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- Mike: Hello, everyone. I'm Mike Urbans, and welcome to It's Your Water. I'm glad you found us. Way back in April this year, 2023, we did a resin refresher with the famous Bill Koebel of ResinTech, and Bill's here with us now. Hi, Bill. Welcome back.
- Bill: Hey, good morning.
- Mike: Welcome back.
- Bill: Thanks, Mike. I think I'm more infamous than famous, but I appreciate the compliment.
- Mike: Well, Bill and I really went into geeking out about resin And I love Bill's style of education, so we have him back here for Resin Refresher 2. So if you missed Resin Refresher 1, go back and listen to it because we went through resin lifespan, resin fouling, resin construction, the percentage of cross-linking, what makes resin strong and durable, or not durable. We went into resin - physical color of resin and some pH drop, which kind of segued us - pH drops was into the anion. So that's where we're going now. Cation resins are like - kind of like the working diesel truck of the water treatment industry, but they're kind of boring, right - right, Bill? I mean, really.
- Bill: Oh, yeah.
- Mike: Yeah.
- Bill: And, I mean, it's - it's doing the same thing over and over again.
- Mike: Over, and over, and over.
- Bill: Not as - not as fancy, you know?
- Mike: Yeah. But anion resins, whoa, that's where we get into the good stuff, the really cool stuff like nitrate removal, PFAS, we know these forever chemicals, right? Anions for tannins, we've always used the tannin resins, and we also want to go into - oh, anion for arsenic, right? Forgot that. And we're probably going to sum it up with silica, explained. Everybody - I - I get a lot of calls about silica, so I want to get Bill's perspective on silica. But getting back - starting out with anion resin, and we talked about it in Part 1, but what makes an anion resin be able to, like, focus on these things, like nitrates? I know they have dual purposes, like, where they'll do nitrates and they'll do tannins, you know, but what really make an anionic resin so different than the boring old cation?
- Bill: Sure. Well, I mean, obviously, the functional groups are different. So when we talk about cation resin, you know, we're removing hardness and iron, things like that, right? They are cationic species. The functional group on a cation resin is



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really anionic. So when you think of a cation bead, it's actually a big ball of anionic charge, negative charge. So an **anion resin is just the opposite, it's a big ball of positively charged functional groups which are mean in nature.** I always call them **organic ammonia.** You know, **it's what causes that lovely fishy smell** that we get to talk about all the time, right? And depending on what we're looking at doing - so there are different versions of those resins that we call specialty resins that, yeah, we'll use those for removal of nitrate resin we call - is just a different functional group. When we talk about the PFAS resin, that's just a different functional group but it's all the same type chemistry. It's all in a mean functional group attached to this plastic back bound, and they all smell like fish but they're all designed to do a different thing. So when we talk about nitrate removal and using a quote/unquote nitrate selective resin, what that really is, is a resin that is not selective for higher charges. So if you think about nitrate, that's a minus 1 charge, and there's other things in the water, like sulfate, that have a minus 2 charge. So those selective, or specialty, or nitrate resins, as we call it, really what they are, are resins that are deselected, don't like mean, don't like minus 2 charges. And the reason that works is, the technical term is sterically hindered, the functional groups are just bigger and there's more in the way. And I want you to think about how selectivity works. Those functional groups, one on one, have a certain selectivity for, say, one charge. But when you bring in two into the equation, meaning there's a minus 2 charge or even a plus 2 for a cation, you need two functional groups close together to make it work properly. When we say sterically hindered, what we're really saying is the functional groups really act like they're further apart so that the ion that you're trying to attach really can't reach 2, it can only reach 1. So when a very high selective minus 1 charge comes in, it's going to knock that minus 2 out of the way, and that's really how it works. And there are other highly selective minus 1 charges, that's what the PFAS chemistry is, right? PFASs are negatively 1 charges, there's - there's not really - I don't want to get into it, but it's not true lying change per se, but the attraction of the PFAS chemistry is that one to one charge pull. We also use selective resin like this for perchlorate removal, that's also a minus 1 charge. So those are kind of the big three minus 1s that we deal with, right? When we get into things like hexchrom, for example, or - and we want to take phosphate out for whatever reason, those are higher valences, those are minus 2 charges. So those - the resins we really use for that are not quote/unquote selective, they're just really standard anion resins that we use every day, right? Now, you get into things like tannins, that's more about the structure of the resin than it is the functional group, so that's a little bit different mechanism.

