not throw the baby out with the bath water here. BUT, do we really need all the pointless tat and widgets and coffee stirrers and plastic cutlery and fast food toys and single use bags and all the other nonsense that make up a good proportion of the roughly four hundred and fifteen million tonnes of plastic that get churned out each year, ninety-one percent of which ends up either in landfill or incinerators or the oceans? I don’t think so.**

**They’re just a by-product of an industry desperately looking for ways to maintain their current levels of oil and gas consumption as the world moves away from a fossil fuelled energy system towards renewables like wind, wave, solar and geothermal energy. That’s an entire discussion in its own right, which I had with industry expert Paul Martin a few months ago. And you can jump back to that video by following the link in the description or by clicking up there somewhere.**

**Some say BIOplastics are the answer. After all, they’re renewable, biodegradable and eco-friendly, right? Well, no, not so much. As we discovered in another previous video, to replace anything like a significant proportion of fossil plastic would require more land than is realistically available.**

**According to a twenty-eleven study, the production of a metric tonne of a bioplastic called PLA uses roughly two and a half tonnes of corn. Replacing just ten percent of fossil plastics with PLA would therefore need an area of land roughly the size of England. And that would be in addition to the already huge tracts of land we humans have commandeered to make bioFUELS. That’d mean massive levels of deforestation, and it would put enormous pressure on our ability to grow food for our own consumption and for animal feed. PLUS bioplastics like PLA are no more water soluble than normal plastics, so if they find their way into the ocean, which they often do, they don’t dissolve, they just break down into microplastics that harm aquatic life, get into the food chain, and eventually end up in the metabolisms of human beings who eat seafood.**

**And all of that brings us nicely to the main focus of this slightly rambling monologue, which is this recent research paper from a team at the Riken Centre for Emergent Matter Science or CEMS, headed by an internationally renowned chemist called Professor Takuzo Aida.**

**Aida and his team have developed a class of material known as supramolecular plastics, which in plain English means polymers with molecular structures that are held together by reversible bonds, or to give them their proper name, non-covalent interactions.**

 **That sets them apart from petrochemical plastics, all of which have very strong permanent covalent bonds, which is what makes them so difficult to break down.**

**Now here’s where it gets a bit sciency, so bear with me.**

**Apparently, the researchers combined two different ionic monomers to form what they call cross-linked salt bridges. One of those monomers was a common food additive called sodium hexametaphosphate which is derived from phosphate rocks and sodium carbonate or soda ash. The other was a guanidinium ion-based monomer.**

**What the heck is that I hear you cry. Well, not to put too fine a point it, it’s bird sh\*t. Well, that’s what it was originally derived from anyway. The posh word for bird sh\*t is of course guano, and back in the nineteenth century a rather obsessive scientist called Adolph Strecker, for reasons best known to himself, spent a lot of time wading through the guano of birds in Peru, and he discovered that as it gradually rotted away it oxidised into a material that he called guanidine. I mean the days must have just flown by!**

**Anyway, the bottom line is that guanidine contains nitrogen, which is useful.**

**Modern science has found a way to synthesise guanidine, usually from ammonium-derived compounds.**

**A guanidinium ion has a central carbon atom that’s double bonded to a nitrogen atom with two additional nitrogen hydroxide groups attached. It’s very alkaline or basic, it’s water soluble and it’s capable of forming strong hydrogen bonds and ionic interactions, which is why it makes such a good partner to sodium hexametaphosphate.**

**Now, we WILL have a look at the environmental and energy costs of extracting and processing those two different materials a bit later in the video, but first of all, let’s have a think about how they combine to make a plastic.**

**The key here seems to be that salt bridge that I mentioned earlier. When the Riken team mixed sodium hexametaphosphate in water with a form of guanidine called alkyl diguanidium sulphate, the mixture separated out into two layers, one very watery and the other much thicker and more viscous. That thick layer contained strong cross linked salt bridges that bonded the two monomers together into a polymer. The Riken researchers found that they could dry this layer out to produce a useable plastic called alkyl SP2**

**In that new material, the salt bridge structure is irreversible, UNTIL it gets exposed to electrolytes like those found in seawater, which reverse the interaction and destabilise the plastic in just a few hours.**

