

Podcast 74 – Unique Hydrogen Leak Detectors

[00:25] **Brian:** Well, hello everyone and welcome to episode 74 of the Hydrogen Nowcast for May 19, 2023. The HydrogenNowCast is sponsored by New Day Hydrogen, who's helping fleet owners meet their zero-emission vehicle needs. If you're with a fleet or transit operator and your fleet is wondering how to convert to zero emission vehicles but still meet your operational needs, new Day Hydrogen can give you the option of fuel cell vehicles by providing public hydrogen fuel stations near you and showing you the available fuel cell trucks, vans and buses. To find out more information about both vehicles and fueling, visit the newdayhydrogen.com website where you can also submit requests on the contact page.

Well, as you listeners know, hydrogen is a tricky substance to work with. In some ways, it's safer than other flammable gases because it dissipates so quickly. But in other ways it's more difficult because it's odorless and colorless, and a hydrogen flame doesn't emit much light or radiant heat. And add to that, because it's such a small molecule, it's harder to prevent leaks than with other gases. So obviously, detecting hydrogen leaks is infinitely important and not just the fact that there is a leak somewhere in a system, but to find and fix it quickly, you need to know exactly where. Now, most hydrogen systems are a maze of pipes and valves, and that makes leak-finding extremely time consuming. But what if there was a way to sprinkle dozens or even hundreds of low-cost sensors around a system that would trip an alarm if there was a leak? Then to help you even further, what if there was a coating that changed color in the presence of hydrogen so that you could pinpoint the leak in minutes instead of days? Well, a company right here in Boulder, Colorado named Element One has three very unique products that do just that. So to give us the details, we have Julie Bannantine, who's the VP of engineering at [Element One](#), and Bill Hoagland who's the CEO and founder. Julie and Bill, welcome to the show.

[02:23] **Julie:** Brian, thanks so much for having us. We really appreciate the opportunity to talk to you about Element One today. It's really an exciting time to be in hydrogen.

[02:32] **Bill:** Thanks Brian. Great to be here.

[02:35] **Brian:** Well, we really appreciate the time for both of you to be here. And I am very excited about this because I think these products are really, really helpful to the whole hydrogen community. Well, Julie, why don't we start with you giving the listeners an overview of these three hydrogen detection products that you have. And then we'll turn to Bill later and he can jump in and talk about the development of the products and their unique capabilities and some of the details.

[03:01] **Julie:** Great, Brian. Thanks. As you just said, hydrogen leaks are notoriously hard to find. We believe [Element One](#) has a unique and innovative suite of products to easily identify a leak and probably more importantly, to detect the source of the leak. The ability to rapidly pinpoint the source of the leak can result in significant cost savings through the reduction of downtime. We believe we're a great addition to the hydrogen safety strategy for current and planned hydrogen applications.

We have three main products. We have, first the tape, which we call DetecTape, which is a self-fusing tape that changes color when exposed to hydrogen. So you can wrap it around a joint or flange or swage-lock connection, and one can easily see evidence of a leak by the color changes. This has been tested at NREL with excellent results.

Next, we have a paint which we call DetectCoat. It also changes colors in the presence of hydrogen, and Bill will be talking a little bit more about this in just a few minutes. Finally, we have electronic sensors. These are wireless sensors that can be interrogated remotely. We have two types. We have an RFID and a Zigbee type. The sensors work in that they have a significant drop in resistance when a hydrogen leak is detected. Both are very low cost and, as you said, could be widely populated in a plant or a hydrogen application.

The RFID sensors are unique in that they are, besides being small and low cost, they require no power. The wireless Zigebees are connected to a Zigbee network, which is then connected to a gateway, and then finally to the Internet so that they can be monitored from a remote control-room or actually any place someone wants to sit and access the Internet. We've been funded by the Department of Energy for development of these electronic sensors for possible use in natural gas pipelines carrying a mixture of natural gas and hydrogen.

[05:06] **Brian:** Well, thank you, Julie. That overview really gives us a good idea of just the big picture of how these sensors work. And Bill, I think we'll turn to you maybe for some more details on how they work and how they're used. But maybe before we do that, I understand you were formerly a hydrogen program manager with NREL, and that several NREL veterans founded Element One. So why don't you give us a little background there and then give us some more details about the three products.