Mike: Yes. That's - that is the fringe science that - it's hard to understand and hard to explain, if you could just give it - because anions are anions, and they have their charges, but tannins, it's kind of a peat moss ball rolling around out there.



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Bill: Right.

Mike: That we're trying to capture, right?

Bill: Yep.

Mike: And that's why they call it a trap.

Bill: Yep. And I always use an analogy. I like to use an analogy of highways and cars, okay?

Mike: Uh-huh.

Bill: It's an easy way to visualize.

Mike: Uh-huh.

Bill: So let's imagine, like, our typical everyday ion that we're talking about is the size of a regular old sedan or maybe a small SUV, right? When you're talking about a tannin molecule, they're huge. They're just large in size. We measure these things by molecular weight. So we talk about tannic, humic, fulvic acids, things like that, right?

Mike: Mm-hmm.

Bill: These are large molecules. These are like your triple trailer, oversize load on the highway.

Mike: Yeah.

Bill: Right?

Mike: Yeah.

Bill: They take up four, six lanes, they're just huge. So a car can go anywhere, it can go on the highway, it can go on the backroads, it can get into your neighborhood, right? But about that big, oversize tractor trailer load, well, that pretty much can only go on the highways, they have to block off roads, like, it has very limited pathways. And every resin is porous. We don't see it when we think of an ion exchange bead. We think it's a solid piece of plastic, it really isn't.

Mike: Right.

Bill: You know, it's plastic with water inside, we know that, but there's also pores, holes. So the bigger the hole, the more tannin, quote/unquote, it can take on, it can exchange better, right?

Mike: More porous, I guess.



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- Bill: Correct. So when we look at what tannin resins really are, they're the same old strong base anion resins we use every day for other things but they just have massive pore structures. They have big holes.
- Mike: Mm-hmm.
- Bill: So that those big tractor trailer oversize loads can fit inside of them versus a car that can go anywhere, right? So we can still use a tannin resin to take out other things, but why would you want to? It's not designed for it. So really, what a tannin resin is, is a big-holed anion resin that can accommodate these large molecules to enable them to go in and out of the resin bead with somewhat quote/unquote relative ease, right, but it doesn't always work that way.
- Mike: But there's a tipping point of making the perfect tannin resin and compromising structural integrity, because you make the holes so big that the resin bead is weak. So you can't make - the perfect balance would be what?
- Bill: Yeah. Right. It's a macroporous version of either acrylic, you can use a styrenic. But the challenge we really face using tannin resin is keeping the resin clean so that it can be used over and over again. So what I always tell people, if you got two years out of a tannin resin, you did really well. Right? Most of the time, these things will foul out in a year, 18 months. And it's not because the resin's not made good, it's just because we're limited in what we can do in a typical field regeneration scenario. The ideal regen for a tannin resin would be to apply, like, two to five percent brine concentration at 140 degrees Fahrenheit for four hours, right? Not practical for our - when we look at a typical home application.
- Mike: Yeah. Put a little heat plate underneath your -
- Bill: Yeah.
- Mike: - brine tank.
- Bill: I mean, you get into an industrial or commercial environment, yeah, you might be able to pull something like that off. But I've been involved in even large commercial applications, we're talking municipal -
- Mike: Mm-hmm.
- Bill: - and I bring these things up, and they look at me like I have three heads. Right? It's like, well, we can't afford that, we can't do this, we can't do that. And I'm like, okay, then at least try to extend the brining if you can, and let's hope you get a few years out of the resin. So that's always the struggle, is, really, when it comes to tannin removal, you can start with various different tannin resins but it's how you regenerate it that'll really extend the life of it over time. And we're limited with our equipment and what we're really willing to do.



