WE ARE ETH – Episode 46

Fajer Mushtaq, ETH Alumna, Founder of Oxyle

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Chapters:

[00:00:00] Fajer Mushtaq: A tiny drop in a concentrated fashion is enough for your drinking water to be toxic in a few days. So you really have to go to the source of the problem, decentralize, where you can have the biggest impact.

[00:00:15] **Susan Kish:** In this episode, I'm talking to Fajer Mushtaq. ETH alumna and mechanical engineer who is the co founder and CEO of the ETH spin off Oxyle, which focuses on removing forever chemicals from water. This is the We Are ETH podcast and I'm Susan Kish, your host.

Fajer, did I understand correctly that you literally just got back from India like yesterday or today or something?

[00:00:45] **Fajer Mushtaq:** Today's my first day back from my two-week vacation and back home in Kashmir, yes.

[00:00:49] **Susan Kish:** Back home in Kashmir, home of these beautiful scarves.

[00:00:51] **Fajer Mushtaq:** Yes, we make Kashmir there, yes.

[00:00:54] **Susan Kish:** Very cool. Any bit of culture shock whenever you come back to Zurich?

[00:00:58] **Fajer Mushtaq:** Yeah, these things just run on time. Yeah, like you're expected to actually be at nine if you say you're going to be at nine. You have to be there. So it's always a bit of a very gentle culture shock.

[00:01:08] **Susan Kish:** So did you grow up in Kashmir?

[00:01:10] **Fajer Mushtaq:** I grew up in India, north of India. I lived there till I was 17 and then I moved for my education. So I've lived in north of India my whole childhood. Yeah.

[00:01:20] **Susan Kish:** And you went to university at Aston University. In the UK, yes. Where is Aston University?

[00:01:27] **Fajer Mushtaq:** It's in Birmingham, actually. Birmingham. The best Midlands in the UK. A great place to study, to get to know the culture, and if you're a 17 year old child, it's really nice to have independence and just explore. So it was nice.

[00:01:41] **Susan Kish:** So your parents were okay with you jumping on a plane to go to?

[00:01:45] **Fajer Mushtaq:** I wouldn't say they were okay, but I think there were those parents who really trust you and they want you to make your mistakes and learn from them. So I wouldn't say they were excited, but they were cautiously optimistic.

[00:01:59] **Susan Kish:** That's pretty welcoming for that. So how did you get from Birmingham, I'm sure there's a correct way to pronounce it. Birmingham. Birmingham to Zurich.

[00:02:09] **Fajer Mushtaq:** Well, what brought me to Switzerland was just I wanted to explore more, study more, and the topic of microanalysis systems was just really fascinating for me.

[00:02:17] **Susan Kish:** What is microanalysis?

[00:02:19] **Fajer Mushtaq:** A Microanalysis system is basically just full studies of anything on the micro nano scale. So nanometer scale basically, right? So a human hair width, for example, is a hundred micrometers, for example. Okay, so then you even go like thousands of times. under that resolution for nanoscale and it was really interesting because when I finished my studies in the UK, I worked in industry for a year or two and I was working with transistors. I was an electrical engineer working with transistors.

[00:02:46] **Susan Kish:** You were installing devices into cars, right?

[00:02:49] **Fajer Mushtaq:** Exactly. So I had to like solder these really small nanochips and I can do a car. So we were doing audio infotainment systems for automotive. So very different fields from what I'm doing now, but that's part of life's journey, right?

And that's when I was first learning of people were advancing this whole field of nanotransistors in a place called ETH Zurich in Switzerland, where they had invented the smallest transistor was like five nanometer scale, and it was going to completely change the processing power of chips. And I was like, this sounds like something I would like to learn more of.

This field of micro nanosystems that was something I've never heard before or learned about. And ETH Zurich offers one of the really cool courses in micro nanosystems. It's very hard to get in. They take 15, 20 kids a year. It's a competitive course, a small course, but I really wanted to give it a shot to see if I get in.

And that's what basically brought me to Switzerland now, 12 years ago.

[00:03:44] **Susan Kish:** So Fajer, let me just make sure, because I am not a mechanical or an electrical engineer. A transistor is a component. Of a chip, of a semiconductor chip?

[00:03:53] **Fajer Mushtaq:** Yeah, so you have a lot of different components. You would have resistors, you have capacitors, right?

