

Analyze That episode transcript

Building confidence across the CCUS value chain

This transcript has been lightly edited for clarity, readability, and length. The content reflects the original discussion and technical intent of the speakers.

Danielle: Hello everyone, and welcome to Analyze That, a series where we explore the impact of analytical solutions across industries — from metals and power generation to pharmaceuticals and beyond. Today we're discussing carbon capture, utilization, and storage, or CCUS. While many people think carbon capture is simply about removing CO₂ from emissions, the reality is much broader. Once carbon dioxide is captured, it must be transported, potentially utilized in industrial processes, or permanently stored. Across that entire journey, confidence depends on understanding exactly what is in the CO₂ stream. I'm joined today by Trevor Tilmann, Applications Engineer at Thermo Fisher Scientific, who will help us unpack the CCUS value chain and the role analytical technologies play in supporting it. Trevor, welcome — can you tell us a little about your role?

Trevor: Thanks, Danielle. I'm Trevor Tilmann, an Applications Engineer with Thermo Fisher Scientific. I focus primarily on clean energy applications, including CCUS using the Thermo Scientific™ MAX-Bev™ CO₂ Purity Monitoring System and clean hydrogen applications using the Thermo Scientific™ MAX-iR™ FTIR Gas Analyzer. My background is in chemistry, and I've been with Thermo Fisher for about three years. I'm very passionate about environmental sustainability and the broader clean energy transition.

Danielle: CCUS is receiving significant attention globally. Why is it gaining so much momentum, and why is it considered such an important tool for industrial decarbonization?

Trevor: CCUS provides industries with a way to offset greenhouse gas emissions while continuing to operate existing infrastructure. Its growth is being driven by government regulations, emissions trading programs, and corporate sustainability goals. Many companies are establishing emissions reduction targets and using carbon credits to help meet them. CCUS creates opportunities for facilities to reduce net emissions without completely rebuilding production systems overnight.

Danielle: People often focus only on the capture portion of CCUS, but it's really an entire value chain. Why is that broader perspective important?

Trevor: Capturing the CO₂ is only the first step. Once captured, the gas must be transported and then either utilized or permanently stored. Utilization includes applications such as beverage production, fertilizer manufacturing, chemical processing, e-fuels, and industrial materials like low-carbon concrete. Storage typically involves injecting CO₂ into depleted oil wells or saline aquifers for long-term sequestration. Across the entire value chain, analytical measurements are critical for monitoring purity, protecting infrastructure, and ensuring compliance.

Danielle: Let's start with the capture side. What are the main carbon capture methods being used today?

Trevor: There are four primary capture methods. The first is pre-combustion capture, where fossil fuels are partially combusted and converted into syngas containing hydrogen and CO₂. The hydrogen can be used for power generation while the CO₂ is captured for storage. The second is post-combustion capture, currently the most common approach because it can be retrofitted onto existing facilities. In this process, solvents such as amines absorb CO₂ from flue gas streams. The third is oxyfuel combustion, where combustion occurs using pure oxygen instead of air, resulting primarily in CO₂ and water vapor, making separation easier. The fourth is direct air capture, which removes CO₂ directly from the atmosphere. Although it is currently more expensive due to low atmospheric CO₂ concentrations, it offers flexible deployment opportunities and is gaining momentum.

Danielle: Once the CO₂ leaves the capture site, transport becomes a critical stage. Why is transport such an important part of the process?

Trevor: Transport introduces significant infrastructure and safety considerations. The impurities present in captured CO₂ depend entirely on the industrial source and capture technology used. Compounds such as sulfur species, nitrogen oxides, oxygen, and water can react to form corrosive acids that damage pipelines and storage systems. Many transportation networks rely on existing carbon steel infrastructure originally designed for oil and gas. Because of this, monitoring and verification are essential at custody transfer points and throughout the transportation network. Transport may involve pipelines, ships, or even trucking systems for landlocked facilities.

Danielle: Let's talk about utilization. What does utilization look like in practice, and why is it becoming increasingly important?

Trevor: Utilization means turning captured CO₂ into valuable products. Since carbon capture itself can be expensive, creating marketable products from CO₂ helps improve the economics of CCUS projects. Today, captured CO₂ is used in beverages, fertilizer production, industrial manufacturing, and emerging e-fuels applications. For example, CO₂ can be combined with hydrogen and carbon monoxide to create methanol, which can then be processed into sustainable fuels and hydrocarbons.

Danielle: You mentioned beverages specifically. What are the purity requirements for beverage-grade CO₂?

Trevor: Beverage-grade CO₂ must meet extremely strict purity standards established by the International Society of Beverage Technologists, or ISBT. The gas must typically exceed 99.9% purity, while impurities must remain at very low parts-per-billion concentrations. The Thermo Scientific MAX-Bev System was originally designed for this application, and its capabilities now support measurement needs across the broader CCUS value chain.

