CERAMIC TECH CHAT

Episode 34

Title – "The everlasting relevance of brick: John Sanders (E34)"

INTRO

De Guire: "I'm Eileen De Guire, and this is Ceramic Tech Chat.

> The American Ceramic Society was founded by a group of nine brick manufacturing engineers who were attending the February 1898 National Brick Manufacturers Association Meeting in Pittsburgh, Pennsylvania. The story goes that one young man named Elmer Gorton gave a detailed science-based talk on his methodology for developing glazes for terracotta. The talk reportedly put much of the audience to sleep, but it grabbed the attention of some others in the audience who were really intrigued by the rigor of his scientific approach because at the time most clay-based formulations and processes were empirically determined.
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> An unexpected and maybe even serendipitous snowstorm kept all the brickmakers indoors during the conference's free time, and some of them got to talking about starting a new society for ceramic chemists to apply and share scientific methodology for the benefit of all. And The American Ceramic Society was born!
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> So today, we're very excited to come back full circle to talk about brick with John Sanders, director of the National Brick Research Center, which is housed at Clemson University in South Carolina."
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> (music)

SECTION 1

De Guire: "How did you get interested in brick and other clay-based construction materials?"

Sanders: "Well, I don't really have like a lightning bolt moment, but I was always interested in inorganic materials. I really enjoyed that in high school chemistry, and I sort of stumbled into ceramic engineering at Clemson after I found out that chemical engineering was mostly organic based.

I also needed money as a sophomore. So, I went around to the professors' doors looking for a job, and Dr. Gilbert Robinson and Dr. Denis Brosnan actually hired me. And Dr. Robinson actually started the ceramic engineering department at Clemson in 1946. And he'd retired as department chair, but he was still very active with his industrial base that he'd always worked with.

So, I was really, I really got involved in working with the manufacturers and working on my studies. I really ended up enjoying it and ended up staying for a master's and a Ph.D. So, my master's is in material science, but my B.S. and my Ph.D. are in ceramic engineering."

De Guire: "Great. And I'm curious, what was your Ph.D. thesis about?"

Sanders: "Well, at the time, maximum achievable control technology related to emissions from kilns was a very hot topic. The Clean Air Act had been introduced in the early '90s, and this was, you know, coming into compliance with those rules that had been established. So, my master's was actually on fluorine emissions from clays and how to capture and control those. And then, in a related manner, my Ph.D. was on sulfur emissions, which you know, depending on where you are in the country, raw materials contain some pyrite or some gypsum, and some of the sulfur gases come off during firing, and you have to have control technology to maintain air quality. So, you know, I just happened to be in the right place at the right time."

De Guire: "Right. And actually, that's really pretty interesting because sustainability is coming around again as a really key driver for new technologies and manufacturing. So, really, you were at the leading edge of that and kind of ideally positioned to start addressing that again."

Sanders: "We absolutely are. You're very correct in that, yeah."

De Guire: "Most people have a picture in their mind of what a brick is, but how does the National Brick Research Center define brick? And what are the main types of brick, in terms of compositions, various applications, and so forth?"

Sanders: "Bricks are made from natural clays and shales. Originally, in colonial times, typically the clays and shales were mined on the site where you were going to build a building. And you made the product and you fired it and then you built the building and then you covered up the pit where you took the materials [from]. Obviously, we're a little more sophisticated than that now. But being that these are natural materials, and, you know, we've got a big country, and the geology varies a lot around the country, it could be quite a bit of variability in those raw materials from place to place. And that's something that makes brick a little more challenging than other materials. You know, if I'm a civil engineer and I want to go work with a particular alloy of steel, I can go look up in a book what its properties are. Clays and shales aren't quite like that. We have to do a little more work to understand what we're getting and then how to make a good product out of them. So, that's answering part of your question. Where the raw materials come from. So, natural materials.

Typically, we think of a modular sort of rectangular product with some holes in it. That's how we make brick in this country. It's not how bricks are made in most of the rest of the world, and we can talk about that probably a little bit more later. But we use brick here mostly for a veneer. They're used for residential housing, and they're the outer building

envelope. They're not structural. They don't carry the load of the roof. But they're sort of a screen [that] protects you from the outside world. And we know that these products last for potentially millennia because, you know, our historical record tells us that. We don't take full advantage of that the way we build in this country. And hopefully, as we focus more on sustainability, we're going to go in the direction that the way other parts of the world use brick."