So you solder all these small things in and you are basically working on a very small scale, atomic scale pretty much, right? And the smaller and smaller you can make these devices, you can get really amazing bulk properties out. So if you were to make a transistor from 100 nanometer to 5 nanometer scale, scale, suddenly you can fit a lot more of them and then get more processing power, less heating.

So really cool things that you can do, which is also why our electronics are moving at such a high speed today than they were moving a decade ago, for example. So it's a really cool field, but it's not just what you can do with electronics. You can do so much with micro nano systems. You can play with materials or you can play with properties of mechanical systems.

It's a really cool field of how much you can do very versatile.

[00:04:43] **Susan Kish:** You have a company that you co founded, and you're CEO, Oxyle. I appreciate that you came here on your first morning back, because I'm sure everybody at the office is like, Ah, hello, follow, hello. But can you tell us, just in short words, what it does? And why you picked that area.

[00:05:01] **Fajer Mushtaq:** So at Oxyle what we have developed is a complete technological platform solution that removes forever chemicals or PFAS as they're known scientifically from bodies of water. So it could be drinking water, industrial water, municipal water. And we do that in a way which is not that we're not filtering them.

We're not absorbing these chemicals, we're destroying these chemicals with a chemical oxidation reduction process. So you take a huge block of, let's say of a one single PFAS molecule, and then our technology, our catalyst, this nanoporous awesome material that I developed, and this can then get activated under the right circumstances and starts to hack the bonds of this molecule.

All organic becomes inorganic, which is safe to discharge then. So it's very different from the conventional solutions today that are either filtering or absorbing them, because as we know, if you just filter, absorb them, the problem always remains. You just concentrate the problem. It never goes away. But when you destroy them, you actually get rid of those chemicals from scratch, helping customers, helping the environment and not burdening any stakeholder with a secondary waste as well.

[00:06:07] **Susan Kish:** Okay. Let me say it back just to make sure I get it. So these PFAS molecules are long and complicated. And what you've done is figure out a way to hack across the connection of the atoms so they break into their little components. You have a building of Legos and you broke it into the individual Lego pieces. But you slipped in a term of you have to catalyze this thing that breaks it into the Lego pieces. How does that happen?

[00:06:36] **Fajer Mushtaq:** So this is the hot piece of technology, pretty much. It is this patented material that I was developing during my PhD at ETH Zurich. So this material is nanoporous. It's amazing. You put mechanical stress on this material. And it gets activated. So it's a piezoelectric material as a property.

[00:06:53] **Susan Kish:** I have no idea what that means.

[00:06:54] **Fajer Mushtaq:** I can very easily explain that. So piezoelectric material, you stress it, it polarizes electrically. So your, for example, your lighters, for example, right? You put a bit of stress on it and you see a spark come out.

That's because of electric charge. So it's the same kind of property this material has. You stress this material at a nanoscale, and then it starts to generate positive negative surface charges, it gets electrified pretty much. And then when it's electrified, it starts to form these radical species, a chemistry term now, which breaks these molecule bonds, basically.

So in a simple application, you put the material in, let's say, in a vessel. You put mechanical energy like bubbles, vibrations in the water, that's the energy source this material needs, it gets activated, and then starts to break these bonds of these PFAS molecules, pesticides, pharmaceuticals, whatever it is.

So it's a really simple principle. Stress this material and it will activate, and then it starts to clean the water with that principle.

[00:07:53] **Susan Kish:** So theoretically, you put it in a waterfall or you stir the water up or something, and that should be enough to activate it. What happens to that element after it's done?

[00:08:04] **Fajer Mushtaq:** The catalyst? It does not get used up. It has a very long lifetime. It stays in the water for years on end, just doing the same treatment again and again. So you deform it, it gets electrified. It doesn't get consumed in the process. It stays there. It's a catalyst.

[00:08:20] **Susan Kish:** So is it just another forever chemical?

[00:08:22] **Fajer Mushtaq:** No, so forever chemicals are very different, right? So forever chemicals are, they are, they're forever, right? But they're not a catalyst, right? So they are pollutants in the water, freely floating. Our material is a physical embodiment. It's a physical material. Like it looks like a granule, for example, right? It is not used up in this reaction.

[00:08:40] **Susan Kish:** So can I drink it?

[00:08:41] **Fajer Mushtaq:** The material is perfectly safe to use. We are using that to treat drinking water, for example. The first test that we ran with the water that we treated, we could show that after a treatment, the water had much better response in a Calix test than bottled drinking water would have on cells.

So it's even safer than what you would pick up in a Coop or Migros store here as a bottle drinking water because we know that today even bottle drinking waters have a lot of forever chemicals in them. And after a treatment, we could show that there's nothing in the water. It's even safer than what you buy in a store.

