Podcast #61 – Natural Hydrogen Wells

Brian: Hello everyone, and welcome to Episode 61 of the Hydrogen Nowcast for September 16, 2022. The hydrogen nowcast 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, today on the podcast, we're going to talk about an important but little-known source of zero carbon hydrogen that occurs naturally underground in an ongoing and sustainable process. And to tell us all about this, we're fortunate to have one of the leading authorities in the world on natural hydrogen, Viacheslav Zgonnik. Viacheslav, welcome to the show.

Viacheslav: Thank you for the invitation, Brian. It's a pleasure for me to chat with you.

Brian: Well, thank you for your time to be with us today, Viacheslav. Now the regular listeners will know that you were on the podcast recently on the Ukraine episode, which was number 55, along with Olekander Ripkin. And Oleksander is the president of Ukrainian Hydrogen Council, among other things. But Viacheslav, you're a Ukrainian citizen but now living in Paris, and you have friends and family still in Ukraine. Do you want to take a minute just to comment on the war and its impact on hydrogen and the energy transition?

Viacheslav: Yes, absolutely. The Russian invasion of Ukraine heavily affected the entire country, and energy projects are not exception. Of course, no one can think about innovation and clean energies when your city has been bombed and occupied. Millions of people fled the country and tens of millions were displaced inside of Ukraine. Here I would like to use the opportunity and say thank you to all of the listeners who were helping Ukraine in any way and tell that their help is very important.

So 20% of the territory of the country was occupied with old infrastructure in it. Of course, I've seen in the news about months ago that Russians were disassembling the largest solar plant in Ukraine and stealing solar panels at the same time.

The war affected not only Ukraine, but the entire world and Europe. Especially here in Europe, the price of natural gas increased by four, five, up to ten times. Comparing with the past year, the price of electricity increased more than tenfold from last year. The main driver for that is the dependency on Russian gas. One fifth of European electricity is generated by gas fired power plants. So drops in supply inevitably led to higher prices. So at the same time, this is a powerful driver for Europe, Ukraine included, to develop alternative sources of power.

In the previous podcast, we discussed that Ukraine has the potential to supply Europe with huge amounts of green hydrogen using the network of gas pipelines which was underloaded even before the full-scale invasion. And now most likely, the pipelines will be available entirely to transport hydrogen. And those of you who would like to learn more about this topic, I invite to check the Episode 55. And here I would like to add that such high electricity prices have immediate negative impact on the cost of producing green hydrogen. With such a high price of electricity, for example, in France it is one €100 per megawatt hour today. Compare it with less than €80, the price which was the last year. So the cost of producing 1 kilogram can be around €50. Of course, the expectations are that prices will drop to previous levels, but the fact of such high dependency is sometimes something to be considered in the future hydrogen projects. That's where comes the interest for natural hydrogen, the topic of our today's discussion, because it's the only type of hydrogen which does not require spending energy to produce it.

Brian: Well, thanks, Viacheslav. Our thoughts and our prayers go out to the Ukrainian people, and we really hope for an end to this conflict soon. And I guess people in America should be pleased that their price of gasoline only went up as much as it did when you hear the prices that have gone up in Europe. But let's hope this conflict is over soon.

Well, let's turn our discussion to this topic at hand, which is of course natural hydrogen. And for the many people out there who are unfamiliar with this, what is natural hydrogen and where does it come from?

Viacheslav: Natural hydrogen, like its name suggests, is hydrogen found in free state in nature, in its molecular non-bonded form as H_2. Unlike hydrocarbons, which are stored underground for millions of years, natural hydrogen is constantly generated in the earth's crust and mantle by geochemical

reactions. There are many reactions which can generate hydrogen, but the main two which can produce very large quantities are degassing of primordial hydrogen, which is stored inside of the earth since its formation. And the second method is water reaction with rocks, mostly those which contain iron, in not completely oxidized state. And this reaction is called serpentinization. The discussion between scientists what is the main mechanism is still ongoing, but what is important to remember that all possible mechanisms are non-fossil and are taking place at the present time, what makes natural hydrogen a renewable resource?

Brian: Wow, that's fantastic. Well, you know, as Franz Westenbrink – who's my co-founder of the Colorado Hydrogen network – a is fond of saying, if it weren't for the need to decarbonize our energy systems, we wouldn't bother using hydrogen. You know, consequently, I think a lot of sources and means of generating hydrogen that really have been known for decades or even centuries are only now being developed. So is this true for natural hydrogen as well? I mean, are there natural sources that have been known about for some time? And why weren't these developed earlier?