De Guire: "So, other parts of the world use brick as a structural material."

Sanders: "Exactly, yes. They use it as both a structural material, as your thermal barrier around your house, and it's fireproof because it's already been to a very high temperature. It is impact resistant. If you live in an area with hurricane activity or tornado activity, it's really the material you want to be in. I don't know if you've ever seen any impact tests. We've done some, and it's scary whether you have vinyl siding or other less expensive cladding materials on your house. It's scary how easy those can be penetrated.

We actually did a series of tests, and it's on YouTube, where we were doing 2x4 missile impact. And for fiber board or vinyl siding, the missile at 50 or 60 miles an hour penetrates right into the interior of the house. Brick, we shattered the 2x4s. We even, just to be funny, you know, the guys who are doing the test wanted to play some, and so we shot oranges. You can shoot an orange right through vinyl siding. As long as it doesn't hit the stud in the wall, it's going right through into the interior, through the dry wall and everything. When we hit the brick with the orange, it makes a really nice smell and you get a mist of the debris from the orange as it explodes.

So, for me, brick is the most durable, long-lasting product. It provides the highest level of life safety. And it's kind of a no brainer for me, but that's something we have to educate consumers about."

De Guire: "So, how is modern brickmaking different from the manufacturing processes that our friends in 1898 would have been using?"

Sanders: "Well, in those days, most bricks were molded or pressed. Some of the higher-end bricks were pressed. What's amazing is there are actually clubs out there where people collect those old bricks because every manufacturer, because they were pressing, they would stamp their name. And there's clubs that collect these. And there's an International Brick Collectors Association, I think, is the name. They have a website. And the people compete on how many types of old brick that they can find. But again, goes to show the durability of the product. But today we extrude, which allows for much higher manufacturing rates. So, it's a continuous process now, where things were much more of a batch process back then.

In the late 1880s, the kilns were periodic kilns, often called beehive kilns, where you started off with the kiln cold, you loaded the brick in, you sealed up the door, you heated it up, you waited for it to cool off, and then you unloaded it. So, there was a lot of thermal inefficiency from heating up the kiln and cooling it completely every time. But you

couldn't unload it while the bricks were hot. Now we use tunnel kilns, and tunnel kilns are basically, they're fixed-temperature zones and the brick move through those zones. So, you don't have that heat up, the loss from heating up the refractory and cooling off the refractory every time.

The last thing, modern [brick plants] are mostly robotic now. The robotic plants, you see very few people when you walk through. You know, a brick plant can be a hot place, especially near the kiln, and it's not work people generally want to do voluntarily, especially in a hot environment. But robots don't seem to mind. And that's the way it seems the industry is going."

De Guire: "Very interesting."

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SECTION 2

De Guire: "Can you tell us a little bit about the National Brick Research Center and how it got started and what its mission is?"

Sanders: "Sure. Well, originally, like I said, Dr. Robertson started the department in 1946. It's the ceramic engineering department just like Ohio State or Alfred or Missouri, Rolla. That department grew into a materials science department as most ceramic engineering departments ultimately did. But there was a desire to keep that industrial focus. And so, Dr. Robertson formed the National Brick—well, at the time it was called the Center for Engineering Ceramic Manufacturing—in 1987. And so it was within ceramic engineering, but it was becoming its own entity, and it eventually split off into its own entity.

And then sometime around 2000, it was renamed the National Brick Research Center because we were focused on brick. Originally the intent was to do all traditional ceramics, but other school specialized. You know, Alfred is the whiteware school, and Missouri, Rolla did more with refractories. So, clay brick kind of stayed with us. And that's where the National Park Research Center came from."

De Guire: "And is it supported through like industrial members?"

Sanders: "Exactly. So, we're kind of an oddball in the university. We're part of the College of Engineering and Applied Sciences here, but we are completely self-funded. So, we have our own building in an off-campus research facility, and we pay all the overhead on that through industrial sponsorships, testing services, and sponsored research."

De Guire: "Okay. So besides research, what other services and resources does the Center offer industry?"