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- Mike: I used to call it a warm brine squeeze, which was - so, the more - if you could actually program your valve – follow me here, maybe – and I think there’s some new electronics. The electronics have really revolutionized their industry, and - where we could pull in a brine and then shut the process down. Like, literally let the brine sit and cook in there for a while, and then continue the brine program. So, let’s say, like, an hour, or something, if we could shut the brine down.
- Bill: Anything is better than nothing, trust me.
- Mike: Right. So the longer the brine kind of sits in there, and obviously if we could heat it up before it went in there, it would be the best, but that won’t - you know, it’s impossible, but.
- Bill: Yeah, and raise pH. You know, some guys will throw some soda ash in there, but it’s not like you can throw a bag of soda ash in a brine tank and walk away because it’s extremely soluble at low concentrations. It would be something you would have to do every single regeneration, and if you’ve ever worked with soda ash, it’s a pretty nasty bag of dust. So again, the practicality of it versus what looks good in a lab on paper, with equipment designed solely for this purpose, it gets tricky when we’re looking at the typical 5, 10 gallon a minute flow rate.
- Mike: I get this question a lot, and now we’re talking anion resins. Is there an improper way or proper way to try to clean? Do we add a cleaner of some sort? Is there a do and don’t of a - is it resin with -
- Bill: Yeah. With anion resins?
- Mike: Yeah.
- Bill: Anions are tricky. It’s a lot more straightforward, as you know, for softeners, because we have a myriad of options there, right? It’s basically citric acid, phosphoric acid, the hydrosulfite, those are kind of the big three, right? When it comes to anion, quote/unquote acid cleaners don’t really do anything for us, unless, for some reason, you get iron fouling because of precipitants or something, right? We’ll put that over here. But when we’re talking about hardness fouling, which is common - obviously, these organic fouling, right, we have to be a little bit more cautious. So when it comes to organics, really the best approach is raising pH of the brine. So can you add sodium hydroxide, can we use soda ash? You know, we have to make sure hardness is not present because those things will precipitate, right? Calcium carbonate scale, even calcium sulfate scale is a problem. So when you’re approaching cleaning an anion, it’s really heat, brine, and then raise pH when it comes to organic fouling. If you hardness foul an - an anion resin, honestly, the best thing to use is hydrochloric acid or muriatic acid. And again, that’s the equipment. This is where you get into, like, can your



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equipment handle it? You can buy muriatic acid at Home Depot, right? So that would be the best approach. I'd like to see us avoid using citric acid and the phosphoric acids, two main reasons. One, they're just not strong enough to really dissolve scale, they're weak acids but, also, citrate is an extremely selective ion to the anion resin and it's hard to get back off again. So, in essence, if you throw citric acid in an anion resin, you're going to kind of foul it as you're cleaning and you're going to lose capacity on the subsequent uses.

Mike: This is good, because I get the question a lot and this is why we do these podcasts.

Bill: You're going to pick one - if you're going to pick an acid cleaner for an anion, stick with the phosphoric acid based stuff. It's just not strong enough, though, so it may not accomplish your goal but you're not going to screw the resin up, it'll regenerate back off again.

Mike: Could you tell the technician to say all right, Mrs. Homeowner, or Mr. Homeowner, we're going to pull this into your resin and let it sit overnight and we'll be back tomorrow. Is it better, the longer - better?

Bill: Yeah, of course. I mean, the more exposure that you can put any of the cleaners - and if you're going to do something like that, I would really hit it hard. Keep in mind, these - the instructions that you'll get for the quote/unquote resin cleanings, a lot of times they're just designed for everyday regeneration, because they're meant to be used as a preventive maintenance item that you have dripping in the brine tank or you put into the brine tank, right? But if you're going to do a - a cleaning, like, hit it hard, you can let it soak, it's not going to do anything to the resin - which is good - and then just make sure you rinse it all out first, then kick it into regeneration. And you should always do, like, a double regen, meaning extend the chemical addition time twice as long just to ensure you're getting it out of there. Just ramp up the salt that's - whatever you choose, there.