[05:32] **Bill:** Thanks, Brian. Yes, I was the manager of the early hydrogen program at NREL for 17 years in at [SERI](#) before that. And another one of our founders, Dave Benson, was the director of materials research at NREL for his entire career. As I said, we were NREL veterans, and this technology grew out to a great extent of Dave Benson's research with electrochromic coatings for windows, where the opacity of glass could be changed to reduce energy losses.

So, using similar technology, Element One first developed a color changing film that changed color when exposed to leaking hydrogen gas. This was a thin film. The reaction was quick, and the first prototype changed reversibly. However, in our early work with NASA, they indicated that they would also like a non-reversible indicator. They thought that would be beneficial because when they refueled the space shuttle, they evacuated the area for several miles and wanted to come back in later and see if it had leaked at that time. So we developed a non-reversible version of this as well. We first developed the thin-film and then we went on, on our own and developed hydrogen color changing pigments. And out of that we developed paints and tapes and a number of other products that we are continually developing now.

[06:56] **Brian:** All right. Well, thanks, Bill. So that gives us a good overview of the detect tape, the tape that can be applied, and the detect coat. But that's of course useful when there's people around to look at it.

So let's move on to talk about the remote sensors that can give us an indication. And maybe before I do that, I should also mention that there's a paper from NREL that describes the detect tape. And I created a shortcut for the listeners to more easily find that it's at tinyurl.com/detecttape. And Detectape is spelled D-E-T-C-T-A-P-E. So let's move on to talk about the remote sensors. And maybe to start with, for listeners that aren't familiar with RFID sensors, why don't you start by giving us an overview of how that technology works and how those sensors are reported and then tell us a little bit about how these work and how they would be applied to a system.

[07:54] **Bill:** Okay. Thanks, Brian. We have two main areas of research. We have thin films and pigments. And as you can imagine, the pigments are used in tape and paints. And our thin films, although they do change color, just like the pigments, a thin film coating will change its conductivity by three or four orders of magnitude when exposed to hydrogen gas. So this change in conductivity or a change in resistance in a sensor allows us to have a wireless or wired sensor. And we have hooked that up to both [Zigbee](#), a number of protocols, and wireless. But we've hooked it up to Zigbee and RFID. And if you're not familiar with RFID, it's very common. RFIDs are used to tag clothing and things so that an alarm goes off if you try to carry it out the door very cheap. So we have interfaced our sensor with RFID, and more importantly, passive RFID, since I think we're the only sensor I know of that requires no power to react to hydrogen gas. And this lack of a requirement for power makes it uniquely acceptable for RFID. So we're developing that and a number of wireless protocols. We're finding that combining these wireless sensors with something like detect tape gives people a combined visual and electronic reaction that adds to the level of safety.

[09:30] **Brian:** All right. Thanks, Bill. Well, let's go on to talk a little bit more about the RFID sensors because these are the ones that I see as being really beneficial to sprinkle around a system. So the RFID sensor itself is just a small chip and those are placed on pipes or fittings or whatever with some kind of sticky tape or whatever, but they're very tiny. I guess I think of them as like a Band-aid (or for our British listeners, a plaster) that you could stick on things. And then there's no battery, they're wireless. And so those are read with some kind of a scanner. So obviously a technician could walk into a system and wave a scanner over those. But even more importantly, the system itself could have permanently mounted scanners that are continuously monitoring those. Is that right? Am I characterizing that correctly?

[10:23] **Bill:** Yes, that's exactly right. The challenges we're trying to overcome is that true passive RFID has a very short range and is more aptly used with handheld interrogators and sensors. We're talking about a range maybe up to a meter on that. There is another very similar version of RFID which does incorporate a battery which can last eight to ten years. So we're looking at both of these. But in truly hazardous atmospheres, a passive RFID is both cheap and effective. So the trick there is trying to get an acceptable range for a network.

[11:03] **Brian:** Right. And certainly a meter isn't a problem in a system. You could have scanners all over the place to find those. But I think the really intriguing thing about that is that it really would help you home-in to a precise location in your system where the leak is. So you're not delegated to just, there's a leak somewhere. Now I've got to go start searching to find it. Maybe we'll turn to Julie to talk about the other type of sensor that uses the Zigbee wireless protocol. And for the listeners, Zigbee is a wireless digital communication protocol that's similar to Bluetooth or WiFi, but it's simpler and less

expensive. So how would the Zigbee and the RFID be used complementary in a system? And how do those work?