So that's how we know the material is absolutely safe for drinking water, but also for really complex typical industrial waters as well.

[00:09:22] **Susan Kish:** I think I understand. Great. So you found this magical compound, for lack of a better term, that is able to, once activated, break the bonds of the forever chemicals, then it goes to sleep until it's activated again and repeats.

And it's safe to consume. And it's not another kind of pollutant. Now, from what I know around chemical production at scale is complicated, right? These are huge plants and huge companies with enormous amounts of safety and registration and regulation and the big chemical companies in the world are doing it.

They're big. How do you get your magical compound to scale?

[00:10:07] **Fajer Mushtaq:** It's a really, really great question. It's something that was part of already my PhD thesis, in a way, where I wanted to make sure that if we are developing these materials, they should be scalable. Otherwise, it'll just stay in the lab. So it was important to me that the fabrication process should be something that is already applicable on industrial mass production scale for some other application, right?

So, for example, today, the way we make our catalyst, it is the way you make chewing gum, for example, or chocolate, for example. So you make a solution, a huge batch of solution,

[00:10:36] **Susan Kish:** mhm

[00:10:37] **Fajer Mushtaq:** Mix all the raw materials in. make a slurry, so to speak, or a chocolate, like molten chocolate, and then you pour them into molds, as you would do with the chocolate, you put the liquid into a shape, solidify the chocolate, and then you get the hardened chocolate out.

It is pretty much the same way we make our material today on the industrial large scale, where we make the solution, put them into molds, all automatically, it is really something you can industrialize with the existing infrastructure, with some minimal customizations to the equipment, for example, and that's The best way to scale, making sure you're not 3D printing something.

You're not making everything one by one. It should be a production scale that exists, that there are machinery available for that and processes already available. So you can work with a manufacturing partner who's maybe making chewing gum or chocolate and now helps you make your material, for example.

[00:11:26] **Susan Kish:** Where are you in terms of technology readiness level or on that FOAC, NOAC, first of a kind, endth of a kind journey?

[00:11:34] **Fajer Mushtaq:** So actually, in next month, middle of October, we are installing our first full scale commercial product on a custom site. And 15th of October, we go live as a company with a product installation, and this will be a big product installation. So we're treating about 100 meter cubes per hour with this customer, which is quite a significant,

[00:11:55] **Susan Kish:** I'm sorry, 100 cubic meters per second, an hour and 100 cubic meters. Just so I can visualize, I have no idea what that is. That's one swimming pool, 10 swimming pools.

[00:12:06] **Fajer Mushtaq:** It depends on the swimming pool, but for the Olympic size swimming pool, it'll be like a five to 10 of these swimming pools, really. It's quite a lot, right? So it's a hundred times thousand liters per hour. So...

[00:12:18] **Susan Kish:** Got it. And just talk us through this technology in the little tablets. That sounds, as I said, like a magical kind of compound. How do I start to use this? I live in Boston. We have great water. I drink straight from the tap. Yeah, but I grew up in Michigan, not so far from Flint, which did not have such great water.

Can your magical compound be applied to those kind of issues or refugee camps where water is really an issue. What's the breadth of application? And have you looked at those markets?

[00:12:51] **Fajer Mushtaq:** That's a really great question. It's something that keeps the whole team on our toes because obviously we want to get to as many people as possible, as fast as possible.

And we know we can make Really good direct impact in the lives of people. If we go to every household, install this under the sink, probably a small device, right? Or help refugees or NGOs with people who need access to water. That's a good question, because that has a direct impact, right? What is not so clear to us today is the willingness to pay for people for technology like that, because we're still getting the first information from so many different countries about the quality of water, but people and general public still do not have the full understanding of how much of these chemicals they have in the drinking water, which there's quite a lot of them, but they don't know.

So there is not this awareness or this willingness to pay when it comes to consumer version of it. So a B2C market for ferrochemicals is being explored. It's still quite young. And I think with more and more regulations and more public pressure, this will grow. So today we do have a question mark on that, right?

But where we do not have a question mark is the people who pollute, the polluter pays principle, which, for example, the EPA in US has established, where if you're a polluter, you have to pay for that. So there is no question mark there. So if you're a company who produces PFAS to make a Teflon pan or waterproof clothing, cosmetics, any semiconductor, it's used everywhere.