Danielle: The other major end point is storage. What does permanent storage involve, and why is monitoring still so important at that stage?

Trevor: Permanent storage typically involves injecting CO₂ deep underground into saline aquifers or depleted oil reservoirs. These storage sites are designed to securely retain CO₂ for extremely long periods of time, often with leakage thresholds below ten percent over a thousand years. Monitoring is essential because impurities and reactions under pressure can degrade wells and infrastructure. Accurate quantification is also required for regulatory reporting and carbon credit programs.

Danielle: A major theme throughout this conversation is understanding what's actually in the CO₂ stream. Why is that such a challenge?

Trevor: The composition of the CO₂ stream varies dramatically depending on the industrial source and capture process. Fermentation-derived CO₂ is very different from combustion-derived CO₂, and direct air capture introduces its own unique impurity profile. Certain contaminants — including nitrogen oxides, sulfur species, oxygen, water, and glycols — can create highly corrosive conditions even at low concentrations. Because of this, monitoring systems must measure multiple impurities simultaneously at extremely low detection levels.

Danielle: That brings us to the Thermo Scientific MAX-Bev System. Where does it fit within the CCUS value chain?

Trevor: The MAX-Bev System is typically deployed after the CO₂ has been captured, purified, and liquefied. It can be installed at storage tanks, transportation custody transfer points, compressor stations, and sequestration hubs. The system continuously verifies CO₂ purity and impurity concentrations, helping operators confirm compliance with specifications while protecting infrastructure and maintaining traceability across the entire value chain.

Danielle: What role does the MAX-Bev System play specifically in purity monitoring?

Trevor: The MAX-Bev System directly measures CO₂ concentration with extremely high precision while simultaneously monitoring critical impurities. In many cases, it measures more than fifteen components at once and can provide results in as little as thirty seconds. That speed is critical because if off-spec CO₂ enters a pipeline, the issue can quickly spread across long distances.

Danielle: The system uses FTIR technology. For listeners who may not be familiar with FTIR, can you explain what it is and why it's effective in this application?

Trevor: FTIR stands for Fourier Transform Infrared Spectroscopy. Molecules absorb infrared light at unique frequencies based on their molecular vibrations. By passing infrared light through a gas sample, the system can identify and quantify different compounds based on how they absorb that light. FTIR is particularly valuable because it can simultaneously measure compounds ranging from low parts-per-billion concentrations all the way to nearly 100% concentration. Another major advantage is calibration flexibility. Additional calibrations can be remotely uploaded to the MAX-Bev System as requirements evolve, reducing downtime and supporting continuous operation.

Danielle: Trevor, this has been a fascinating discussion. We've explored how CCUS extends far beyond carbon capture itself and how confidence across the value chain depends on accurate, continuous measurement. Transport, utilization, and storage all rely on understanding the composition and purity of the CO₂ stream. Thank you for joining us today, and thanks to everyone listening. We'll be back soon with more episodes of Analyze That.

John: Yeah, I appreciate calling out the aluminum as well, right? Because we just mentioned how important aluminum is and how that importance is growing, right? So that need and sort of the attention to detail in the sample prep, think is important to call out. And I just want to be clear, this is like a, a technology specific, right? That's any handheld XRF analyzer. That's best practice. yeah, I think that's not always understood. And I think it's worth noting. So, thanks for kind of touching upon.

Kyle: Yeah, lot of these, again, it's a surface measurement. you're not, you know, you're not burning down into the material. Like even, even some of the, some of the old LIBS out there as you can burn through it, but it's, we've done a lot of testing internally and it's just, it's not, especially on the aluminum, you're going to want to make sure to remove any of that surface contaminant to get good and accurate readings.

John: That's fantastic. And again, right, that's, that's, that's a sort of a sample prep that I don't think is always well understood, but I appreciate kind of going into it. and to take it one step further, right? So, we've talked about, you know, the variations in scrap recycling operations, sort of the general value of the technology. Can you go a little bit more into say, you know, we've talked about the ROI, the return on investment that a scrap recycler may see when using handheld XRF analyzers.

Can you kind of detail exactly how they're realizing and maximizing that return on investment?

Kyle: Yep, so a lot of times you know you've got a guy out in the yard. They're like hey, this guy's been doing it for 20 years. You know he's as good as gold. They've had gone back to the old, you know spark tester where you know they grind on it looking at the sparks the way it goes. But that's those guys are few and far between now so. Even customers that were hesitant in the past that were, know, we don't want to invest in in an XRF. You know I've had one case in point. There was one customer that I talked to at one of the scrap and recycling shows years back. He had purchased a truckload of what he had intended was 316. It was kind of a trustworthy customer he bought it from. Said, yeah, we'll buy it. Typically, 316 is about a 10 to 14 % nickel. So, you're paying per pound of it, 10 to 14%. Soon as the truck arrived, he had just recently purchased an XRF about six months before.