Mike: Well, back to the pH cleaning. Anion notoriously, if you raise the pH up really high, you'll get the - drive the amine fishy smell off. Will that be temporary, so they whack it with maybe a little sodium hydroxide, which is very dangerous and very - you know, you should handle that with care and expertise. But if you do the soda ash route, could that possibly give them a post cleaning odor?

Bill: If they do - so let's say you did a cleaning or some level of addition, right - whether it was caustic or soda ash, right - and we push the pH up of that brine. You know, soda ash is limited to 8.3 but caustic will take you all the way to 14 if you go crazy, right? So if you were to do that, you were to leave the resin and you just rinsed it out and put the resin online, it's going to smell, for sure. So that's what's key about a regen, post the treatments, is to remove any high pH that's left in the resin so that it returns back to normal. So again, you're not going to ruin it,



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it's not detrimentally broken, you just need to kick it into a hard normal brine regen to get all of that high pH out of there and you shouldn't have any issues after that.

Mike: Yeah. Ultimately, though, and I know there's probably a charge for it unless you're a big ResinTech customer, you can analyze ion exchange resin, cation and anion, to give it a certificate of death, you know, what - what -

Bill: Yeah, right, or it's still good to go, something else is wrong. Right? Yes. Our lab can test any of these products for health. Just a standard analysis is great most of the time. It - you know, it's the capacity left, what's the moisture content, how do the beads look in terms of integrity, cracked, broken, whole, all that. Most of the time that tells you everything to know - need to know. We can get into the weeds on things. This is more on the industrial side, but we can look at the levels of regeneration. We can digest the resins to tell you what metals are on them, you can go as crazy as you want. But yes, I mean, all of these can be analyzed and reviewed. And if you are going to take a sample, try to get a good representative sample of the bed, because if we just get it off the top that tends to be where the worst resin lives. So if you want to set yourself up for a replacement, go ahead and scoop it right off the top. But if you want to make sure you get a good representative sample, just try to get a core sample or get samples at various points in the bed, bottom, middle, and top, so that you can send in a mix of it.

Mike: We do this mostly commercially, big beds above 7 cubic feet. That's when the people start getting into big money. Your homeowner stuff, eh, you got two years out of it. Sometimes with these really bad tannins, you might just consider dumping it.

Bill: Well, especially tannin, you can see, because that resin's usually very white or clear. You know, if it turns black, it's a good indicator is pretty fouled.

Mike: It's shot.

Bill: It'll change color on you within the first couple of months of use. It's actually pretty cool. It'll go from that light - let's just call it white, and you'll start seeing it turn a light brown, a darker brown in it, but if it looks jet black coming out of your tank, then yeah, it's probably fouled. And then, you can also check bead integrity. I mean, it's qualitative, but just roll some resin through your fingers. If it turns to basically, quote/unquote paste or dust in your hand, it's probably oxidized or it's lost its bead integrity, it's time to replace it as well. So that's another good trick.

Mike: How much can you see with a fun little home microscope?



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Bill: Oh, microscopes are great. In fact, when I started this job many years ago, I went and bought a kid's chemistry set from the toy store, right? You only need, like, 20 or 30x magnification, which is not very much. Like, if you ever see the pictures of resin analysis that you'll get, that's all you're seeing is 20 or 30x most of the time. So, you can get a nice little pocket microscope, you can buy them on Amazon, I've seen them on there, and just take a look for yourself. And if it looks - you don't see nice, round spheres -

Mike: Yeah.

Bill: - you know, it's a good indicator the resin's broken up pretty good.

Mike: But it is pretty cool. I - I've looked at resin, and seen a lot of analysis, and seen some that look like golf balls, they have little dimples in them, and -

Bill: Oh, sure.

Mike: - and stuff like that. But -

Bill: We just had one come through our lab for a customer, it was severely ox- - like, moisture was, like, 80 percent, right? And you could just see how the chlorine attacked the cation resin. You could see it penetrating the outside diameter. Outside radius was, like, pulverized, and the inside of the bead was still okay, but it was pretty cool.