And you're polluting, you have to pay for that. That's a very clean, clear market. So we're directly addressing the industrial customers today for that reason. So technology can scale. But apart from that, the biggest driver, which is in line with the mission as a company, where we go to industrial customers, is because you can make the biggest impact there.

So if an industrial customer even has a small leakage of this water that was not treated that seeps down, becomes your rivers and lakes contaminated, your groundwater is contaminated, and the drinking water is contaminated. A tiny drop in a concentrated fashion is enough for your drinking water to be toxic in a few days. So you really have to go at the source of the problem. Decentralize where you can have the biggest impact and industrial customers provide us that avenue where if you stop the problem where it's originating from, eventually the drinking water would not be a problem as well. And this also helps us scale, become a bigger company, have the revenue needed to then push also for a B2C market in a couple of years.

[00:15:16] **Susan Kish:** So you're writing down the experience curve to reduce your costs. And you're writing up the curve in terms of volume of production. When do you start being profitable?

[00:15:25] **Fajer Mushtaq:** That's a lovely, lovely question that every founder would say. It depends upon the market and customer, which is true, right? In our case, it also depends upon the customer's willingness to pay and the regulatory landscape.

It is a regulatory driven market. That's very important to understand. But based on the customers that we have in the pipeline today and who we are doing paid projects with, we believe by 2026, 2027, we should be cashflow positive with the projects that we know today of that are in the pipeline in the next three to four years.

[00:15:54] **Susan Kish:** Talk to me about how those years in the lab, which I think you described as being six levels below ground at ETH, how did those years affect your path and your choices?

[00:16:08] **Fajer Mushtaq:** I mean, Yeah. It's a really great question, right? Because if you ask this question to anyone who did a PhD, they always give you a very different answer, because some of them have very positive experiences and some not so much.

But I think what I've learned is the common answer in all the people is that it teaches them how to handle stress and do just better time management and project management that everyone can see, even if the outcome was not fruitful or the PhD thesis was not successful with multiple papers, what they learn is a lot about themselves and how to do just do life, pretty much. And that's how I also look at my PhD years. For me, it had direct impact on what I'm doing today. So I was developing these materials of water treatment applications in my PhD. And I'm doing that now with my startup, Oxyle. So it does have a very direct correlation. So it added up to something.

But beyond that, what it's really taught me was how to run multiple projects, how to work with people, how to sell your idea. Because when I was doing my PhD thesis, I supervised more than 30 different thesises in those five years. I had a lot of bachelor's students, master's students. So you have to really pitch the idea to them for them to pick you and your project to do, right? Because there's such amazing projects available. And for a bachelor thesis student or a master thesis student, you have to really convince them that for the next six months, they're going to give everything they got to your project and get a good grade in the end.

So I learned quite early on this art of designing really cool posters and almost interviewing students in multiple stages and then picking the one that's going that suited the project best and back then it was all fun and games. I thought, you know, I'm just learning. It's really fun to do it like that.

And I realized when I look back at that time now, I was already running a startup back then without knowing as a PhD student when I had 30, 40 students to supervise in those years, right? And making sure every one of them succeeds and all of them are motivated and they're all different ideas, right? I'm a PhD without realizing it's helping me be an entrepreneur later.

[00:18:03] **Susan Kish:** Would you recommend coming to the ETH?

[00:18:05] **Fajer Mushtaq:** Well, definitely. It's one of the, really, one of the best places to study and explore, like everything you need in terms of facilities, resources, exposure, like that was international student mindset, all of those aspects are really here. So if you're passionate and you want to explore and you just want to try something new, they should definitely do that.

It is also very affordable place to study. It's not as expensive as other places in the world and it's in the middle of Europe so you can easily move around as a student as well. So I think it has all the best competence to offer being one of the most prestigious places in the world to study.

[00:18:42] **Susan Kish:** You mentioned in passing that your growing up in India gave you sensitivity to this question of taking water for granted. Can you tell us more about that?

[00:18:52] **Fajer Mushtaq:** Of course. I'm originally from Kashmir. It's north of India. It's called the water basket of India because we have so much water. It's called the crown of India. It's the northernmost part. So we have a lot of beautiful rivers and lakes clean rivers and lakes. We do drink tap water there, which is a rarity in the rest of India. But it always has been like this politically charged area with India, China and Pakistan always fighting for it. So it was not the best place to grow up. So I grew up in New Delhi, the capital of India. Most of my childhood years and there, the reality I faced after living in Kashmir in the beginning was completely different when it comes to access to water.