Sanders: "Well, we offer educational services to our industrial sponsors. We do webinars, we do short courses. Our short courses have been going on since sometime in the early '70s, I

don't have an exact date on that. But we've been offering that continuously since then. We also have an annual Clemson Brick Forum. It'll be 69 this year. We've met continuously, with the exception of COVID-19, we had to meet virtually that year. But that meeting, the proceeds from that help us to equip and keep our lab up to date. So, we have some really nice equipment from that.

We can do everything from the raw material, everything you need for your raw material, thermal analysis, to look at any firing conditions or developing firing cycles, dealing with problems that happen in the kiln all the way through to certification on the finished product. So, we have ISO 17025 certification to do the ASTM test, and we produce product certifications. They go to architects or end users. So, sort of from the ground into the building, we do testing on all of that."

De Guire: "That sounds like a terrific resource for the industry."

Sanders: "That's what we try to be."

De Guire: "So, what are some of today's challenges, and what are some examples of current research activities that are happening at the National Brick Research Center? And are there any surprising applications that you guys are working on?"

Sanders: "You know, right now, you touched on it earlier. Sustainability, reducing carbon footprint, those are big things that are going on right now. Sustainability, the metrics around sustainability, in my opinion, and I'm not an expert on sustainability, are still being developed and understood. And so, making sure that we interpret the data properly, especially with respect to the lifecycle of the brick. We don't kind of fit in to the same categories as other materials because our products last so long. So, you know, we need to come up with a way to help educate people on that. And, you know, we're doing work on that. I mentioned the energy code work and the thermal simulations and the thermal testing we do. We are doing some fire testing and some impact testing. And again, it's all to help the manufacturers educate consumers on those benefits of brick.

To me, one of the big opportunities right now is reuse of recycled material in brick. And particularly the one I always preach about is glass. You know, a lot of cities take recycled glass and they don't have a home for it, and so it piles up and then they stop taking it. It's a beautiful material to use as an aggregate in brick. There's no reason with a good clay you couldn't make something 50, 60% recycled glass. So, the beauty of that, it's previously fired, so there are no emissions other than the fuel that it takes to heat it up. And you've got the potential of lowering your firing temperature. And you've got a high recycle content, which goes into the whole sustainability thing, and you're not taking as much raw material out of the ground.

You know, some of the things we're working on, if you go to a zero-energy house or a low-energy input house based on the multi layers of brick, you still have to do something about humidity. When we live in that house, we're breathing moisture out, and it could get

to the point where it's uncomfortable or possibly unhealthy if you're not circulating air with an HVAC system.

So, one of the ideas that we keep going with is using brick as a passive moisture management material. So, intentionally designing a brick that's very porous, that has a certain pore size distribution, so it would naturally absorb moisture. They do this some in Scandinavia with wood veneer. They do all kinds of studies, and different kinds of woods absorb moisture at different rates. But it's one thing to absorb it, but then you have to remove it from the interior. So, I've been working with some professors at Clemson who work with polymeric systems on developing basically a hydrophilic side and a hydrophobic side and sort of grading that through the pore structure. We make a passive pump for moisture. We still got a lot of work to do on that, but that's one of the ways we're looking.

And then I've got a senior design class now, and basically, we're geared toward brick, what can we do with these products. So, I've got one group working on making improved ceramic water filters that are basically bricks with certain pore characteristics that would be used in Third World countries to purify water. One making insulating brick using waste newspaper, and then one making adobe brick where they're trying to mimic what termites do when they build their mounds in Africa that last for a century or so. So, there's all kinds of interesting things we can do.

Bricks are also used as pavers. There's an artistic avenue you can go with brick and make all kinds of designs. Architects like to do that.

And then they're also used in harsh chemical environments. So, there's a class of chemical-resistant brick that are used wherever you're handling acids or other materials, other types of fluorine materials can't withstand. And the brick, pretty impervious to acid, and is used quite a bit for those kind of applications."

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BREAK

De Guire: "The American Ceramic Society's Structural Clay Products Division emphasizes the most efficient and economical ways to manufacture brick, pipe, red-body tile, and other structural clay products. This Division organizes its annual summertime meeting along with the ACerS Southwest Section and Clemson University's National Brick Research Center. Learn more about this Division at www.ceramics.org/scpd."