Viacheslav: The main reason is because no one was looking for it. And no one was looking for it because people were thinking that such a light and reactive gas as hydrogen cannot remain in a free state for a long time. Moreover, hydrogen is odorless, tasteless, invisible, and most importantly, very diffusive. This significantly limited any possibility for an accidental discovery.

To add another layer, there was no suitable measurement devices for hydrogen. Portable gas detectors were not equipped with hydrogen sensors, while laboratory gas detectors were using hydrogen as a vector gas. It means the gas which transfers the sample to analysis chamber. Therefore, discovery of hydrogen with such device is impossible, even if there is hydrogen in the sample. All these reasons led researchers to consider rare and accidental discoveries of hydrogen in natural samples something anecdotal. Sometimes they were even removing hydrogen from the gas analysis, thinking that it was an error of measurement.

Despite that, the number of such discoveries was growing with time. And when I was studying scientific literature, I was finding more and more examples described in all sorts of publications, but often like secondary facts, those which, in the mind of a researcher, not worth a separate publication, but are mentioned in publications written for other results.

However, humanity was dealing with hydrogen rich natural gases without knowing this since a long time ago. The famous example is the place with eternal flames in Turkey. It is called Chimaera, or in Turkish, Yanartas. This place, according to legend, is believed to be the origin of the first Olympic flame. There are flames coming out of rocks, and they are burning constantly. By the way, you can find a video of this place on my YouTube channel. Directly below the fires, there are ruins of the temple of Hephaestus, the Greek God who was associated with fire through his role as the blacksmith to the gods. I had a chance to visit this place last year, and it is beautiful. If you happen to be near Antalya in Turkey, I recommend you make the tour and visit Chimaera.

Brian: Wow, that's fascinating. Well, how common really is natural hydrogen? Is it found widely around the world, or what are the reserves of this?

Viacheslav: Before talking absolute numbers, I need to say that the work is still in progress and the topic is relatively new. Because of that, our understanding of natural hydrogen increases and the estimates increase as well. What is remarkable that the estimates of the global annual flux of hydrogen from geologic sources increase by an order of magnitude every decade or so. When I was doing my literature review, I was able to combine existing data and my estimate was on its turn, larger than the previous one by an order of magnitude. So today we're talking tens of millions tones of hydrogen per year. But in my opinion, the real value must be two to three orders of magnitude higher, as there are still no global estimates available for recently discovered hydrogen seeping features which are very abundant on the surface on the crust. Also, the understanding of the input of deep-seated primordial hydrogen is still low, and I think it can contribute much higher volumes than the serpentization process, which is studied in more details.

The most recent results show that natural hydrogen has the potential to replace fossil fuels. This is hard to believe, I know and I understand that, especially when people hear about natural hydrogen for the first time. But for me, for someone who read all the literature available on this topic, this is an evidence I assure you will hear more and more about natural hydrogen in the coming years. What I want to emphasize that when we are talking about reserves of natural hydrogen, it's better not talk reserves, but the flow. So I want to answer your colleagues. Franz Westenbrink brings a comment you cited earlier, that if it weren't for the need to carbonize our energy systems, we wouldn't bother using hydrogen. I believe that hydrogen has so many advantages over hydrocarbons that once there

will be a way to make it cost competitive with them and sustainable and clean hydrogen will replace them faster than coal replaced wood and oil replaced coal.

Brian: Wow, that is fantastic. Well, as you mentioned earlier, natural hydrogen is generated continuously by natural processes. So I assume we would consider it a renewable source of energy, right?

Viacheslav: Indeed, because it is constantly generated and constantly degassing, we're dealing with a flow of energy rich matter, as all renewable sources of energy are based on flow, like sunlight, wind, or flow of water. Natural hygiene, by definition, is a renewable energy. To understand this better, it can be compared with geothermal energy. In geothermal, we capture the heat raising from the depths. We search for places where it's the most concentrated and closer to the surface. Once the well is drilled, it will be producing heat for a long time. Or we can say forever comparing to our lives, the same situation is with natural hydrogen. So once we drill a well, once we hit the flow, which is constantly replenished, hydrogen will be produced, and produced again and again to highlight its clean nature.

It was color coded as white hydrogen. So natural or white hydrogen are the same thing. Another important thing to know about that because it is constantly degassing, and if we don't use it, it will be lost. Large portions of it are consumed by soils, mostly by microorganisms living there. What is amazing that hydrogen consuming microorganisms are present in all types of soils around the globe, including desert soils and frozen soils in Antarctica. The researchers studying those microorganisms believe that hydrogen, and not sunlight, was the primary source of energy for early life. Because of that, such microorganisms are of particular interest for astrobiologists, people searching for life on other planets and their satellites.