[11:44] **Julie:** Great question, Brian. As Bill just said, the benefits of RFID is that they require no power. So you can imagine for hazardous applications like Class 1 Div-2 applications which prohibit an ignition source, this would be a great application that is limited due to the limited reader range. So we have the Zigbee, which provides an alternative – the Zigbee. It's the same type of sensor connected into a Zigbee network that then connects to the Internet. It allows this remote interrogation. The Zigbee does require a battery, although we're working on an intrinsically safe model of this. So you have an option there. You can imagine for pipelines or some other very large remote locations, you might prefer a Zigbee application. In a more hazardous contained environment, you might prefer a RFID version of the sensor. So we really believe we have some great choices for the specific application of someone monitoring their hydrogen safety protocol.

[12:50] **Brian:** All right. Thanks, Julie. Well, let's talk a little bit about the business aspects of the products. Now. I think the first thing is, from a user's point of view, without the Element One products, the DetecTape, the DetectCoat, the RFID sensors, and Zigbee sensors, what would users have to go through to try to detect and locate hydrogen leaks?

[13:09] **Julie:** Thanks, Brian. Many safety protocols require area monitoring for hydrogen applications. And as you know, these are sensors that are often mounted to the ceiling or the wall to detect leaking hydrogen. And if a hydrogen leak is detected in the room or the building or the area, the room needs to be or the area needs to be evacuated until the leak source is found. As you can imagine, this can really result in significant downtime, because hydrogen leaks are notoriously hard to find.

Other times in a small leak in an outdoor application, such as the situation that occurred at NREL and which the paper refers to, they didn't know they had the leak. It was through use of Element One's DetecTape that they identified hydrogen leaks. And we've already mentioned that pipelines or remote locations, it's really difficult to say to even know whether you have a leak or not for a small leak.

So we believe Element One has this set of products that will significantly reduce downtime and increase safety. We have the ability to both visually indicate the presence of a leak and send an electronic signal and to combine these to use these together. So you can imagine that an operator making rounds daily with a handheld reader could monitor an RFID tag in conjunction with a detect tape. If he gets a reading, he can go over and visually see that he has a color change at the joint and identify the leak. Alternatively, if one may prefer, or a company may prefer to monitor the sensors at a remote location and be alerted by an alarm and then visually inspect and verify the color change after the alert has been identified in the location. Identified.

I personally think a really interesting application for our sensors is Marine fuel cell applications. You can imagine a marine vessel powered by a hydrogen fuel cell. If there's a hydrogen leak, the vessel would literally be dead in the water. Our RFID sensors, which don't provide an ignition source, can really be used to quickly and safely identify the source of the leak and get that vessel back operational. So we think there's a lot of future hydrogen applications that we will really provide a unique and worthwhile solution. Another idea we think fueling stations are a logical application for our leak detection products, and that's evidenced by our success at NREL. As we said at the beginning of our conversation, we believe we're a great addition to the hydrogen safety strategy for current and planned hydrogen applications.

[15:44] **Brian:** Oh, I absolutely agree. And I'll echo your thought about using it for fuel stations because a lot of the early hydrogen fuel stations will be autonomous. They won't be manned necessarily hour by hour by somebody. And so to be able to have that indication there's a leak, get out there, fix it very quickly, because you now can locate it more easily. I just think it's an absolute necessity.

Bill, why don't we turn back to you to talk about the availability of the products, kind of where you are in the production cycle and things like that. And I know you've got an ecommerce website coming really soon. Yeah.

[16:20] **Bill:** Thanks, Brian. Before that, though, I just like to add to what Julie said is a key point with our sensors. Although they're not quantitative, you can tell subjectively how big a leak is. And what that means is that a plant operator can make a decision as to whether a detected leak is either a maintenance event or a safety event and act accordingly. This is a huge advantage economically when your option before that was simply to shut the plant down while you looked for the leak. We've been told by a number of plant operators that this is very important to them.