Mike: Yeah. That's the stuff. Now, I'm going to keep our last part here to something that's very important to me because a lot - and to you guys out there, gals, it's silica. Silica, explained, and why it's so frustrating, and why people get frustrated with it, and I keep - I tell everybody, it's 9 to 90 - you know, 9 to - whatever - I'm trying to come up with a phrase because I didn't have one - but almost impossible, is what I'm saying, is - to remove, in a practical way -

Bill: Yeah. Practically, it's - it's - so let's just talk about silica for a minute.

Mike: Yeah.

Bill: Silica is pretty much in every single water on the planet. You know, it's one of the most abundant elements in our world, right? We see it every day. It's not uncommon to have silica concentrations anywhere from 5 parts per million all the way up to 30, you know? And when you look at mineral waters, and even synthetic mineral waters, why does the mineral water taste so much better than your typical RO water, right? It's because of these mineral contents, and one of the reasons is silica. In fact, when they make synthetic mineral waters, they are literally adding silica back into the water. They will RO it first, and then they'll usually put in some salt of silica, they'll raise the pH, they'll throw some alkalinity in there, those are what make waters taste good, right? So silica, in



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general, is something we deal with and have in our waters every day. So when I get the phone calls you do, right, like, hey, I've got a silica problem, it's causing my scale. And I said, well, scale is really something caused by other things and it just kind of pulls silica with it. Silica, itself, is extremely soluble, right? So do I really have a silica problem, or do I have a scaling problem, or is it just evaporative water leaving residue behind and it's really a dissolved solids content problem? So when I get those questions, I'm always trying to get to the - really, the root cause of the issue, right? Why do you think you have a silica problem? Oh, I have scale in my dishwasher, or I'm getting this powdery coating in my whatever.

Mike: Mm-hmm.

Bill: You know what I mean?

Mike: I get it on the - the glass shower doors.

Bill: Yeah. Right.

Mike: That's what flips people out.

Bill: These are - these are the nature of TDS, these are the nature of calcium and alkalinity in water. One thing I always like to do when these questions come up, if we have the data, is, I like to look at the scaling potential. I'm sure you're familiar with Langelier Saturation Index?

Mike: Yeah, the LSI. We see it as -

Bill: Yeah, LSI. And then there's the Ryznar Index, which is similar, different numbers but same principle.

Mike: He lost -

Bill: There are five -

Mike: Yeah. I'm sorry. No, I was saying -

Bill: You're good.

Mike: - Ryznar lost out to Langelier, you see, so.

Bill: Yeah. They - right, they - they arm wrestled it out, right? But there are five things in both indexes that dictate scaling or corrosion potential. They are water temperature, there are calcium levels, alkalinity levels, TDS, and pH, right? And what do we really deal with every day, you know? We're talking about hardness, sure, we can take it out with a water softener, right? Alkalinity, less common, but we can take that out with a dealkalizer, right? TDS, we deal with, well, we use an RO, right? So if you look at those indexes for your water chemistry and see that



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it's severely scaling, for whatever reason, then your problem isn't silica, your problem is you need to address this hardness, alkalinity issue, right? Well, let's say you put a water softener in and you're still getting this powder, and we run that index and the water says, oh, it's corrosive, right, or slightly corrosive, or not scaling, right? Then this is probably a TDS issue, a temperature issue, your water's too hot, it's evaporating, it's leaving that white dust behind. Removing silica is not going to get rid of your white dust, it's just going to change what you identify is your white dust, right? So silica, to me, is not always the problem. We always try to see if we can steer it towards another problem. Because I remember, this was many years ago, I did this for a customer and I had him put a dealkalizer in. And they were like, oh, Bill, that worked great, it solved that silica problem. I said, no, no, I just solved your scaling problem. Had nothing to do with silica, right? So it gets misinterpreted. I need some of that silica resin. Well, really, what they were talking about is, I need dealkalized water, right, to get the scaling potential down even further. So that's kind of the discussions I like to have when the silica question comes up. But if we talk about how do we get it out of water, we don't have a lot of options. Right? There is - on an industrial level, we use deionization for that every day, right, hydroxide form anion resin. They can use an RO, by raising pH after you've controlled the scaling, that's another way to do it. Right? But silica in water is not an ion, it's just a species that floats around, right? But when you raise pH, you can get it to ionize, it goes from silica to silicate. But you need a pH of, like, 10 to get it fairly well ionized, right? So, in theory, Mike, we could raise the pH of a water to, like, 11, throw a chloride form strong base on there, let it rip, you're going to see 80 percent silica reduction. But what do you do with pH of 10, 11, 12 water that stinks like fish? I mean, it's not practical, right? People have said, oh, I want to put a desilicizer in, which is basically using a hydroxide form anion resin after a water softener. This is a nightmare, pH is coming out of there at 12. The softeners never work 100 percent, so you're going to build up scale over time on the resin.