But going back to hydrogen, if we don't use that flow, it's lost into atmosphere and then to space, because hydrogen is so light that it cannot be retained by Earth's gravitation. By the way, Earth has a tail like a comet, which is composed of hydrogen atoms. The tail is so long that it extends beyond the orbit of the moon. It is, of course, invisible to our eyes. But it was detected during the space missions using scientific instruments.

And the surprises are not over. Hydrogen affects the atmospheric chemistry. It extends the lifetime of methane molecule in the air before it is oxidized. And also it reduces the thickness of a zone layer. So both these reactions led to increase of temperatures of the atmosphere. In other words, they participate in global warming. The problem that current climate models don't take into account the flow of geologic hydrogen, because the topic is still new. In my opinion, climate scientists must incorporate natural hydrogen into their models. And do you think it is? It is over no hydrogen in soils and underground, it's converted by a specific group of microorganisms called methanogens into methane. And as you know, methane is a strong greenhouse gas. A large portion of atmospheric methane is of biogenic origin. Usually, agriculture is blamed. But again, the scientists studying this topic are not well aware about the flux of hydrogen from geologic sources. So this is why I think that intercepting flow of natural hydrogen will help to reduce the effects of the climate change.

Brian: Wow. I'm starting to get the impression that the Earth is outgassing a tremendous amount of hydrogen. And, boy, if we can capture some of that, not only might help global warming, but it would also give us a source of hydrogen.

You mentioned that natural hydrogen is referred to as white hydrogen. But I think we should point out to the listeners that because it's renewable and because it doesn't emit essentially greenhouse gases in making it, I would consider it green, but we'll use white since that's a little bit more specific to it. Now, if we want to try to capture this natural hydrogen, like I say, we are going to eliminate these emissions into the atmosphere. Is it possible to capture it and extract it? I mean, what are some of the current examples?

Viacheslav: Yeah, I will comment first on the color because it's the common discussion during all events related to natural hydrogen. I agree with you that it can be classified as green because it is clean and renewable. Actually, any type of hydrogen can be classified in only four categories by using two criteria. Is it clean or not, and is it sustainable or not? Both natural and green hydrogen fall into clean and sustainable category. Of course, our team was calling natural hydrogen green till our colleagues pointed out that natural hydrogen is not manufactured artificially and it is the primary source of energy. It was proposed to call it White to differentiate from hydrogen produced by electrolysis using renewable electricity, otherwise known as green. Here, the word green replaces six words produced by electrolysis using renewable electricity. And the word white replaces five words. Natural hydrogen from geological sources. What facilitates the conversation, I must say, word about

the primary energy source. Unlike all other types of hydrogen in the hydrogen rainbow, natural hydrogen is the only one which is the primary source of energy. This means that to produce any other type of hydrogen, you need to spend energy either in form of electricity or natural gas, or coal or biomass, et cetera. But natural hydrogen is the source of energy. Therefore, you don't need to spend any energy to manufacture it.

And the following question, can we extract it? And the answer to this question is yes. There are already some examples with most known. Located in Mali, Africa, a well there is producing 98% pure hydrogen since 2012, and the company is actively drilling to find more. My company, Natural Hydrogen Energy LLC, drilled its first exploratory well for hydrogen in the USA. We were the first to drill such type of well in the United States, but also in all the Americas. Currently, we're working to test the well and preparing for the next drilling. Other companies started to explore for natural hydrogen. There are at least few of them on each continent. Because of that, we can say that exploration for natural hydrogen already started and it's becoming a separate branch of the energy industry.

Brian: Well, I wanted to mention to the listeners that I saw your well there in the Midwest, and I met you there in June of 2021, which was very exciting to me to be at such what I would almost consider a historic event and a historic source of hydrogen. Could you tell us maybe a little bit about the cost to extract natural hydrogen? I know it is a pretty simple well bore. There's not a lot to it.

Viacheslav: Indeed, estimates show that it will be cheaper to produce natural hydrogen than the cheapest hydrogen today, which is gray. Natural hydrogen is expected to cost less than a dollar per kilogram. I will explain you why.

To manufacture gray hydrogen, you need natural gas, which is converted to hydrogen via process called Steam Methane Reforming, or SMR. The costliest part of this process is the reforming itself, which contributes approximately to a half of the final cost of hydrogen. Another half is the cost of natural gas. In order to get natural gas, you should do prospecting and exploration, drilling, purification and transmission. So the same with natural hydrogen. The value chain is similar. One still needs to do exploration, drilling, purification and transmission. But with natural hydrogen, you don't need the reforming part.