In the months of summer, we had to ration water and I do come from a privileged background and me and my sister, we still had to discuss, do we shower today or do we water the plants today? Like we really had to make decisions. And when you're growing up like that, you think it's very normal. Like you don't think about it because that's your reality.

But then you come to Europe and you realize oh, the tap water just freely flows and water is always available and you think the water is safe to drink and that's what we always were taught. But then you start to think about the quality of water that you're drinking in Europe, like in the UK, it's full of chlorine.

You open the tap water, you smell chlorine because there's so many pollutants in that water, you need to disinfect everything with chlorine. So how safe is that water to drink? How much are we taking that for granted? The same case of Switzerland, where we take so much pride in the quality of drinking water, and then we see all these new reports come out where there are pesticides in the water that are a 20 time higher concentration, but they making them carcinogenic in the drinking water of so many cantons, including Canton of Zurich, where we have forever chemicals in 200 sites in Switzerland, for example, in the drinking water in concentrations that are very carcinogenic.

So then you also start thinking about how much are we taking it for granted in Europe as well. It might look clean and clear. But those pollutants are still there. That did have an impact on me for me to realize we should not take this for granted. And I had this naive outlook that in Europe we don't.

But the more I'm realizing about the water cycle and how industries in Europe are treating the water, or mistreating the water, let's call it that, I realize that we have already been taking it for granted in Europe for many years without having this sort of lens on this problem, which is now coming, which is great.

But like I would say 5 10 years ago, we did not know the full scope of the problem in Europe. And now we do, which is good. It's a bit scary, but it's good that we know so we can take care of it.

[00:21:18] **Susan Kish:** Fascinating. This has been a really great conversation. Thank you for explaining and talking through the mission. It feels like Oxyle is on the path to making a real difference.

[00:21:30] **Fajer Mushtaq:** Yes, I think we are.

[00:21:31] **Susan Kish:** Fantastic. I'm going to close by asking some of the questions we love to ask our guests. And I think the first one is, when you were young, I guess this meant when you were in Delhi, what did you think you wanted to be when you grew up?

[00:21:47] **Fajer Mushtaq:** Um, I think I just wanted to be an engineer. I wanted to work with my hands and build things, um, and that's kind of what I'm doing today as well. Maybe not physically anymore, but I'm building a company. I'm just a builder. I like to build things. So it stays true still.

[00:22:01] **Susan Kish:** One of the things that characterizes folks who went to the ETH is curiosity, right? What are you curious or learning about today?

[00:22:09] **Fajer Mushtaq:** I'm really curious about how human beings work. I'm always curious about what makes people Or just how people think and how they react under different stimuli and what makes for great teams and what makes for great leaders and how can we make people work better together by honing on what binds them together versus what separates them.

So I'm just someone who generally is curious about the human psychology. Everyone is so unique. It's just amazing to me.

[00:22:35] **Susan Kish:** What books are you reading? What's on your bedside table or on your Kindle or your phone or whatever medium?

[00:22:41] **Fajer Mushtaq:** So I just came from a vacation. So I read a couple of books, but I'm currently really reading actually. It's a really cool book. It's called The Mind Gut Connection. I haven't finished it, so I don't know how it ends. But it's a really fascinating book which talks about how a brain and a gut, which a gut is called the second brain, how they're connected and how, if you're stressed, for example, you will feel that reaction in your stomach.

But also if you eat something wrong, you could feel tired because the gut isn't talking to your brain. Really fascinating. So that's what I'm reading.

[00:23:09] **Susan Kish:** Fantastic. That was a great conversation.

[00:23:14] **Fajer Mushtaq:** Thank you. Thank you for having me. And thank you for the lively conversation. Yeah.

[00:23:17] **Susan Kish:** I'm Susan Kish, host of the We Are ETH series, telling the story of the alumni and friends of the ETH Zurich, the Swiss Federal Institute of Technology.

ETH regularly ranks amongst the top universities in the world with cutting edge research, science, and people. The people who were there, the people who are there, and the people who will be there. Please subscribe to this podcast and join us wherever you listen and give us a good rating on Spotify or YouTube or Apple if you enjoyed today's conversation.

I'd like to thank our producers at Ellie Media and congratulate them on their brand new offices. This is a first recording at that location and the folks at ETH alumni who do the production and select our wonderful guests and thank you most of all our listeners for joining us today.

The book mentioned in this episode:
The Mind Gut Connection: https://www.amazon.de/Mind-Gut-Connection-Conversation-Impacts-Choices/dp/0062376551