SECTION 3

De Guire: "So, what do you think are the future outlooks for the brick industry?"

Sanders: "Given that we've been around so long, I don't see that we're going away. The industry is losing wall share to less expensive material; that's been going on for a long time. So,

there has to be something there to deal with that. So, in the future, brick may not look like they look today. In the last 10 years, there's been a movement toward thin brick applications, where you're essentially using brick like a tile but you're producing it like a brick so you can get the texture and the characteristic appearance that you can't get with a tile that you press. So, there's a lot of movement in that direction. I'm not the biggest fan of that. I like the more structural. You know, if you're gonna make a brick, make a brick and use it like a brick, is sort of my philosophy. But I think we will be around for a long time. But I don't know that bricks are going to look like a little modular rectangular unit with a few holes in it. I'd like to see larger blocks that are highly cored. That's what's done in Europe now. The cores are set up so that you can stuff insulation in. They're designed to give not a straight path for heat flow. So, there's a lot of zigging and zagging for the heat to flow through the unit."

De Guire: "That's very interesting. In a global context, where would you say the biggest innovations for the brick technology are coming from?"

Sanders: "They're coming from Europe for the most part. Europe is ahead of us because they have more stringent energy requirements, not only from the housing side but also from the manufacturing. I'll say that the expected gas crisis because of the conflict in Ukraine has even sped that up more. A lot of the kiln manufacturers and things like that are based in Europe. We do have several in the U.S. and in Ohio, but a lot are international. We have all of those participate in that forum I was telling you about. So, we do try to exchange ideas.

And that's one of the things that is sort of unique about the brick industry. I've worked in the tile industry after I finished my degrees at Clemson. And then I went in the refractory industry, I actually lived in Pittsburgh. Those industries tend to be much more tight-lipped and there's less collaboration between manufacturers. Brick industry's an open book where you have competitors working together to solve a problem. That's what we do. That's why they fund us. And it's really nice, the camaraderie in the industry. It's unique from the other industries I've worked in."

De Guire: "How interesting! Because that's exactly how the Society got started, was competitors collaborating together to solve common problems.

Do you have any interesting stories from your work at the Center?"

Sanders: "Sure. I got a call one day from a police detective, and he was investigating a cold murder case. The story was, and this plant has been torn down, it's not there anymore. It was an old mom-and-pop brick plant. But supposedly the owner had disposed of his spouse by cremating her remains through the kiln and then added those ashes back to the brick and built a room on his house. And so they had the brick, and they wanted me to tell them if there were human remains.

So, I had to explain to him, 'Okay, you know, from the firing process, there's no genetic material left. Because if you cremated the person, and then you added the ashes, it's been

through the kiln twice. So, it's been up to 2,000 degrees roughly twice. Depending on how they doled those ashes out, whether it was all at once or a little bit over time, you know, that calcium and phosphorus that's left is just gonna kind of blend into the background. There, there's no trace, if you will.'

So, we did some testing, and they had some brick from the yard and some brick that they suspected had the remains, and we couldn't, there wasn't a statistically significant difference. So, we tried to help, but that was the strangest one I ever got."

De Guire: "That's pretty strange. I'd probably go to a paranormal specialist and find out was that addition haunted or not."

Sanders: "Right! So, I don't know if they ever got a conviction or anything, but we tried."

De Guire: "Wow! That is really quite a story."

Sanders: "Yeah."

De Guire: "Alright. Any final thoughts?"

Sanders: "No. I appreciate you doing this, and hopefully if somebody's interested in brick, they can go to our website, https://brickandtile.org, and my contact information is there. And I'd love to talk to them."

(music)

CONCLUSION

De Guire: "More than one hundred years since The American Ceramic Society began, ceramics have advanced far beyond what the original founders may have imagined. But brick remains an integral—and interesting—part of today's built world that is positioned to help support our sustainable future.

I'm Eileen De Guire, and this is Ceramic Tech Chat."

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"Visit our website at ceramics.org for this episode's show notes and to learn more about John Sanders and the National Brick Research Center. Ceramic Tech Chat is produced by Lisa McDonald and copyrighted by The American Ceramic Society.

Until next time, I'm Eileen De Guire, and thank you for joining us."