What makes natural hydrogen less expensive than gray hydrogen? This is why its estimates are so optimistic and predict that natural hydrogen will cost under a dollar. I must also mention that environmental impacts of drilling for hydrogen are very low. They are similar to drilling a straight gas well or a geothermal well, and the surface impact of that is very low as well. What I mean, that surface of land you need in order to obtain is the lowest when compared to all other types of hydrogen, and a cherry on top of that, that helium is a common byproduct with hydrogen because their physical properties are similar. They both have very light gases. But unlike hydrogen, helium cannot be manufactured and can be only mined. It's a critical element for many high-tech industries, and the demand for it is constantly growing. So its market price, therefore it represents an additional value stream for natural hydrogen exploration.

Brian: Oh, that's fantastic. Well, and I can attest to the listeners that when I saw the well, it was just a simple bore going down, and I think once the trucks and everything were removed from the site, it would be very simple and just look like a typical water well, probably.

How do you think this new source of energy is going to impact the hydrogen economy and even the whole energy industry in general?

Viacheslav: The main issue of the energy industry is its scale. It is huge. Therefore, it takes years and billions of dollars to make even a tiny change. People often don't realize how big is energy consumption. I heard a very nice example in the presentation by Eric Tune from the breakthrough energy ventures. The excellent company is now developing a gigantic new offshore oil field, Hebron, in the Atlantic Ocean. They are spending $5 billion to put the field into operation, and it will cost them another $4 billion to operate it for the next 30 years. Imagine the company is now hiring young people who will spend their entire career developing this field. 30 years. During all this time, the oil field will produce as much oil as the humanity is consuming. During try to guess how many days, only eight days of consumption. So, 30 years. $9 billion, for 8 days' worth of oil. Therefore, the only way to reduce emissions in a timely manner in the energy industry is to leverage the existing infrastructure. And natural hydrogen allows to do that. Instead of drilling in one place on the map for hydrocarbons, it's possible to use the same technology and the skill sets to drill in another place on the map for clean hydrogen. This will allow to quickly pivot from hydrocarbons to clean and sustainable energy, and this will allow to save jobs in the oil field industry.

Brian: Oh, amazing. Thanks, Viacheslav. Well, as we wrap up our discussion, what are some of your parting thoughts?

Viacheslav: What about the potential of natural hydrogen? People often say it's too good to be true. If it's so great, why we're still not driving on hydrogen? I will answer that. It is true that venture funds are waiting for someone to take the risk and find the right way to extract hydrogen. Our company and other startups are working on this, but this works takes a lot of investment, but also a lot of time. Therefore, rapid and massive investment is necessary to unlock natural hydrogen's potential. The upside of such an investment is huge. It is of planetary scale. It will allow to start producing clean energy very fast, almost tomorrow.

Brian: Well, and I'll add to that comment about if it's so good or too good to be true, why don't we see it today? And people have to keep in mind that we're in the process of developing this entire market for hydrogen, both supply and demand, and we have to bring them up at the same time, in the same scale. It's going to take some time, but I think it's going to start happening really fast.

Viacheslav, thank you again for your time to be here with us today. This has just been absolutely fascinating. I'm sure you're going to get a lot of inquiries.

Now, I want to mention to the listeners that they can access your scientific paper which talks about natural hydrogen on the Colorado Hydrogen Network website, which is at Colorado-hydrogen.org/resources and they can just look for the paper there that's actually been on the site for some time now. But if listeners want to learn even more or invest in natural hydrogen or contact you what's the natural hydrogen energy website?

Viacheslav: The address is nh2e.com, n for natural, h two and e for energy. I invite the listeners also to follow me on my LinkedIn page for updates. That's where I publish news on the topic of natural hydrogen. And thank you, Brian, very much for this opportunity to share my passion for this topic.

Brian: Well, thanks Viacheslav. I've been waiting for almost a year to get you on the podcast. I'm so happy that we've finally done it because I think this is a really important source not only of hydrogen, but also it's important for the energy transition. So I'll be sure to include contacts for you and other things on the show notes.

So listeners, let me conclude by saying, as always, if you enjoy listening to the hydrogen nowcast, 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 now cast.

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And lastly, if you'd like to contact me, I'd love to hear from you, and you can reach me through the website at Colorado-hydrogen.org or on LinkedIn. So until next time, this is Brian DeBruine wishing you health and prosperity. Goodbye.