Was able to shoot the material, the entire load actually showed up as Nickel 200, verified it, grinded it down, shot the ends of it, making sure it wasn't a thermal spray or an overlay. He positively identified it as Nickel 200, which is a 99 plus percent nickel. So his profit went absolutely through the roof. And he likes to tell that story, said, look, you know, I paid off my XRF and literally one load. So that was a pretty fun story that I like to share pretty often. He jokes about it every time we see him. Pretty good story on how successful they can be.

John: That's awesome. I don't think we can guarantee that for every single experience. The first load you use the analyzer on, but it kind of shows you all it takes is one positive

use case like that, and again, it goes back to point of what we think we have, what we see in front of us is not always what is there. Using these tools to kind of get that next level analysis.

Kyle: Yeah, it's actually a double-sided coin. I had one customer, a fairly large customer, really, really heavy copper buyer. They ended up buying a few trucks full of what's considered Copper No. 1, which is pure copper. you know, basically 99 plus percent copper, they're using it, you know, in really critical connectivity applications. They basically ordered a bunch of trucks of it, get it on site. They have quite a few of handhelds on site.

Once the units arrived, or once the trucks arrived, they went out and started sorting all the material, shooting it, got it all sorted out, cleaned up. You know, months later it was shipped off to the mill. The mill came back to them, providing them with a pretty hefty, I want to say it was like a 30 % downgrade, because they ended up finding out that that copper was not pure copper. It was not copper one. There was actually a, there's a type of copper out there that has a specific element. It's only half a percent and it's a pretty small amount. But unfortunately, they did not have the appropriate analyzer in their hands that they were able to detect that particular element.

So just that downgrade alone, them having the right analyzer in their hands would have helped save that. So, they ended up coming to me asking what a solution would be for that. We were able to provide that, get the correct analyzer in their hands. Now going forward, still doing a lot of copper one in their business, but they can verify that, is it really copper one or is it this specific grain of copper that has a need out there. So now they're even sorting to a deeper depth.

But again, it kind of goes back to having the right analyzer. Now it's not always the most expensive. It's just talking to your rep, making sure that you got the right analyzer in your hand. That's the key. So if you're going to invest in one multiple, I like I said, these guys have five or six of them on their site. So it's very important to make sure you got the right analyzer.

John: Yeah, I really like that example, right? Because one you mentioned two sides of the same coin, right? So, the first sample that customer, he's constantly joking about that story. Assuming the second one maybe isn't joking about it as often. But right, the key word there is verification.

Kyle: Yes.

John: Yeah, you want you want to know what you have want to know what that what that material actually is scrap recycling. A lot of material can come from a lot of sources, so really hard to track that back. Yeah, that's fantastic examples. Appreciate that Kyle. So just kind of looking at time. This has been great. I want to close up maybe with a final question of. What advice would you give to an operation scrap recycler yard who's?

who's just starting to implement handheld XRF technology, what do they need to know first, getting their hands on these tools?

Kyle: Yeah, I mean, I'll say first thing is, you know, try to get an expert out there. Don't just don't just get online and start searching for, know, the cheapest analyzer you have out there. I mean, we get it, you know, startups, you know, that the capital may not be there, but know, it's free to get one of us like myself or somebody else out there. Like get an expert out there, you know, really walk through, talk about your applications, talk about your needs, finding out exactly what you need. I mean, there's a lot of options in handheld XRF out there. I mean, there's.

There are pre-owned options that will, particularly that we can sell through the factory, new ones. Also getting into the local round tables, the ISRI shows, the remote round tables come into, those types of things, or even some of the large conventions, kind of talking to your peers and finding out really what's making them successful.

There's a lot of us scattered throughout the countries, throughout the world. So if you have any questions, just reach out to us. mean, Thermo's got a pretty large web, so we're here to help you in any way we can.

John: Yeah, that's great. So earlier you mentioned, hey, just simply buying the most expensive analyzer may not be the best fit. And simply buying the cheapest analyzer may not be the best fit. Yeah.

I think that's really good advice. Find out what tool you need for your operation, what your applications are. I think that's just really well said. And hopefully, I think.

Very often, Kyle will be the expert I would refer you to. So, clearly know your stuff.

Again, thank you so much for joining me today. I'm John Ferguson, Product Manager for Thermo Fisher Scientific, joined by Kyle Schneider with Premier Analytical Solutions.

If you want more information, please reach out. You can find us at thermofisher.com/scrap.

So again, thanks everybody and stay tuned for more episodes of the series.