Mike: Yeah.

Bill: You've gotta lower the pH with acid. So that's not a practical solution.

Mike: No.

Bill: Right?

Mike: It's dangerous. It's all chemical pumps, and homeowners set it and forget it, yeah.

Bill: It's a disaster waiting to happen. So from an ion exchange perspective, there really isn't a solution. Now, we deal with these absorption medias every day for arsenic, right? We talk about it all the time, the GFOs, the iron hybrids, even the titanium - the titanium medias.



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- Mike: Yeah, titanium oxide. Mm-hmm.
- Bill: One of the biggest interference that these medias have for arsenic uptake, or even antimony, for that matter – because I get that question from time to time – is the silica levels in the water. But you can manage the capacities of those medias by lowering pH. So if you ever look at capacity curves, at least for our materials, right, we'll show you a curve that says, oh, well, your pH at 8 where you are, you're going to get this, but if you drop the pH to 7 it's going to increase three to four times. Well, all you're doing in those scenarios by lowering pH is, you're minimizing the silica's ionization potential, meaning we're making silica less of an interferent. Right? So you could use these medias to take out silica but you might only get, like, 25 percent reduction, 40 percent reduction on a good day. Right? So if you have 10 PPM of silica going in and you're only getting 7 coming out, does that really do anything for you?
- Mike: Right. Yeah. I see a lot up above 30. I get 35, 40. It kind of wreaks havoc on shower doors and things.
- Bill: Yep. I agree. So all you can really try to do is control the scale and corrosion potential, blend the waters down, I don't know - you know, like, have an RO. But again, what's the practicality of it all, right?
- Mike: I've heard a lot with antiscalants - just to tickle everybody with a feather, as they say. I'm going to probably do a future podcast on antiscalants, because they're - seem to be coming into fashion with these whole house ROs that people are putting in. And it's basically an acid, just like what you're saying, but it's a functionalized acid. But they're pre-feeding to ROs, and usually on a colossal scale, because it becomes - the softener would be too huge to treat a massive RO. But anyway, that's for a future podcast, and I don't to say - it's a little teaser.
- Bill: No, but it's the same basic principles. We're lowering pH to minimize the - getting the silica to just pass through. That's really what those guys are doing.
- Mike: Right. Right. Right. The valence, just to keep them carrying -
- Bill: Don't foul the membrane, get - stay in the concentrate or the permeate, pick one.
- Mike: Yeah.
- Bill: You go, right?
- Mike: We do mention that membranes are almost disposable now, they're so inexpensive for the homeowner's side. But the - your basic 4x40 is now, like, under \$300.00, so.
- Bill: Yeah, that's crazy.



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Mike: Yeah, so chuck it. But, okay. Well, cool. That - I mean, that's the stuff. I really appreciate you hitting on this. And these are the things that I get asked all the time, with the nitrates and, you know, the PFAS, but they're all anionic and they all can be prone to organic fouling. So you've really got to pay attention to a very extensive water analysis, I will preach this forever and ever and ever. ResinTech has a really good lab, comprehensive water test, and then we can go from there and say, okay, your anion is probably going to foul, or you're going to need this kind of pretreatment because it all comes back to that water analysis. But these questions have come with the cleaning we - we addressed, fouling we addressed, silica explained. This is all good stuff, and I really appreciate your time, Bill.

Bill: Anytime, man.

Mike: It's really, really, really good that I have you out there as a resource, so.

Bill: Sure.

Mike: Okay. Well, everybody, thanks for listening, and Trust the Frog. Take care. All right. Bye bye.