**Now obviously that limits the number of applications for this new material, but nevertheless there are some significant upsides to producing a polymer like this. It’s non-toxic and non-flammable and, unlike fossil plastics, it can’t produce any carbon dioxide emissions.**

**It can be reshaped, just like other thermoplastics, at temperatures above a hundred and twenty degrees Celsius, and by testing different forms of guanidinium sulphates, the team was able to generate plastics that had varying hardnesses and tensile strengths, all of which, at least according to them, were comparable to or better than conventional plastics.**

**But the real plus point here is genuine recyclability. The researchers found that by dissolving the plastic in salt water they could recover ninety-one percent of the hexametaphosphate and eighty-two percent of the guanidinium as powders. That has to be up there as one of the simplest and cheapest recycling processes anyone’s ever come up with.**

**So that’s nice.**

**And when they buried a sheet of alkyl SP2 in a bed of soil they found that it completely degraded over the course of ten days, releasing phosphorous and nitrogen, both of which are extremely useful for the microbes that support plant life.**

**So that’s nice too.**

**But nothing is free in this world, is it? There is an energy cost to all human activity, and this stuff is no different. Phosphate rock has to be mined and transported to a processing plant where its treated with sulphuric acid to make phosphoric acid which is then neutralized with sodium carbonate to form the sodium phosphate salts that are then heated up to about six hundred degrees Celsius to produce sodium metaphosphates that cool down to become sodium hexametaphosphate. It is a genuinely recyclable material though, unlike most of the fossil plastics, and the overall energy costs of its extraction and production have been estimated to be between ten and fifteen gigajoules per ton compared to something like twenty-seven Gigajoules for fossil derived polyethylene. And of course it’s not derived from hydrocarbons like oil and gas so there’s no intrinsic carbon dioxide problem there either.**

**As for Guanidine?**

**Well, according to** **this** **twenty-nineteen paper the traditional method for producing guanidine synthetically is also quite energy-intensive, especially in comparison to other nitrogen compounds like ammonia or urea. The current method, known as the Frank–Caro process, is about eight times more energy-intensive per fixed nitrogen atom than the Haber–Bosch process used for making ammonia​. And of course if that energy is derived from fossil fuels then we’re back to having to worry about CO2 emissions again. So, although it’s a very efficient process with a more than ninety percent yield rate, in its current form, guanidine production is not considered sustainable by modern standards.**

**That little wrinkle has driven interest in alternative, biological production using engineered microbes that fix carbon dioxide and nitrogen into guanidine, all powered by photosynthesis and conveniently bypassing the energy-intensive inorganic route. Those efforts are still only experimental though, so for the time being at least, it’s all a little bit ‘Houston we have a problem’.**

**It’s annoying isn’t it? Just when you think someone has come up with a nice benign solution to one of the problems of modern day life, it turns out there are some not insignificant energy and environmental costs when you scratch the surface a little bit. The reality of course is that there IS no BENIGN solution to human consumption. Everything we humans do places a material and energy burden on our planet. Our task is to do as little damage as possible by moving away from very obviously harmful stuff like burning fossil fuels and tearing down country-sized areas of forestry land, and you know, maybe just thinking a bit more carefully about all the throw-away stuff we use every day, so we start to manage the finite resources of our planet a bit more sensibly.**

**Anyway, you will no doubt have your view on that one, so if you’re champing at the bit to express that view right now, then as always the place to leave your thoughts is in the comments section below.**

**That’s it for this week though.**

**Thanks, as always to the amazing folks over at Patreon, who help me keep this channels content completely independent and free of ads and sponsorship messages. If you find these videos useful and interesting and you feel you could support the work I do here each week at Just Have a Think then jump over to Patreon dot com forward slash just have a think to find out how you can join the team and have a look at all the exclusive perks you can get there, including additional Patreon-only videos and monthly content polls.**

**Don’t forget to visit the Everything Electric LONDON website to check out what’s on and get your discounted tickets using the Just Have a Think code.**

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**Most important of all though, thanks very much for watching! Have a great week, and remember to just have a think.**

**See you next week.**