Now, with regard to the availability on the current market, DetecTape is available on the market. We now have a good stock. We are going to be putting in place a number of distributors and an online ecommerce section. So it should be readily available. But for now, anybody who wants to try DetecTape should contact us directly through our website or email us. The email address is on the website and it's just info@elem1.com. It's been on the market for a few years, although it hasn't been adequately marketed, but we have had many, many positive responses and feedback to this comment. We find that it doesn't give false positives. The color change material is somewhat unique to active electronic sensors, is that if you do not get an indication of a leak, you know there's no leak where if an active sensor, it could be two things. It could be no leak or the sensor is not working. So we have a positive indication of both a leak and the absence of a leak.

Our other products, we've done a lot of development work on them and we're very far along. We've currently worked on a couple of small business grants and we're currently working now with the fossil fuels area on the blending of hydrogen and natural gas. And we've had good results there. We found that natural gas doesn't affect our sensor at all. These products we hope to have available soon, and we'll certainly let people know. If people have an interest in whatever product, they can contact us and we will let them know exactly when these products are available.

So we've done a lot of work. We think the products are very close and we need to do some field testing and get data, because as you can imagine, when you're offering a safety related product and you have to get insurance, you have to have a lot of field data before you introduce them. So that's where we're at. We think we got a great future coming up. We've been waiting a long time to see hydrogen get the attention it has, and we're trying to react to it.

[19:01] **Brian:** Yeah, things are changing very fast right now, so I just can't imagine a system, though, without these sensors. So I think there's going to be a big demand.

Well, Julie and Bill, as we kind of wrap things up again, I want to thank you for your time to be with us today. And maybe I'll turn it over to say if there's anything that I haven't asked you about, would you like to add and maybe Julie, if you want to start.

[19:23] **Julie:** Yeah, I'd just like to piggyback on what Bill just said. As I told you, one of our funding sources is that we have a phase two [SBIR](#), phase two with the Department of Energy, and part of that objective of phase two is field testing. We have funding to work with partners to test our equipment in their facilities and applications. And we're looking for several partners to test our RFID and Zigbee products in their applications. The benefit to them is there's little to no cost for them, but we obtain field data and customer feedback, which is crucial for our development. So we'd encourage anyone who's listening, who might like to evaluate our products to reach out to us. We'd love to partner with several other companies to get our products out in their field.

[20:11] **Bill:** Yeah, I'd just like to add on to what Julie said. A lot of our information and knowledge has been as a result of inquiries from potential users. And I'd welcome anybody who has an application or use they'd like to talk to us about to please contact us, and we can tell you how we might respond. And a lot of times we've actually worked on an application to give people data. They'd like, great.

[20:35] **Brian:** Well, thanks, Bill. And thank you, Julie. I will add that I do know someone who develops hydrogen systems and he's used the detect tape for quite a while and he loves it, says it works really great. And I know Bill, I think you mentioned that, or maybe Julie mentioned it, that NASA has used the tape.

Well, listeners, I've been talking with Julie Bannantine and Bill Hoagland of element one. And again, the website for element one is elem1.com. And Julie, if listeners would like to get in touch with either of you, what's the best way to do that?

[21:09] **Julie:** You can contact us. I'm going to give you my personal email, j.bannantine@elem1.com. Or as Bill said, there's an info form on the website elem1.com, and we would encourage people to reach out. We do want to get our sensors out, although the tape is out, and we're happy with that. And the coating is very close, so we hope that we'll be a big player in the hydrogen market.

[21:38] **Bill:** Yes, and I'll just add that the info@elem1.com is an email and I will get a copy of that directly if you send to that one.

[21:49] **Brian:** Yeah, and just to clarify, the @ for the emails as well as the website is at E-L-E-M-1 dot com.

All right, well, thank you both. And I will conclude with saying, listeners, if you enjoy listening to the HydrogenNowCast, please consider subscribing to the podcast and also give us a rating in your podcast app. A good rating helps us be discovered by other people. And of course, word of mouth

recommendations are really important. So consider letting people in your own network know about the Hydrogen nowcast.

And lastly, if you'd like to contact me, you can reach me through the website colorado-hydrogen.org or on Linked-In. So until next time, this is Brian DeBruine wishing you health and prosperity. Goodbye.